Regional Climate Change Initiative Republic of Cyprus

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Report of the Task Force on

The Built Environment

Eastern Mediterranean and Middle East Climate Change Initiative

Task Force Management Board

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Prof. Manfred Lange, Future Earth MENA Regional Center
Prof. George Artopoulos, The Cyprus Institute

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Editorial Review and Assistance

Ms. Ioanna Kyprianou, The Cyprus Institute
Dr. Stavroula Thravalou, The Cyprus Institute

Contents

Abbreviations vii

Executive summary ix

1 Scope 1

2 Geographic and socio-economic setting 3

2.1 Geographic setting 3

2.2 Socio-economic conditions 4

2.3 Consequences for the building sector 4

3 Overview of the building sector in the EMME region 7

3.1 Characteristics of the built environment 7

3.2 Problems affecting the built environment 29

3.3 Outlook and needs of the built environment 42

4 Policy landscape 44

4.1 International policies on climate change adaptation and mitigation 44

4.2 Policies and regulations in European countries 47

4.3 Policies and regulations in North Africa – Egypt 48

4.4 Policies and regulations in the Middle East 48

4.5 Policies and regulations in the Arabian Peninsula 54

4.6 Policies and regulations in Western Asia 63

4.7 Identified open gaps 66

5 Lessons learned and research directions 67
5.1 Integration and co-ordination of mitigation and adaptation measures 68
5.2 Regulatory inertia and carbon lock-in 69
5.3 New forms of co-ordinated management of city-regions 70
5.4 Alignment between the national and local levels on climate response 71
5.5 Institutional co-ordination in the development of climate responses 72
5.6 Moving forward with mitigation and adaptation strategies 73
5.7 Facilitating initiatives 77
6 Conclusions and good practices 81
6.1 Urban design, planning and sustainable development 83
6.2 Governance and policy integration 84
6.3 Economic support and access to finance. 85
6.4 Technology-enabled and data-driven communities 85
6.5 Resilient and equitable communities 86
References 87

Boxes

1 The case of peri-urban Greater Cairo 8
2 Tall buildings. 13
3 Greenhouse gas emissions from municipal solid waste 28
4 Exemplary waste disposal practices 29
5 Future Saudi Cities Programme 72
6 Eskişehir's building efficiency policies and projects. 75
7 Growth of informal settlements in Egypt 79
8 Informal settlements in Lebanon: The case of Beirut 80

Figures

1 Aerial view of Greater Cairo. 8

2 Urban and rural population distribution in the EMME region, 1960-2019. 12

3 Skyline in Doha, Qatar. 13

4 Total population and annual rate of population growth (top), and fraction of urban versus rural population (bottom) in the MENA region, 1971-2019. 16

5 CO_2 emissions per capita in EMME and world, 1971-2019.. .18

6 Carbon intensity in several countries in the EMME.. 19

7 Total final energy consumption by country. 19

8 Total final consumption by sector. 20

9 Solar PV generation (TWh) across the EMME region. 20

10 Energy intensity in the building sector in selected regions in the Sustainable Development Scenario, 2000-30. 21

11 Frequency of extreme heat anomalies during summer in recent and end-of-century periods. 22

12 Air Quality Index in selected cities, 27 November to 3 December 2020 23

13 Satellite picture taken on 1 April 2014, showing a desert dust storm affecting several countries in the EMME. 25

14 Per capita generation of MSW and C&D waste in selected countries of the EMME. 26

15 Composition of municipal solid waste in selected countries.. 27

16 Composition of MSW in the EMME region (average %). 27

17 Vulnerability map of countries in the EMME, November 2020. 32

18 Number of natural disasters in the EMME region, by disaster type (top) and by country (bottom), 1930-2020. 33

19 Estimated water scarcity in the Middle East and North Africa by 2050. 35

20 Building energy codes by country (top) and building energy certification adoption worldwide (bottom). 46

21 The Porter School of Environmental Studies building at Tel Aviv University. 49

22 Comparison of per capita CO_2 emissions in Bahrain, 1967-2013. 55

23 Monthly electricity consumption by sector, 2014. 56

24 Energy intensity in Iran and selected regions, 2010. 63

25 Characteristics of the Riyadh Metro Project covering metro and bus public transport. 72

26 The transformed urban area of Eskişehir, Turkey. 75

27 Urban population and proportion of slums in some Asian countries, 2001 77

28 Informal settlements in Cairo, Egypt. 79

29 Image of Syrian women and girls in an informal settlement in the Bekaa Valley, Lebanon. 80

Tables

1 Geographical and economic characteristics of countries in the EMME, 2018 6

2 Characteristics of buildings and populations in the Middle East 9

3 Average dwelling floor area in the EMME, by country 10

4 Predominant building materials used in construction in the Middle East. 11

5 Field experiment studies of the UHI phenomenon in EMME cities. 38

6 Typical features of mitigation and adaptation strategies 69

7 Urban population and slum proportion in selected countries, 2001. 78

Abbreviations

C&D	construction and demolition
CO_2	carbon dioxide
EMME	Eastern Mediterranean and Middle East
EU	European Union
GDP	gross domestic product
GHG	greenhouse gas
$GtCO_2eq/yr$	gigatonnes of carbon dioxide equivalent per year
HVAC	heating, ventilation and air conditioning
kWh	kilowatt hour
IPCC	Intergovernmental Panel on Climate Change
MENA	Middle East and North Africa
MSW	municipal solid waste
NO_2	nitrogen dioxide
O_3	ozone
PAHs	polycyclic aromatic hydrocarbons
PM	particulate matter
RCP	Representative Concentration Pathway
SDS	Sustainable Development Scenario
SLR	sea-level rise
SO_2	sulphur dioxide
UHI	urban heat island

Executive summary

This report summarises the existing knowledge on the climate-related risks facing the built environment of the Eastern Mediterranean and Middle East (EMME) region, now and in the future. The vulnerability of urban structures to climate change is determined both by the magnitude of climate impacts and the adaptability and exposure of a given site. The geography and morphology of individual cities of the EMME region renders them vulnerable to climate hazards, while social and economic circumstances determine their adaptability and, ultimately, their vulnerability. Because of such specificities, impacts of climate change can be characterized locally and must be tackled in each geographical context, in addition to internationally coordinated efforts aiming to reduce greenhouse gas (GHG) and mitigate climate change.

The built environment is the human-made setting for human activity (Roof and Oleru 2008). As a complex and tangled global system, with multiple scales ranging from buildings to neighbourhoods to cities (Pacific Institute for Climate Solutions 2020), it encompasses the great variety of places and spaces created or modified by people. These include green spaces; infrastructure like transport, energy transmission, water supply and sewerage networks; and public, residential, commercial and industrial buildings (Torgal et al. 2014). Buildings, in particular, are increasingly recognised as significant sources of both peak energy demand and GHG emissions.

In the race to transform current practices, local authorities can be catalysts of change. Backed by deep knowledge of the characteristics and needs of their communities, they are in a good position to design and implement adaptive actions in line with major international agreements such as the Paris Agreement, the New Urban Agenda, the 2030 Sustainable Development Goals of the United Nations and the Sendai Framework for Disaster Risk Reduction. Adaptive and mitigating actions at the city level would contribute significantly towards the fulfilment of these international commitments while improving local conditions for urban dwellers (Prieur-Richard et al. 2019). Yet insufficient resources, whether in terms of trained personnel or financial support, are holding local authorities back from meeting their potential, especially in relatively small cities and towns. Considering that more than two-thirds of the world's population is expected to inhabit urban centres by 2050, cities must be able to cope with an ever-increasing demand for services while at the same time mitigating the negative impacts of climate change.

In the Middle East, rapid population growth and urbanisation are expanding cities and suburban areas. Across the EMME region in general, shifts in population density towards urban centres and changes in lifestyle have been accompanied by heedless land use, unplanned urban development, increased consumerism and energy consumption, along with higher GHG emissions. Traditionally, the EMME region has played a small part in global emissions; should current trends continue, this is likely to change. Sustainable development strategies are urgently needed in the EMME, across the built environment and in the construction industry in particular (Middle East Institute 2011).

Cities offer fertile ground for the innovation needed to tackle the problems of both today and yesterday. Urban centres have the capacity to facilitate various forms of interaction. Here, social relationships can grow, cultivated by economic and cultural services and products of many kinds. Moreover, cities are home to a diverse range of innovation agents, from researchers to private companies, regional authorities and civic organisations (Vandecasteele et al. 2019).

Innovation holds promise for both sustainable development and the mitigation of climate change. While synergistic relationships between researchers and relevant stakeholders are furthering knowledge, public awareness and relevant policy across the EMME region, few tangible adaptive measures have been carried out. Robust resources, accessible and applicable at the local level, are needed to fully grasp current and projected climate threats. In particular, high-quality data are required for accurate vulnerability assessments.

It is particularly urgent that adaptive measures be implemented in urban centres. While in 1950 cities hosted about 30% of the world's population, today they host nearly 55%, and this share is projected to reach 70% by 2050 (Department of Economic and Social Affairs 2019). Moreover, being hubs of intense economic activity, urban centres are often marked by high financial indicators (Lavalle et al. 2017) and industrial clusters. Their adaptation to climate change is therefore essential in maintaining equilibrium of global economies. Indeed, urbanisation implies economic growth; about 80% of global GDP is generated in cities (Grübler and Fisk 2012), a share that is expected to grow. According to a survey conducted by the World Economic Forum, the factor associated to highest risk to the economy in 2019 and the second highest risk for the next decade is the inadequate action in terms of climate change mitigation and adaptation. In fact, the *Global Risks Report* of the forum specifically estimates that extreme weather of the changing climate is associated to the highest economic threats we have to face (WEF 2021). The possibility of any localised or widespread economic collapse highlights the urgency of creating resilient urban environments; this is reflected in international agreements, frameworks and policies, such as the United Nations 2030 Agenda for Sustainable Development (UN 2015b).

Adaptation in the EMME context, especially in urban settings, has arguably started taking place. However, an evaluation of current adaptation strategies across the region suggests that progress varies by country (UNEP 2018). This report considers that variation, while providing an analysis of existing adaptation efforts of regional authorities occurring in cities of the region.

1. Scope

If the current trend continues, by 2050, cities will contain approximately 70% of the world's population (Department of Economic and Social Affairs 2019) and produce more than 85% of global economic output (Hawksworth, Audino, and Clarry 2017). The Eastern Mediterranean and Middle East (EMME) region is characterised by a growing population and intense urbanisation, which are challenging its social and environmental capacity. Several megacities, such as Cairo and Istanbul, are each home to more than 10 000 000 people. According to the Economic and Social Commission for Western Asia, more than 40% of the region's population can be classified as poor or vulnerable (Abu-Ismail 2018).

Yearly mean temperatures are 1.4°C higher than in the late 19th century, averaged across the region (Cramer et al. 2018), and the intensity, length and number of heatwaves have increased by a factor of 6-8 since the 1960s in the Eastern Mediterranean (Kuglitsch et al. 2010). J. Lelieveld et al.(J. Lelieveld et al. 2016) estimate that under certain climate scenarios, parts of the Mediterranean region will become uninhabitable by some species of the biosphere, including humans. Since 1985, the Mediterranean Sea has been warming by about 0.4°C (Nykjaer 2009) and rising by about 3 centimetres per decade (Tsimplis et al. 2013). Ozone and aerosol air quality limits are often exceeded, with photochemical episodes mainly occurring in summer (EEA 2018). These phenomena, as well as land-use changes, increasing pollution and compromised biodiversity, have aggravated several ongoing environmental problems. The Intergovernmental Panel on Climate Change (IPCC) and the World Meteorological Organisation have classified the EMME region as a global "climate hotspot" exceptionally vulnerable to climate change impacts (Giorgi 2006; Stocker et al. 2013).

In line with the global community, countries in the EMME recognise the urgent need to address regional and national climate change impacts, exhibiting willingness to comply with international commitments stipulated by the Paris Agreement (Horowitz 2016). The next step is to develop a regional action plan addressing the specific needs and challenges that countries are facing and outlining a pathway of adaptation and mitigation.

Building on a previous study (Prieur-Richard et al. 2019), this report outlines an evidence-based roadmap towards effective climate action implementation at the city level. As it considers how climate change will exacerbate the problems already faced by the region's built environment, it recommends actions and solutions that are economically viable and technologically mature. By providing urban policy makers with access to a comprehensive summary of regional knowledge and good practices, it seeks to support the transition towards sustainable cities.

The report thus aims to provide a solid framework for mitigation and adaptation planning in the EMME context. It draws on previous studies and intends to offer support to multiple stakeholders, ranging from national and local governmental bodies, urban planning professionals to private parties with vested interests, international and non-governmental organisations and civil society.

Chapter 2 summarises key geopolitical and socio-economic characteristics of the region, which together with climatic features will inform a structured response to the adverse effects of climate change. Chapter 3 aims at describing the main characteristics of the region's built environment (Section 3.1), highlighting its most critical problems (Section 3.2) and considering the future (Section 3.3). In Chapter 4, mitigation and adaptation strategies are briefly outlined. Next, the policy landscape is reconstructed in Chapter 5. Finally, in Chapter 6, lessons learnt and research initiatives are presented, and main conclusions are drawn in Chapter 7.

2. Geographic and socio-economic setting

2.1. Geographic setting

The EMME region is situated at the crossroads of three continents: Africa, Asia and Europe. It has shaped much of the developed world's cultural and socio-economic frameworks.

Politically, the EMME region comprises the following subregions and countries:[1]

- European Union (EU): Cyprus and Greece
- North Africa: Egypt
- Middle East: Israel, Jordan, Lebanon, Palestine, the Syrian Arab Republic and Turkey
- Arabian Peninsula: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE)
- Western Asia: Iran and Iraq

Geographically, the region, mostly classified as arid to semi-arid, comprises a wide variety of features, landscapes and vegetation covers, including:

- Extended mountain ranges, namely the Taurus, the Elburz and the Zagros mountains, and the Afro-Asian Rift valley;
- Extensive desert areas, particularly in Egypt and the Arabian Peninsula;
- Agriculturally utilised lowlands, for example, the Fertile Crescent between the Euphrates and Tigris rivers, known as Mesopotamia;
- Major rivers and their tributaries and floodplains, which allow for productive agriculture, particularly the Nile, Euphrates and Tigris rivers;
- Extensive coastlines along the Mediterranean Sea, Persian Gulf and Red Sea;
- Major urban areas, including the megacities of Cairo and Istanbul, with their larger metropolitan areas each with more than 20 and 15 million inhabitants respectively, and the city of Tehran, with nearly 9 million.

1. The names of the countries and their short names are written using the convention set by the United Nations Group of Experts on Geographical Names (UNGEGN, 2011).

The region's human geography is characterised by a significant split between urban and rural lifestyles and living conditions. Prosperity, both at the individual and national level, and economic performance differ starkly between those countries with significant hydrocarbon resources and those without. Other challenges include exponential population growth, intense urbanisation, the uneven allocation of rudimental resources such as water and high military spending amid chronic regional conflicts. Meanwhile, efforts at greater integration into the global economy often aggravate long-standing inequalities and create further downstream challenges.

2.2. Socio-economic conditions

After the long struggle endured in most countries of the region to gain independence from their colonial European rulers, the nationalist regimes that came to power tended to maintain significant control over their economies. In the 1960s, a common strategy to gain or maintain economic independence was introducing import-substituting industrialisation in an attempt to create industries and jobs locally, use local resources and allow governments to stop importing Western goods. In the face of inefficiencies in the production system and a heavy bureaucratic burden, this strategy was soon abandoned in favour of opening national economies to foreign investment.

In the early 20th century, long before independence from colonial rule, the discovery of vast oil deposits in the Middle East had coincided with increasing oil dependence in the West. New opportunities arose in the EMME region. Since then, the build-up of the oil industry has created enormous opportunities for development in countries where hydrocarbons are exploited, particularly in Bahrain, Iran, Iraq, Kuwait, Qatar, Saudi Arabia and the United Arab Emirates.

2.3. Consequences for the building sector

The socio-economic conditions described above affect, and are affected by, the buildings and other urban structures of the EMME region. While a review of the history of the region's architecture and buildings is beyond the scope of this section, we will briefly look at the challenges faced by the building sector, in particular those related to climate change.

The EMME region is one of the most vulnerable to climate change and already faces numerous environmental stresses. In the future, the availability of water and arable land is expected to diminish and air and soil pollution, degradation of ecosystems and loss of biodiversity are expected to escalate (Meir et al. 2012). Manifold downstream consequences are also anticipated, such as food and potable water scarcity, ultimately leading to social unrest and local conflicts, as has already been documented (Aw-Hassan et al. 2014; De Châtel 2014). In addition, the expected rapid increase of population and urban growth rates (discussed in Sub-section 3.1.2) will amplify these environmental stresses (Hungate and Koch 2015). Related challenges include:

- The proliferation of urban sprawl and the growth of illegal dwellings ("slums") in many of the large cities in the region;
- Increasing population and building density;
- A growing transport sector (including private cars, public transport and commercial vehicles) and its consequences for urban infrastructure and public health;
- The ever-increasing demand for energy and water among city inhabitants (see, e.g., Lange 2019).

Another major challenge lies in the stark differences in income, personal wealth and lifestyles between rural and urban populations in most countries of the region. This is exacerbated in countries that rely heavily on foreign labour. Disparities can be observed at the national level too, in terms of geographic and economic characteristics, observed in Table 1. For instance, in the country's richest country per capita, Qatar, gross domestic product (GDP) per person was 26 times higher in 2018 than in the poorest country per capita, Egypt.

All these issues must be seen in the light of ongoing and anticipated climate change. The enhanced warming resulting from the urban heat island (UHI) effect will lead to additional challenges in the built environment (e.g. Santamouris 2007).

As with the region's diverse socio-economic conditions, there are likely to be significant differences in the pathways taken towards the Paris Agreement's goals. An essential pre-requisite to progress is to enforce existing regulations and building standards and, at the same time, introduce new and appropriately designed measures to enhance the overall living conditions of people in the EMME region.

TABLE 1. Geographical and economic characteristics of countries in the EMME, 2018

Country	Area (km^2)	Population	Density (people per km^2)	Total GDP (USD)	GDP per capita (USD/person)
Bahrain	780	1 569 439	2 012	37 652 500 000	23 991
Cyprus	9 250	1 189 265	129	25 309 818 139	28 690
Egypt, Arab Rep.	1 001 450	98 423 595	99	249 712 999 437	2 537
Greece	131 960	10 732 882	83	218 138 367 209	20 324
Iran, Islamic Rep.	1 745 150	81 800 269	50	453 996 479 250	5 550
Iraq	435 052	38 433 600	89	224 228 010 474	5 834
Israel	22 070	8 882 800	410	370 587 977 126	41 720
Jordan	89 320	9 956 011	112	42 932 112 676	4 312
Kuwait	17 820	4 137 312	232	140 645 364 238	33 994
Lebanon	10 450	6 848 925	669	54 961 275 742	8 025
Oman	309 500	4 829 483	16	79 788 768 969	16 521
Palestine (West Bank and Gaza)	6 020	4 569 087	759	16 276 600 000	3 562
Qatar	11 490	2 781 677	242	183 334 953 813	65 908
Saudi Arabia	2 149 690	33 699 947	16	786 521 831 572	23 339
Syrian Arab Republic	185 180	16 906 283	92	n.a.	n.a.
Turkey	785 350	82 319 724	107	778 381 859 841	9 456
United Arab Emirates	98 648	9 630 959	136	422 215 043 585	43 839

Source: World Bank, (2021).

3. Overview of the building sector in the EMME region

Greenhouse gas (GHG) emissions are the triggers of climate change, and the built environment is one of the main emitting sectors and among the most exposed to several impacts of climate change. An increase in the EMME region's mean temperature is causing an increase in energy demand for space cooling, and the urban heat island (UHI) phenomenon will further exacerbate local temperatures. The modification of precipitation patterns, with an alternating occurrence of droughts and extreme rainfall, increases the risk of flooding and landslides. A consequent push to abandon both rural and coastal areas increases stress on the local food supply chain. Sea-level rise is also responsible for coastal flooding that causes a reduction of agricultural areas, the depletion of touristic potential and salinisation of water sources. The increased frequency and severity of extreme climate events are further aggravating these impacts and leads to disruptive patterns; infrastructure and services, financial sectors and livelihoods are not spared, often as a result of damaged supply networks for essential goods such as electricity and water. The resulting deterioration in human wellness places additional pressure on health and welfare systems, and, eventually, further pushes urbanisation with increased migration from rural and coastal areas to cities (Wilbanks et al. 2007).

In an effort to better understand climate-change-induced impacts on the built environment in the EMME region, first the built environment's main features are presented in Section 3.1 and then the major problems affecting it are discussed in Section 3.2. Finally, an outlook is drafted in Section 3.3.

3.1. Characteristics of the built environment

In this section, the main characteristics of the building stock in the EMME region are discussed, by country (Sub-section 3.1.1). Next, demographic growth and trends in urbanisation and city development are presented (Sub-section 3.1.2). Some figures about GHG emissions and energy consumption are summarised to describe the recent trends and a projection of energy intensity per country in the Sustainable Development Scenario (SDS) (Sub-section 3.1.3). Finally, the region's environmental quality is discussed with an overview of waste management (Sub-section 3.1.4).

Box 1. The case of peri-urban Greater Cairo

The geography and historical development of the Greater Cairo region make it one of the most unique sites in the world, largely due to the stark differences between publicly owned deserts and intensely cultivated rural agricultural land. For decades, the desert has accommodated various types of interests, including development for public housing, institutional needs and industrial use. Much of this has circumvented environmental regulations. Since taking advantage of vacant expanses of land is state sanctioned and formal urban development is inhibited, the rural fringes of Cairo are becoming more and more dense, filled with informal residential neighbourhoods. Thus, the peri-urban outskirts of Greater Cairo now host more than 20 million.

FIGURE 1. Aerial view of Greater Cairo.

Source: (Madbouly 2009); Wikimedia Commons.

3.1.1. Building stock

According to the United Nations, an urban agglomeration is broadly defined as "the built-up or densely populated area containing the city proper, suburbs and continuously settled commuter areas" (United Nations 1998, 2004). However, since the boundaries between urban and rural areas can be blurry, an exact universal definition cannot accurately encompass all urban agglomerations. For instance, several adjoining cities or towns and their suburban fringes may be contained in a single urban agglomeration (United Nations 2008). The EMME region is one of the most urbanised regions in the world, and most of its population is expected to be living in cities by 2050. Cities of this region share many characteristics, including shared heritage, traditional urban forms and socio-economic conditions, while retaining their unique features.

The EMME region's building stock is in many cases characterised by a "dual-city" construct, whereby a stone-walled medieval city co-exists with the high-rises and malls of a new downtown. The traditional model of the Islamic city shares similarities with medieval European cities, including some economic factors and social aspects (Abu-Lughod 1987). Contemporary politics also decide the urban fabric. For instance, ongoing conflict in Baghdad and Beirut would make the cohesive planning models seen in Dubai and Doha difficult. Across the region, new centres are putting pressure on the urban form of historical cities. In sum, the building stock of urban centres in the EMME is highly diverse, both within and between cities.

The Middle East's approximately 15 million buildings correspond to more than 21 million dwellings; about 80% of these buildings are located in Saudi Arabia, Iraq, Yemen and the Syrian Arab Republic (Dabbeek and Silva 2020), as observed in Table 2. Around two-thirds of the population in the Middle East live in urban centres, though this ratio varies significantly at the country level. One example of intense polarisation between urban and rural regions can be found in Jordan, where 90% of the population is settled in urban centres.

TABLE 2. Characteristics of buildings and populations in the Middle East

Country	Dwellings (residential) (thousand)	Buildings (non-residential) (thousand)	Rural population (thousand)	Urban population (thousand)
Bahrain[1]	203	132	174	1 467
Cyprus[2,3]	644	38	394	800
Egypt[2]	26 500	-	57 492	42 896
Greece[2,3]	9 909	78	2 209	8 508
Iran[2]	-	-	20 404	62 510
Iraq[1,2]	5 350	4 466	11 526	27 783
Jordan[1,2]	1 139	659	889	9 213
Kuwait[1,2]	294	153	2	4 207
Lebanon[1,2]	861	413	771	6 085
Oman[1,2]	551	381	724	4 251
Palestine[1,2]	748	395	1 104	3 581
Qatar[1,2]	280	145	23	2 809
Saudi Arabia[1,2]	4 682	2 980	5 461	28 808
Syrian Arab Republic[1,2]	3 673	2 246	7 712	9 358
Turkey[2]	-	-	20 332	63 098
United Arab Emirates[1,2]	1 176	715	1 291	8 480

Source: Modified from (Dabbeek and Silva 2020),1 (Worldbank 2021)2 and Eurostat (2001)3 for most recent years.

The average floor area of residential buildings in the EMME region is also presented in Table 3. In most cases, floor areas seem to be identical in the urban and rural regions of a country; however, this is likely due to a lack of data disaggregated by urban and rural area. Thus, information in this table should be considered as indicative estimations and not as exact representations of the region's building stock.

In the Middle East, almost the entire building stock (97%) consists of single- or double-storey buildings, and a basement is available in only 4% of residential buildings. In terms of building materials and construction practices, more than half of the building stock is constructed with reinforced concrete, and more than a third is built with masonry techniques. The rest of the building stock can be characterised as adobe and light wood frames. Over the past 30 years, tall buildings (over 150 metres [m]) are rising in number across the region. According to the Council of Tall Buildings and Urban Habitat (The Skyscraper Center 2020), 387 buildings 150 m or taller were under construction across the Middle East in 2018. In 2019, 37 were scheduled for completion, followed by 16 in 2020 and a further 16 in 2021. The predominant types of construction in the Middle East are described in Table 4. Tall buildings in the EMME region are the subject of Box 2.

TABLE 3. Average dwelling floor area in the EMME, by country

Country	Dwelling floor area (m^2)		Source
	Urban	Rural	
Bahrain	170	170	(Dabbeek and Silva 2020)
Cyprus	191	169	(MECIT 2017)
Egypt	90	65	(CAPMAS 2020)
Greece	85	85	(BSO 2020)
Iraq	120	120	(PADCO 2006)
Jordan	140	145	(Dabbeek and Silva 2020)
Kuwait	180	180	(Dabbeek and Silva 2020)
Lebanon	135	135	(Dabbeek and Silva 2020)
Oman	170	170	(Dabbeek and Silva 2020)
Palestine	130	115	(Dabbeek and Silva 2020)
Qatar	200	200	(Dabbeek and Silva 2020)
Saudi Arabia	250	250	(Dabbeek and Silva 2020)
Syrian Arab Republic	110	110	(Dabbeek and Silva 2020)
United Arab Emirates	200	200	(Dabbeek and Silva 2020)

Source: Modified from (Dabbeek and Silva 2020).

The contradictory landscapes of the Middle East's urban centres are further highlighted when a country's tall buildings are compared to its share of the region's population. For instance, while the United Arab Emirates represents just over 2% of the Middle East's population, it is accountable for over 60% of the region's tall buildings. In stark contrast, those countries accounting for more than 35% of the region's population have no tall buildings within their territories (CTBUH 2018).

TABLE 4. Predominant building materials used in construction in the Middle East

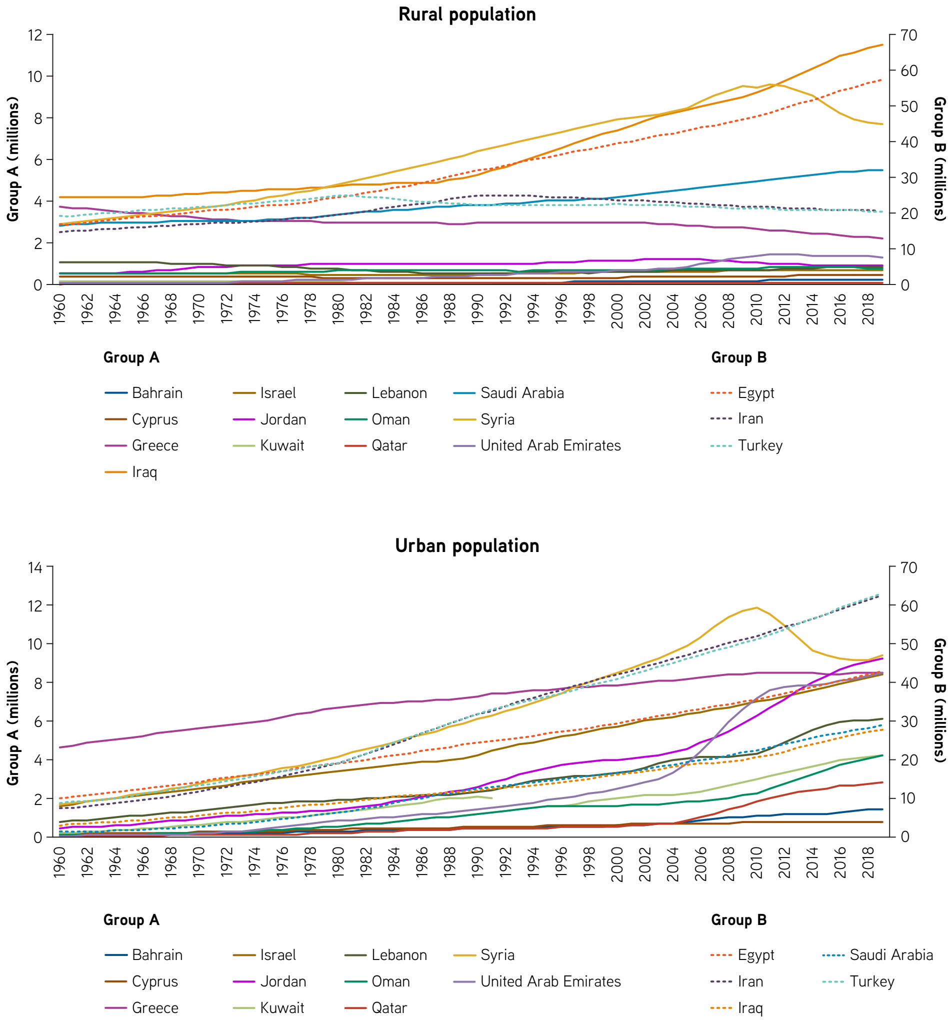
Country	Reinforced concrete (%)	Masonry-stone (%)	Masonry-concrete (%)	Adobe/ earthen (%)	Wood (%)	Other (%)
Bahrain	84	10	0	5	0	1
Egypt	66	11	15	8	0	0
Iraq	45	30	17	8	0	0
Jordan	58	28	10	4	0	0
Kuwait	69	10	10	6	0	5
Lebanon	51	23	18	8	0	0
Oman	63	19	4	5	0	9
Palestine	47	30	15	5	0	3
Qatar	85	10	0	0	0	5
Saudi Arabia	68	12	8	0	0	12
Syrian Arab Republic	44	26	15	10	5	0
United Arab Emirates	85	10	0	0	0	5

Source: Modified from (Dabbeek and Silva 2020), Attia and Wanas (2012) and Attia et al. (2012).

For example, building density maps of the Middle East reveal dense concentrations of buildings in urban centres, often accompanied by extensive plots of desert land that remain without construction. This indicates that populations are concentrated in specific locations, with rural areas remaining intact and uninhabited. Nevertheless, population statistics also reveal that urban populations are surpassed by rural populations, and by large margins in some cases. For instance, in Egypt, while both urban and rural populations increased over the period 1960-2019, the rate of increase in urban areas was much smaller than in rural localities (Figure 2). In 2019, more than 57 million people lived in rural Egypt, compared to almost 43 million living in urban centres.

Detailed information on building characteristics with comparable data across all countries in the EMME is lacking at present.

FIGURE 2. Urban and rural population distribution in the EMME region, 1960-2019.



Source: Data from the World Bank.

Note: Missing data for Kuwait are represented by a discontinuous line and countries with dotted lines are represented in the secondary axis due to very large-scale differences.

As for consumption patterns, the building sector of the Middle East in 2007 was responsible for 27% of final energy demand, a slightly smaller share than the global average at the time (31%) (D. Ürge-Vorsatz et al. 2012). Unfortunately, though generic information can be accessed from the International Energy Agency (IEA), no dedicated database exists for the building sector across the entire EMME region. Nevertheless, consolidated efforts have

Box 2. Tall buildings

Tall buildings have been around for hundreds of years, but once were confined to religious, royal or military purposes. As of the late 19th century, they have become ubiquitous and are reaching ever higher. The Council of Tall Buildings and Urban Habitat differentiates them as follows: tall <300 m, supertall ≥300 m and megatall ≥600 m.

FIGURE 3. Skyline in Doha, Qatar.

The Burj Khalifa in Dubai is the world's tallest building at present, with an architectural height of 828 m. It is likely that others will try and surpass this record. Protruding high above the urban fabric, very tall buildings are exposed to a different climate. In theory, the higher up one is, the lower the air temperature and the higher the wind velocity. However, a dense concentration of tall buildings manipulates air movement and solar radiation, so actual micro-climate conditions around them need to be assessed in each specific case.

Most tall office buildings and residential towers have fully glazed curtain wall envelopes. This makes them completely dependent on energy to ensure indoor thermal comfort. In sunny, warm climates, such dependency translates into vast amounts of electricity, and in turn greenhouse gas emissions. Also, their heating, ventilation and air conditioning design is not straightforward, since the climate changes with altitude climate (Tanya Saroglou et al. 2017; T. Saroglou et al. 2019; T. Saroglou, Theodosiou, and Meir 2020). Furthermore, they cast long shadows, and create specific and often problematic wind patterns around their base. They tend to be exceptionally vulnerable during extreme events that require rapid evacuation (fires, earthquakes, security-related events, etc.), have a heavy impact on their immediate surroundings and local infrastructure (traffic, water and sewage, power supply, services, etc.) and bring with them several socio-economic and behavioural handicaps, which need to be urgently addressed, if such buildings are to stay with us.

Source: (Choi et al. 2020); Wikimedia Commons.

recently been observed. For instance, the BUILD_ME project highlights key features of the building sector in three countries: Lebanon, Jordan and Egypt. According to its findings, final energy consumption in the building sector is highly variable, with Jordan consuming a mere 0.017 terawatt hours (TWh); Lebanon, 13.25 TWh and Egypt, 94.55 TWh (Build_ME 2021).

The density of urban centres has been a point of controversy, especially where intense development has been taking place without proper urban planning. For example, in Dubai, where the government or large private stakeholders control land development, there are distinct differences between areas inhabited by native residents (who are provided with land or housing in specific neighbourhoods) and the privately created and controlled high-end living environments of expatriate neighbourhoods. This divergence is regarded positively by policy makers of the region but negatively by native residents (Alawadi and Benkraouda 2019).

As a result of prioritising economic growth, little attention has been put on the quality or renovation rates of existing housing stock in the Middle East. In Kuwait, for example, the housing stock is built with little consideration for the local climate, resulting in voracious energy consumption patterns, particularly for residential air-conditioning systems (Jaffar, Oreszczyn, and Raslan 2014).

On an international level and following the UN Paris Agreement, countries of the Middle East have set Nationally Determined Contributions (NDCs) to improve the sustainability profile of their building sector (UN Environment and International Energy Agency 2017). For example, the Kingdom of Saudi Arabia and Yemen identify solar energy as part of their sustainable energy actions in buildings. The United Arab Emirates has expressed an intention to undertake comprehensive infrastructure investments in district cooling. Although these commitments are a positive development in achieving low-carbon and energy-efficient buildings, additional steps are required to promote the rollout of sustainable energy technologies in the construction sector:

- Capitalising on existing road maps and strategies for the deployment of high-efficiency products, low-carbon materials and a fossil-fuel phase-out, such as the Global Alliance for Buildings and Construction Roadmap (GlobalABC/IEA/UNEP 2020);
- Establishing clear-cut technological policy pathways, including capacity to track deployment and progress;

- Facilitating the collaboration of stakeholders and governance on the international, national and local levels, securing aligned objectives and commitment to targets;
- Working in tandem with partners and stakeholders to create a robust evidence-based atlas of sustainable solutions for buildings.

3.1.2. Urbanisation and development

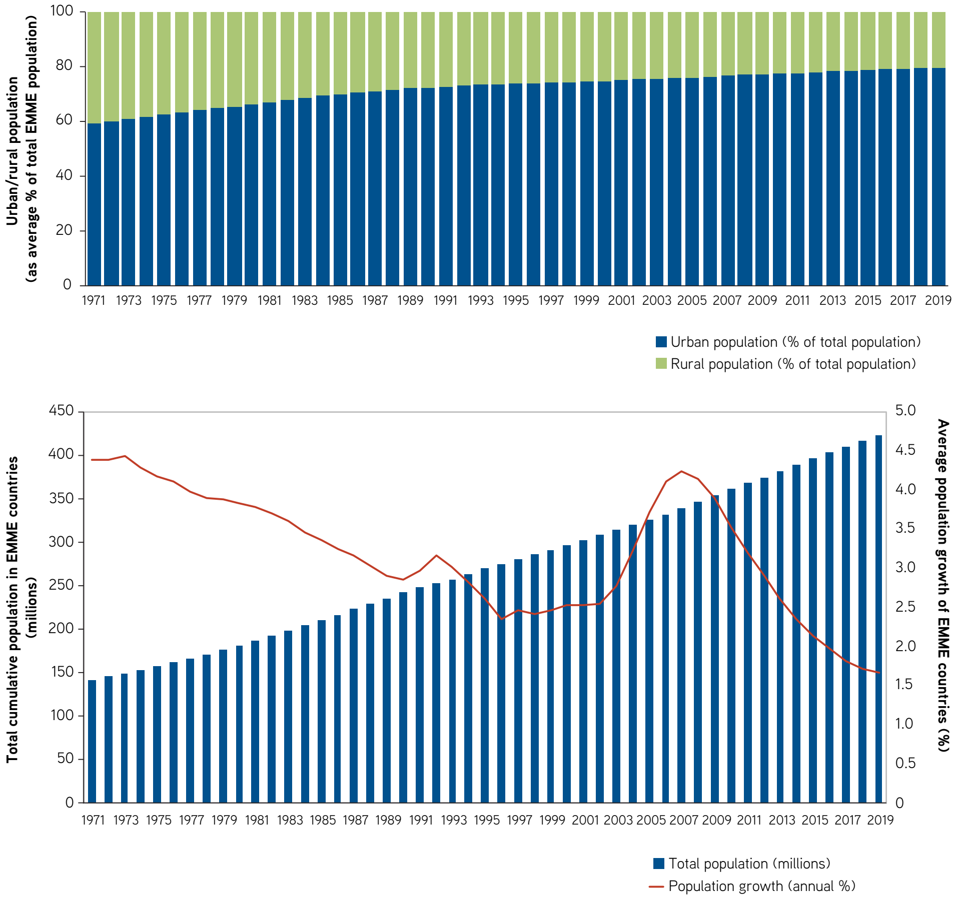
The EMME region is home to some of the oldest civilisations in the world. Thus, its built environment has gone through many periods of growth, development, transformation and decline throughout the centuries, illustrated by archaeological finds that go as far back as five millennia BC, and attracted study even from the 10th century (Elkabir 1983).

Economic and social development is often interlinked with some form of urbanisation, a process that is taking place at different scales and rates in different regions. Approximately 40% of the populations in Western Europe and the United States were living in urban centres by the end of the 20th century (Klein Goldewijk, Beusen, and Janssen 2010), versus only 16% in the Middle East (Bairoch 1988). The expansion of the industrial revolution played a part, as did increased trade in the seaport cities of the eastern and southern Mediterranean (Ibrahim 1975). Even as people moved from the rural to the urban regions of their countries, refugees from other countries were also relocating to cities (Ibrahim 1975). The city of Tel Aviv emerged from such a movement in 1909, and today it is the economic hub of the state of Israel even if its population growth has stabilised in recent years (Municipality of Tel Aviv-Yafo 2004).

Since 1990, the rate of urbanisation in the EMME region has been keeping in line with the overall average population growth rate of 2% (Ritchie and Roser 2018). Most countries are moderately to highly urbanised (e.g., Egypt 43%, Lebanon 87%) (UN-Habitat 2013). UAE function as city-states, with 80% of their population living in urban environments.

The region's uneven rates of urbanisation, briefly discussed above in relation to the building stock (see Sub-section 3.1.1), are examined in more detail in Figure 4. As observed earlier, in Egypt, urbanisation has been very slow, increasing from 31% in 1950 to a mere 43% in 2016 (Elgendy and Abaza 2020). Israel followed a linear trend with over 92% of its population living in urban areas over the past ten years (CBS 2021), while Jordan's urban population grew in spikes due to regional conflicts, also reaching more than 90% of its population in 2016 (Elgendy and Abaza 2020). On the contrary, the Gulf's coastal states were "born urban" due to their harsh and arid environments. Populations settled in oil-rich areas, and with the advent of desalination and air-conditioning technologies, small settlements rapidly grew into megacities.

FIGURE 4. Total population and annual rate of population growth (top), and fraction of urban versus rural population (bottom) in the MENA region, 1971-2019.



Source: Modified from (Worldbank 2021).

As a general observation, many first-tier cities[2] became expanded metropolitan areas (emerging mega-urban areas) (Figure 4). Such cities entail complex governance challenges at a regional scale due to the highly centralised government modalities they typically adopt.

The arrested development experienced in many EMME regions resulted in "urbanisation without urbanism": fast and profitable development went unmatched by appropriate improvements in residents' quality of life. Sustainability, too, was not ensured, as

2. Densely populated, highly developed urban metropolises that have high economic, cultural and political influence in their country and beyond.

densification occurred more rapidly than energy efficiency improvements, further exacerbating the disparity between the surge in urban population and the scarcity of resources and services.

The 30 most populated cities in the region fit into three categories:

- International cities, such as the Emirate city of Dubai;
- Hub cities, such as Amman, Beirut and Tel Aviv, which are incubators of new technologies and concepts, fuelled by entrepreneurs; and,
- Megacities, which have a significant influence on the region due to their population and economic drive. Cairo, Istanbul, Riyadh, Baghdad and Tehran together hosting 14% of the Middle East's population.

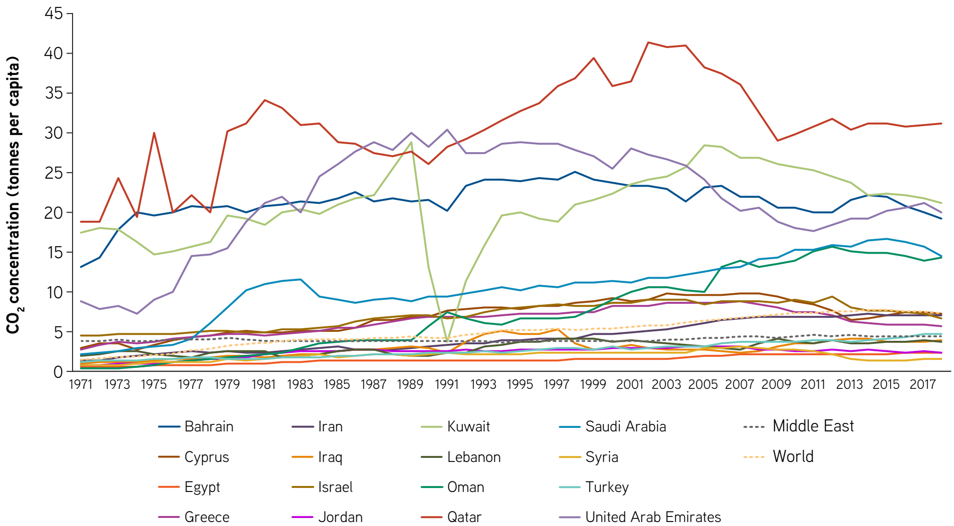
These cities act as secure nodes in a larger regional network of trade and innovation, bringing together local, regional and international key actors. By focusing on urban renewal and sustainability (in accord with the principles of a so-called smart city), new cities too can be developed as centres of innovation, research and technology (Leipzig Charter on Sustainable European Cities 2007).

3.1.3. Greenhouse gas emissions and energy consumption

To substantially reduce the risks and impacts of climate change, the Paris Agreement sets the goal of limiting global warming to below 2°C and pushes for efforts to contain the temperature increase below 1.5°C compared to pre-industrial levels. To achieve these goals, countries should significantly reduce their GHG emissions as soon as possible and aim to achieve climate neutrality by mid-century. Specifically, to limit the global temperature rise to 2°C relative to pre-industrial levels, the IPCC has estimated that GHG emissions should be reduced worldwide by about 25% with respect to 2010 levels, reaching 2.91 tonnes of carbon dioxide (tCO_2) per capita in 2030, and carbon neutrality should be reached by 2070 (IPCC 2018). Furthermore, to meet the 1.5°C global temperature rise goal, a GHG emissions reduction of about 45% is required by 2030. In other words, GHG emissions should be as low as 2.13 tCO_2 per capita in 2030, and carbon neutrality should be reached by 2050.

In the EMME region, some countries are characterised by emissions below the world average (4.79 tCO_2 in 2018). For example, Palestine (0.69 tCO_2 per capita), the Syrian Arab Republic (1.54 tCO_2), Egypt (2.59 tCO_2) and Jordan (2.60 tCO_2) are already below the target values of the Paris Agreement. Most countries, however, will require significant efforts to reduce their GHG emissions and reach their targets (Figure 5).

FIGURE 5. CO_2 emissions per capita in EMME and world, 1971-2019.



Source: IEAC (2020c).

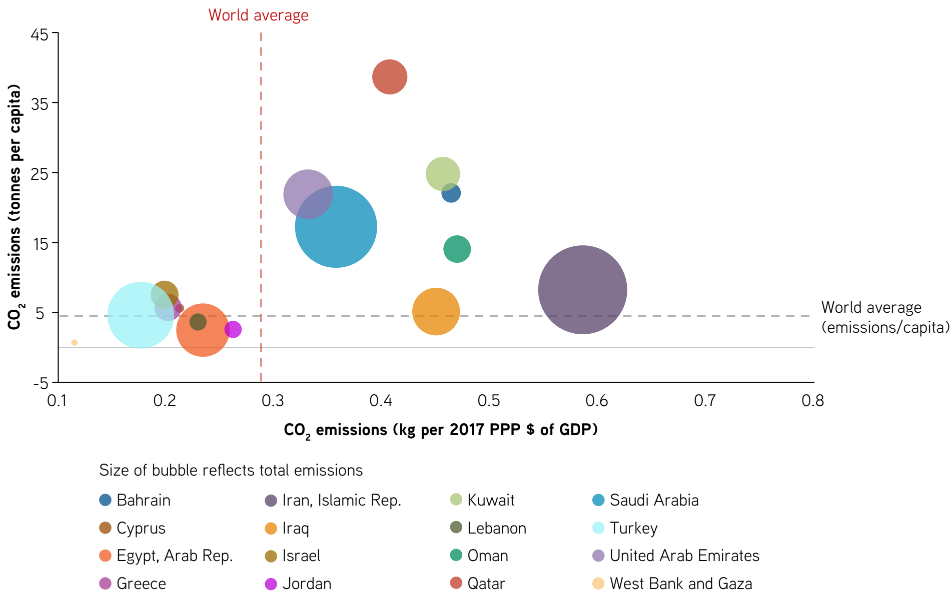
Recent statistical figures on per capita carbon emissions reveal certain trends (see Figure 6). Most countries with high emissions per capita also have high carbon intensity; these include the oil-rich countries of the Gulf region, such as Qatar, Saudi Arabia and the United Arab Emirates. Analogously, low-emitting countries of the conflict-ridden Middle East, such as Jordan, Lebanon and Palestine (West Bank and Gaza), are characterised by less-carbon-intense economies.

Excluding the Syrian Arab Republic since 2011 and Saudi Arabia after 2015, all the other countries are characterised by a structural increase (Figure 7).

Disaggregation of final energy consumption by sector shows a constant increase in all the most important sectors (Figure 8). The residential and commercial and building biodiversitys sectors tripled their consumption between 1990 and 2018, despite energy-saving measures adopted by most countries.

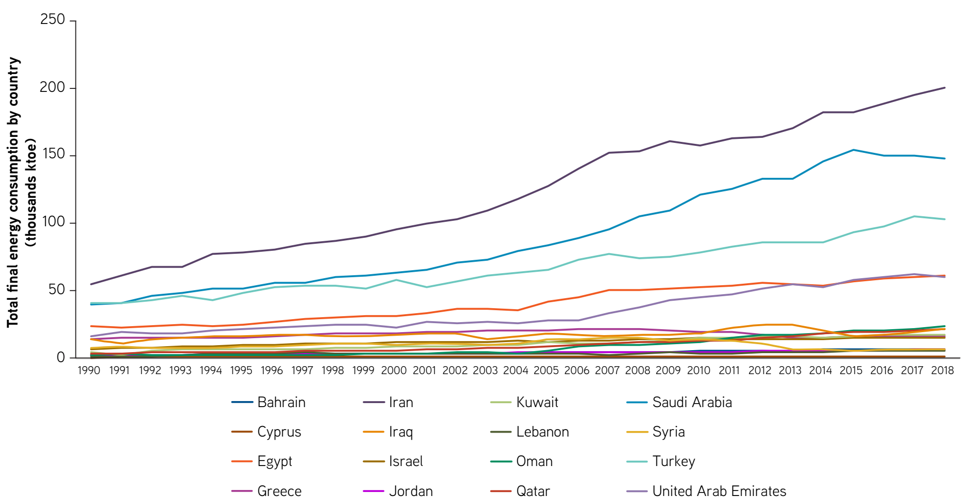
With clear skies for much of the year, many countries in the EMME region have embraced solar-powered technologies on a large scale. Solar photovoltaic (PV) generation has been exhibiting stable or increasing trends across the region (IEA 2020c). Cumulative electricity generation from solar PV exploded from less than 500 gigawatt hours (GWh) in 2010 to more than 17 000 GWh in 2018 as observed in Figure 9 (IRENA 2020). But there is room for more. In a recent study, (Khan, Asif, and Stach 2017) reported that PV integration in buildings had been largely ignored in Saudi Arabia, where it could generate up to 51 TWh, or 30% of domestic electricity demand.

FIGURE 6. Carbon intensity in several countries in the EMME.



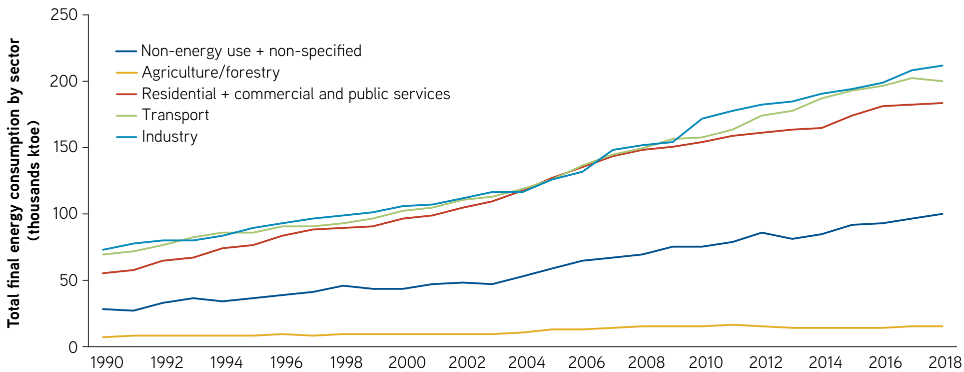
Source: Based on 2016 data from (Worldbank 2021).

FIGURE 7. Total final energy consumption by country.



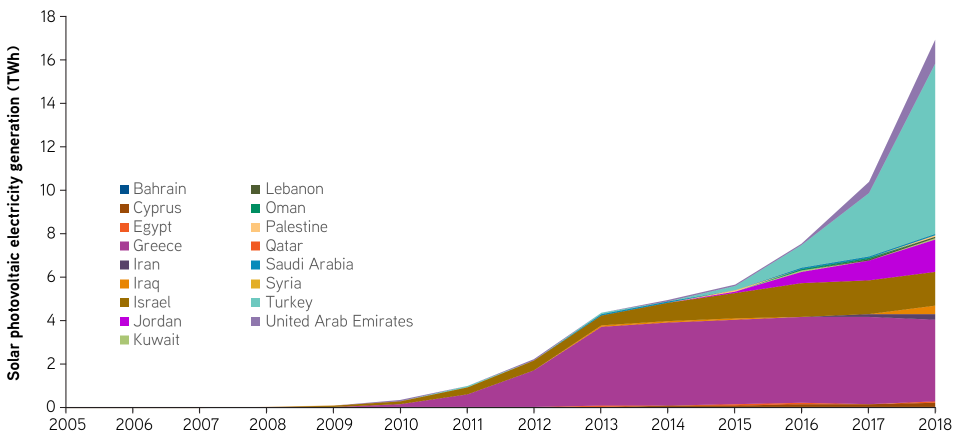
Source: (IEA 2020c).

FIGURE 8. Total final consumption by sector.



Source: Modified from (IEA 2020c).

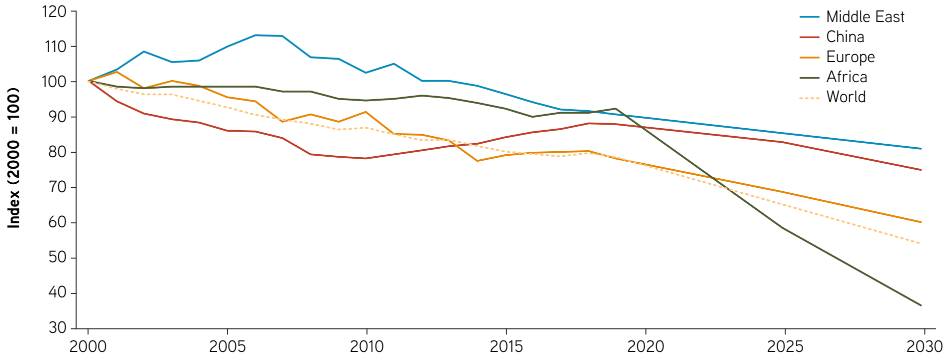
FIGURE 9. Solar PV generation (TWh) across the EMME region.



Source: (IRENA 2020).

The energy intensity (i.e. final energy use per square metre) of the building sector has been continuously decreasing, by 0.5% to 1.0% per year, since 2010. This is attributed mainly to energy-saving measures adopted by most countries (Figure 10). Unfortunately, this reduction rate is lower than the yearly growth rate of the gross floor area that is about 2.5% since 2010. This indicates an energy efficiency potential that is not yet exploited. The requirements of building energy codes are evolving slower than the rapid expansion of the built floor area in developing countries, and renovation rates are low in developed countries. In a similar manner, renewable energy systems, heat pumps and other efficient electric technologies are not replacing fossil-fuel-powered systems at an average global

FIGURE 10. Energy intensity in the building sector in selected regions in the Sustainable Development Scenario, 2000-30.



Source: (IEA 2020c).

level. To meet the objectives set by the SDS, it is expected that energy intensity should drop by more than 2.5% per year. Therefore, to achieve the Paris Agreement goals, more stringent building energy codes need to be developed and enforced through appropriate inspection procedures, deep energy renovations need to be firmly deployed and substantial improvements in the average seasonal performance of cooling and heating systems must be achieved, along with other energy conservation measures (IEA 2020d). Moreover, enforcement of existing building codes and the introduction of incentives are crucial to improve the performance of buildings, alongside awareness campaigns.

3.1.4. Environmental quality

The quality of life of a city's residents and visitors is highly dependent on the state of the urban habitat. The built environment can create welcoming conditions, or harmful ones. Creating the appropriate conditions to accommodate the needs of urban populations is becoming increasingly challenging, due to the often uncontrolled growth of cities, often at the expense of environmental quality. A long list of challenging tasks includes mitigating the amplification of climate change impacts in urban contexts, addressing the high loads of air and water pollutants, adapting to more frequent and extreme dust events and managing the growing amounts of solid and liquid waste sustainably.

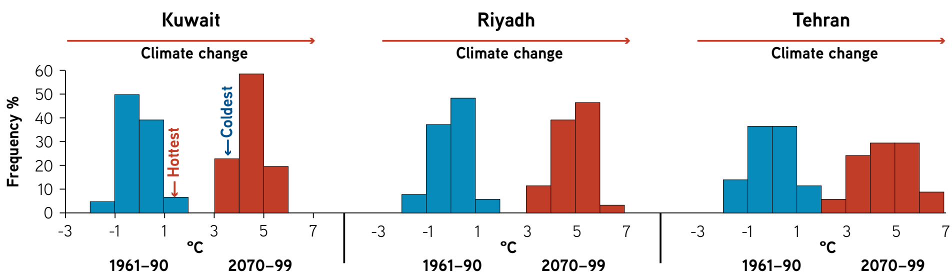
Next, we will briefly summarise the current knowledge on the environmental quality of cities in the EMME region. We will then consider the role of climate change as a driver of transformation. Finally, we will discuss the handling and management of waste in urban contexts.

Climate extremes and local effects

Ongoing and future changes in climate conditions will have numerous adverse effects on the EMME region in general, and on its cities in particular. This is largely due to the UHI effect, which exacerbates warming trends in urban settings (J. Lelieveld et al. 2014; Santamouris 2007).

The main impacts of this effect include a growing temperature of up to 3°C compared to the surrounding rural areas, extended heatwaves, greater water scarcity affecting inhabitants and green spaces, amplification of poor air quality and, in combination with atmospheric pollution, severe health risks for the urban population and the need for increased and extended periods of space cooling in private, commercial and municipal buildings. The increasing number, extent and magnitude of summer heatwaves pose particular challenges to life in major cities, especially those with high ambient pollution Figure 11. As can be seen, the projected coldest mean summer temperatures in the future are higher than the hottest mean summer temperatures in the reference period (1961-90). This will have significant adverse consequences for human health, particularly if the synergistic effects of heat and atmospheric pollutants are considered. As pointed out by Santamouris et al. (Santamouris 2007), the extreme heat in cities has significant adverse ecological consequences. For example, the greater need for water and energy in urban structures is inter-related and described by the water-energy nexus (Lange 2019). Greater water demand is increasingly satisfied through desalination, which is particularly energy intensive. The additional space cooling needed during hot spells requires more electricity – an increase only partly offset by the decrease in energy required for space heating during the warmer winter months (Giannakopoulos et al. 2009).

FIGURE 11. Frequency of extreme heat anomalies during summer in recent and end-of-century periods.



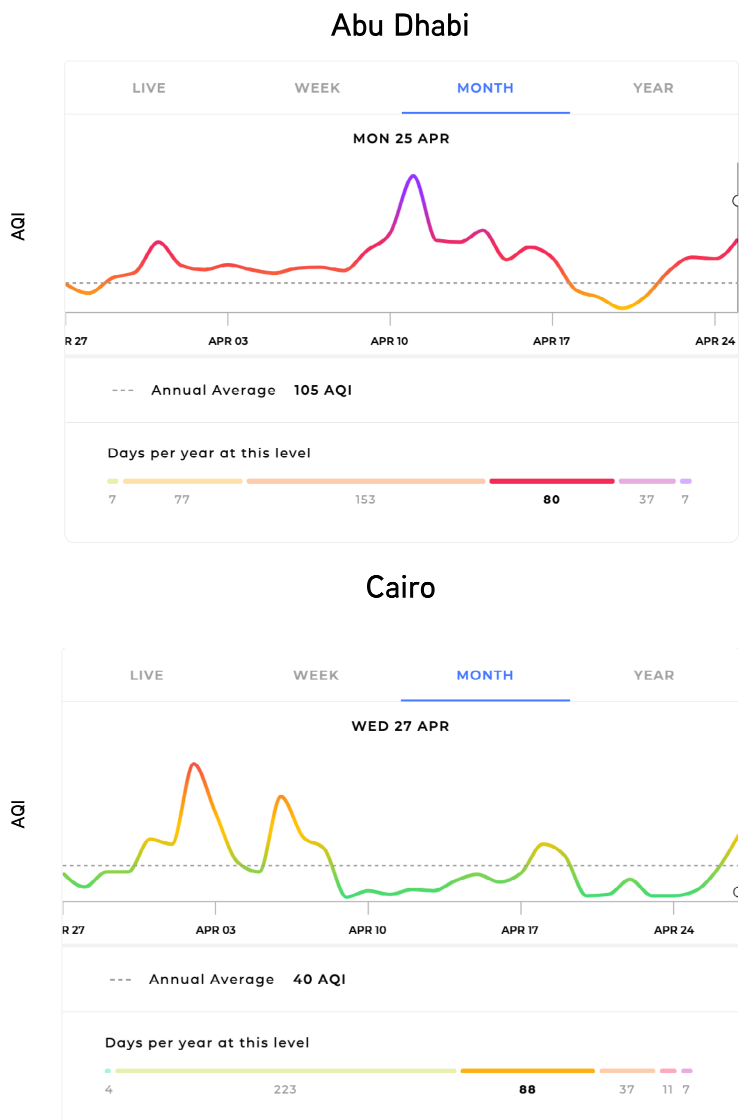
Source: J. (J. Lelieveld et al. 2014).

Note: Blue represents the reference period 1961-90 and red, the future period 2070-99, indicating that by the end of the century the coolest summers may be hotter than the hottest summers of the reference period.

Air quality in cities

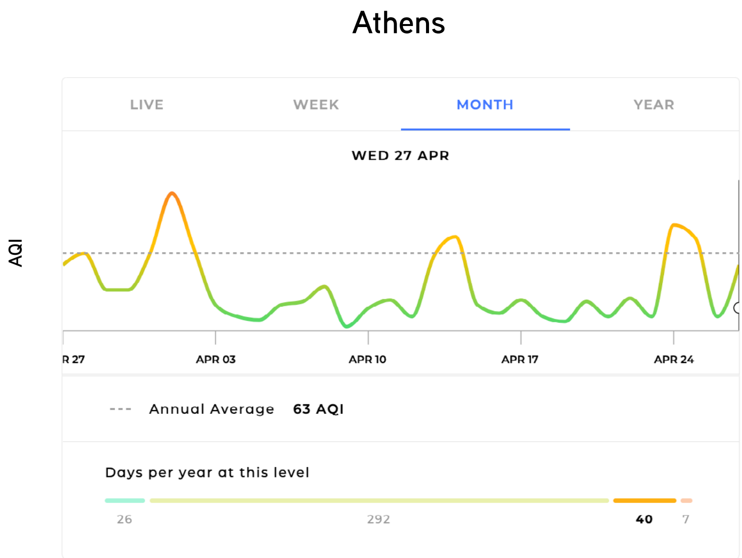
The massive increase of traffic emissions and the rising quantity of energy production from fossil resources have contributed to the ever-worsening air quality in cities of the EMME (see, e.g., Kanakidou et al. 2011). As shown in Figure 12, the Air Quality Index (AQI) in several of the region's capitals and main cities reaches high or very high values, with potentially serious health effects.

FIGURE 12. Air Quality Index in selected cities, 27 November to 3 December 2020



(continued)

FIGURE 12. Continued



Source: Modified after Plume Labs, https://air.plumelabs.com/en/.

Note: For more information on the AQI, see: https://air.plumelabs.com/learn/en/what-is-an-aqi.

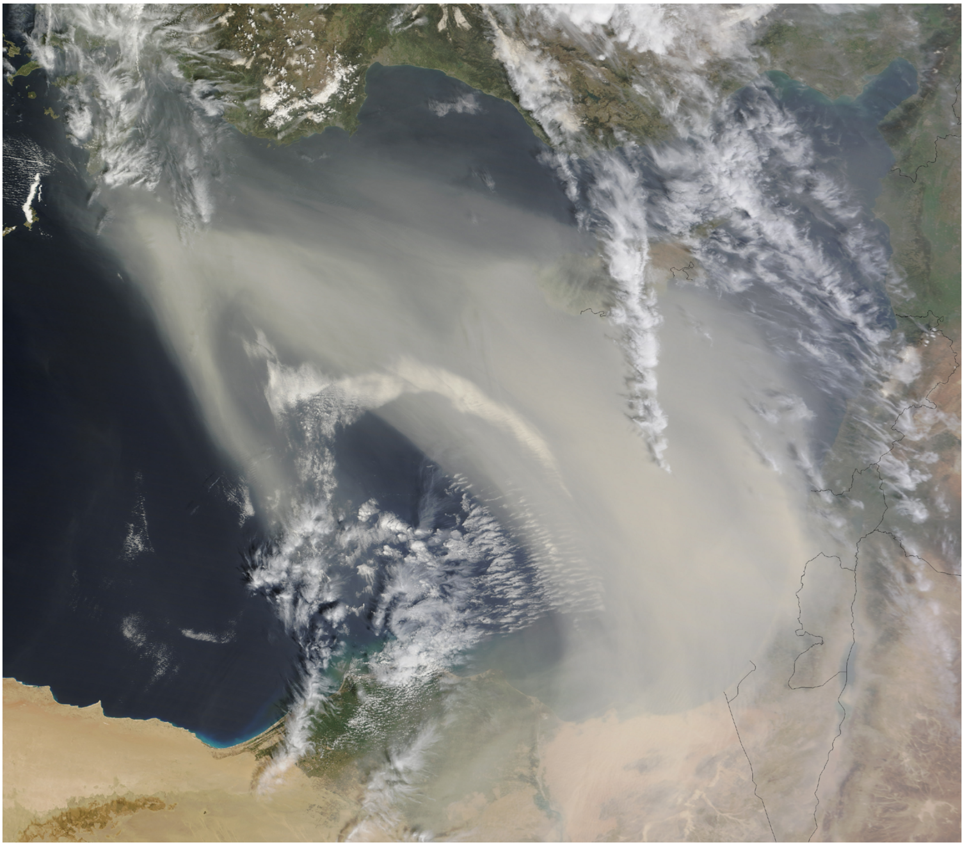
Long-term exposure to high ambient air pollution has significant health risks (Jos Lelieveld et al. 2019). Urban traffic is among the major sources of air pollutants in many countries in the EMME region (see, e.g., Waked, Afif, and Seigneur 2012). An ongoing increase in heat extremes and air pollution in regional cities has been demonstrated, for example, by (J. Lelieveld et al. 2014).

Due to the diminishing supply of water and deteriorating distribution infrastructure, water quality has been adversely affected in the studied countries (see, e.g., Kandeel 2019; Kenway et al. 2011; Shomar 2013). The challenges are exacerbated in many cases by internal and forced external migration (see, e.g., Nagabhatla and Fioret 2020).

Across the Middle East, North Africa and Eastern Mediterranean, dust travels from major deserts towards the north and east (Figure 13), thereby strongly affecting cities and their air quality. Furthermore, increasing aridity as a result of climate-induced change in precipitation patterns is expected to lead to a higher frequency and broader geographical spread of desert dust storms in the region (see, e.g., Al-Delaimy 2020).

It has been shown that dust storms and suspended bacteria and viruses pose severe threats to communities in the EMME region (Al-Delaimy 2020), and are likely to worsen

FIGURE 13. Satellite picture taken on 1 April 2014, showing a desert dust storm affecting several countries in the EMME.



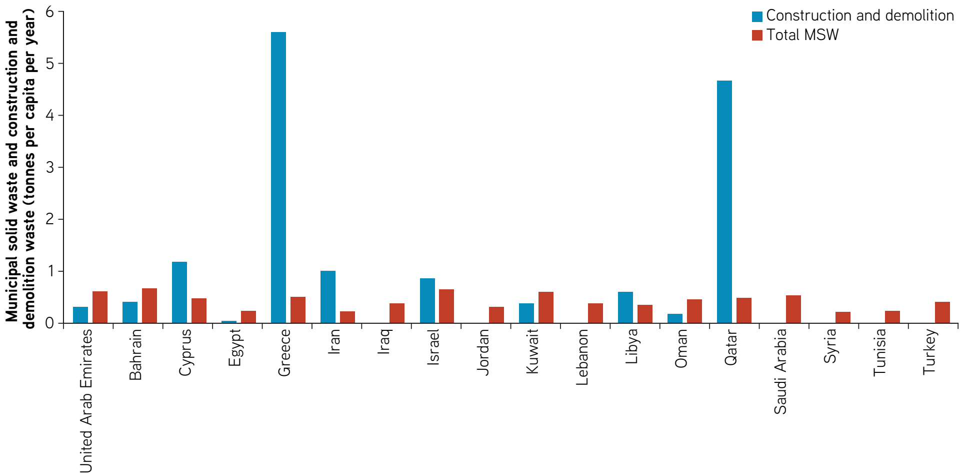
Source: NASA image by Jeff Schmaltz, LANCE/EOSDIS MODIS Rapid Response. https://earthobservatory.nasa.gov/images/80813/dust-over-the-eastern-mediterranean-sea.

due to ongoing climate change. In addition, the economic loss due to dust storms in the MENA region amounts to about USD 13 billion in GDP every year (UNEP 2016).

Handling and management of waste

The EMME region's high population growth and urbanisation rates, changes in lifestyle and economic expansion result in steadily increasing volumes of solid and liquid waste. The total waste generated – including municipal solid waste [MSW] and industrial, agricultural, medical and hazardous waste – is more than 370 million tonnes per year (MT/year) (The World Bank 2018). MSW production per capita ranges from 0.2 to 0.7 tonnes/year, with the highest rates in Bahrain and Saudi Arabia (17 MT in total), and the lowest in the United Arab Emirates (about 5 MT in total). Interestingly, Bahrain, which is the smallest country

FIGURE 14. Per capita generation of MSW and C&D waste in selected countries of the EMME.



in size and second smallest in terms of population, generates the most waste per capita, with an average yearly increase of 10% (Alsabbagh 2019).

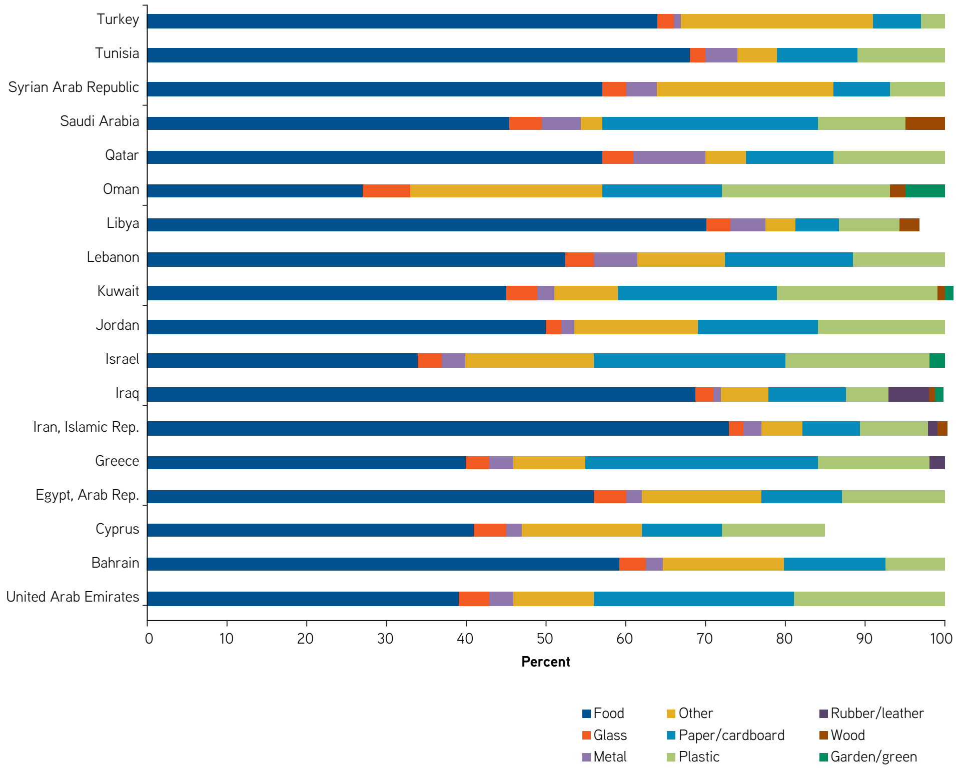
The construction and demolition (C&D) waste generated is double that of MSW, at approximately 170 MT/year, and the per capita share of C&D waste ranges from 4 to 22 tonnes/year (Figure 14). C&D waste is increasing eight times faster than MSW in both Greece and Qatar, which can be linked with the expansion of infrastructure in the two countries.

Through its Domestic Solid Waste Management Centre, Qatar started an initiative in 2015 to introduce the recycling of waste, including MSW and C&D waste. Under the Mesaieed project, 53 171 tonnes of waste were recycled, including timber, glass, plastic, metal and paper.

The composition of MSW consists primarily of organic/food waste (27-73%), of which Iran, Libya and Iraq are the top three generators in the region; and plastic waste (3-12%), of which Oman, Kuwait, the United Arab Emirates and Israel are the top four generators. The per capita share of paper waste is 6-29%, with Greece, the United Arab Emirates and Kuwait being at the top of the list. Smaller shares of metal, glass, wood, rubber and garden waste are also generated (Figure 15).

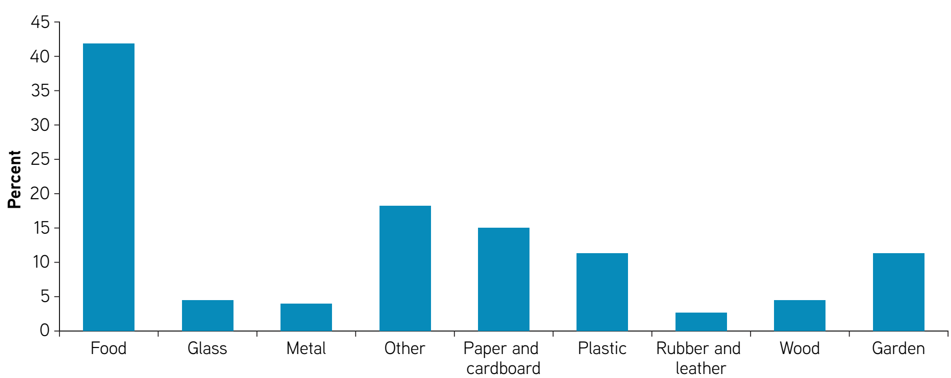
Organic waste is a particularly persistent problem in Cyprus, where intensive farming operations have increased the amount of animal waste to 60% of all bio-degradable waste. Animal waste management typically involves anaerobic decomposition, resulting in the uncontrolled release of GHGs (e.g. methane, nitrous oxide) and other compounds (e.g. ammonia) into the atmosphere (Lijó et al. 2018).

FIGURE 15. Composition of municipal solid waste in selected countries.



Given that food and other organic waste takes up such a large share of MSW (Figure 16), the region has a unique opportunity to convert a significant fraction of this waste to energy by modern conversion systems, such as anaerobic digestion, gasification and pyrolysis (e.g. (Zafar 2020).

FIGURE 16. Composition of MSW in the EMME region (average %).



Box 3. Greenhouse gas emissions from municipal solid waste

Comprehensive and accurate estimates of greenhouse gas (GHG) emissions from waste are becoming increasingly important to climate change mitigation programmes.

A lack of data on municipal solid waste (MSW) management practices and emissions in the region make accurate estimation difficult. For this report, GHG emissions were estimated using the GHG inventory software of the Intergovernmental Panel on Climate Change. First, the software calculates methane emissions, which are then translated into CO_2 equivalent emissions by considering the carbon content of each MSW component.

According to this analysis, average methane emissions in the region from waste amount to 94 778 million tonnes (MT)/year (3.9 kg per capita per year), which is equivalent to 81 kg of CO_2 per capita per year.

In recent years, the waste problem has been exacerbated by the rising number of camps housing displaced persons and refugees, especially in Turkey, Jordan and Lebanon. For example, in Lebanon alone, 15.7% of the country's total MSW generation can be traced back to refugee camps.

Waste collection

The collection and transport of waste from its source to the final disposal or treatment facility are two links in the waste chain that need to be addressed. Cities' infrastructure for managing collection and transportation will directly affect their carbon footprint. The collection of MSW is most often organised at a municipal level and amounts to about 40 MT/year with mean collection rates of about 76%, varying between 65% (Egypt), 85% (in Morocco), and 100% (Israel and Lebanon). In some countries, low collection rates are due to a disconnection between the public and private sectors (which manage some phases of the waste chain), compounded by the lack of an effective management system governed by legalisation and regulations.

Waste treatment and disposal

The simplest and most common method for waste treatment is to collect it in open dumps; a practice favoured in more than half the region. Over 80% of MSW in Egypt, 70% in Palestine, 60% in Algeria and Morocco, but only 13% in Lebanon and 0% in Israel are dumped in open pits. In Israel, 100% of MSW is treated with alternative methods, while in Egypt, Palestine, Jordan and Lebanon, this rate is 19%, 31%, 50% and 70%, respectively. On average, 31% of waste is dumped in sanitary landfills. Unmanaged waste burning is observed in some locales, with a negative impact on human health. Recycling and composting have remained at a relatively low, constant rate (<13-14%) in all countries (European Environmental Agency 2014).

Waste-to-energy solutions have also been introduced in some countries in the region. In Qatar, an energy station generates roughly 153 000 megawatts (MW) of electricity to run itself (making it energy autonomous) and the remaining electricity is fed into the public grid (Ministry of Development 2015). In Jordan an energy station generates 4 MW and there is a plan to increase this to around 40 MW.

Box 4. Exemplary waste disposal practices

Oman has 40 significant landfills. Between 2013 and the end of 2019, 31 large sites were closed and cleaned up in its governorates. At the same time, 23 new open traditional dumpsites, 10 engineered landfills, 14 transfer stations, 2 hazardous waste facilities and 3 health-care waste facilities were renovated.

Dumpsites that were slated for closure were prioritised using a risk analysis technique, with the impact on human health and the environment playing a key role in the decision.

Waste is collected and sorted at transfer stations across the country before being disposed of. These facilities act as staging locations for waste collection and stacking before being loaded onto larger vehicles and transported to landfills (be'ah 2019).

3.2. Problems affecting the built environment

Atmospheric GHG emissions are the main cause of global warming, a phenomenon which is triggering climate change, with manifold impacts. Temperatures and humidity rise, and so do temperature extremes, precipitation patterns (a prevalent decrease in precipitation and river flows) and sea levels. An increasing risk of droughts is induced, as well as loss of biodiversity, vector- and water-borne diseases and forest fires. These impacts are resulting in greater competition among different water applications, increasing demand for irrigation in agriculture, decreasing crop yields and an augmented risk for livestock production. These, in turn, prompt greater urbanisation, migration and population movement, with higher demands for cooling energy, and diminishing tourism patterns, which is an essential part of the economy for some countries of the EMME region. However, several barriers and factors influence cities' ability to decarbonise their building stock, adapt to climate change and mitigate urban vulnerability, energy poverty, UHIs and citizens' health issues.

A common issue is that of insufficient knowledge about climate change, as high quality, accurate information can be a major challenge for urban centres and regional governments. Even if data does exist, their acquisition by local authorities can be an additional hindrance. That is because while national agencies may collect and hold relevant intelligence, jurisdiction issues or unawareness of the existence of such evidence can lead to regional governments that are uninformed and incapable of action. Even when this barrier is surpassed, appropriately skilled scientific personnel is required to analyse and interpret data, producing findings and relevant suggestions (Climate Adaptation Partnership 2018). In addition, just having access to these data may not be enough to convince local actors with preconceptions on the subject. On the other hand, making this information available in the public domain can significantly improve public awareness and materialisation of relevant action by local authorities and citizens.

3.2.1. Urban vulnerability

Vulnerability is a complex phenomenon involving the interaction of numerous physical and social factors. It has been defined by Kyprianou et al. (2022) as "the state of any urban system – city, infrastructures, inhabitants, etc. – that expresses its sensitivity to the adverse effects of one or several external agents. It can be assessed by quantifying the degree of exposure and endurance with respect to environmental aspects, human aspects, urban habitat, technoeconomic aspects, and socioeconomic aspects". In the built environment, it refers to the potential harm a person is exposed to inside a specific urban setting due to, for example, noise, air pollution, excessive heat, energy poverty and monetary hardships, inappropriate urban infrastructure and poor urban design, gender discrimination or poor water management. Key expertise is required in urban planning, architecture, engineering, building science, climate and atmospheric science, human rights, medicine, policy and the economy, etc. to address the complex and multifaceted nature of urban vulnerability. Rapid urbanisation oftentimes has negative impacts as land of marginal quality (wetlands, swamps and floodplains, typically located at the borders of a city) are built up and expanded to create city infrastructure. Reconditioning and transforming those important natural systems can negatively affect water storage and lower the capacity of natural resources during extended periods of precipitation or drought.

The EMME region offers a unique environment for envisioning, testing and implementing strategies of urban resilience as a solution to its high degree of socio-spatial and physical vulnerability. The impact of environmental disasters, such as earthquakes and tsunamis, is amplified due to the high population density or socio-economic instability observed in the studied countries and communities. Climate-induced urban vulnerability is not only distributed unevenly across different countries, but even between and within cities. In general, low-income groups are at higher risk of experiencing environmental hazards in the built environment, due to greater physical exposure and a limited capacity to cope with the consequences of hazards (IPCC 2007). Also, low-income groups live in areas most at risk to extreme weather and deficient in the coverage or operation of basic urban infrastructure and local services. Indeed, local governance is intricately linked to urban vulnerability. An effective and broad provision of basic infrastructure and services can mitigate exposure to environmental risks for the entire population and increase equity between low-income and wealthier groups. These challenges generate the need for new strategies in the emerging field of urban resilience. Urban resilience is seen as a method – or model – that aims at reducing phenomena leading to urban vulnerability. Here, the term "resilience" refers to the ability of a given system, such as an urban planning structure, to adapt and respond to an external (environmental) or internal (organisational) disruption of its normal functioning. The response, in this case, may lead to the initial conditions of its operations or an upgraded set of operations. Today, these notions of adaptability and flexibility to potential disasters are considered by many countries that responded to the UN Agenda 2030. Israel, for instance, has produced its first Voluntary National Review that establishes the framework for responding to multiple aspects of urban vulnerability affecting its urban environment, one of the densest in the world. Among others, Israel proposed the notion of "urban renewal" as a strategy to increase the sustainable quality of its urban environment. To quantify the vulnerability of countries to the adverse effects of climate change, the Notre Dame Global Adaptation Initiative (ND-GAIN) developed a quantitative framework that estimates a country's exposure, sensibility and adaptation capacity by considering six sectors essential to life (food, water, health, ecosystem services, human habitat and infrastructure) (University of Notre Dame 2020). Figure 17 depicts countries' vulnerability to climate change and other global challenges, along with their readiness to improve resilience. The degree of vulnerability in EMME varies across countries, with the lowest value (i.e. least vulnerable) being 0.33 for Israel and the highest value (i.e. most vulnerable) being 0.46 for the Syrian Arab Republic.

Focusing on a local scale, natural hazards such as a rise in sea levels, dry spells, heatwaves and floods are expected to occur more frequently and with greater intensity, endangering cities in vulnerable geographic locations (Romero and Gnatz 2011). To properly address urban vulnerability and the adaptive capacity of urban centres, policy makers should not focus solely on hazards. Instead, a city should be considered from two distinct perspectives: as a whole, and as a sum of its parts. Following this approach, the development of a city is considered in its entirety alongside the individual determinants of adaptive capacity, within the context of the city's socio-demographic and economic sectors. Natural hazards and extreme events can destroy livelihoods, dwellings and businesses, as well as public infrastructure such as roads and bridges. Many of the world's largest urban centres are faced with harsh repercussions from such events because of their proximity to low-elevation coastal zones, where more frequent and more intense events would augment the destruction of public and private property. For instance, flood events in urban centres, which are expected to increase in frequency and severity, can be extremely destructive

FIGURE 17. Vulnerability map of countries in the EMME, November 2020.

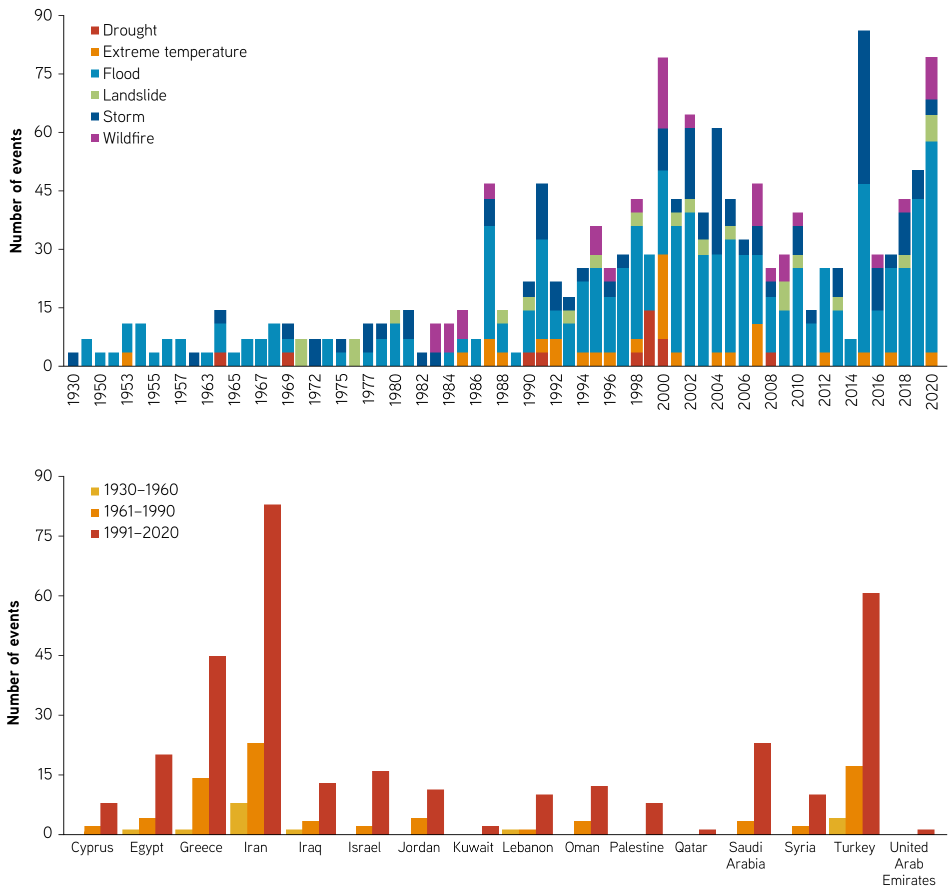
Source: Authors' compilation based on information from the ND-GAIN website.

and costly, both in terms of material and human health damages. If these challenges are not met by adaptive measures, the impacts of climate change can trickle down from the physical damages caused by flooding to the major costs of damage control, and consequently the disruption of livelihoods.

Of all urban centres, coastal ones are at high risk due to their exposure to the elements of nature. Historically, coastal sites developed as trading by sea and rivers led to the creation of economic hubs and cities. Their increasing industrial activity, local economic growth and wealth attracted rural and immigrant labour populations, ultimately fuelling uncontrolled development. Thus, many of the world's first urban centres developed without considering the risks of exposure associated with coastal areas.

The number of natural events occurring in the EMME region has been increasing over the past century as several of its large cities are located in high-risk areas (CRED/UCLouvain 2020). Figure 18 shows the number of events by disaster type for the period 1930-2020 (top); and by country during three periods: 1930-60, 1961-90 and 1990-2020 (bottom). Floods are the most common disaster in the EMME region, with Iran being the most affected. Well-documented events in most countries help identify the largest hazards for the EMME region as floods and storms. Droughts, heatwaves and wildfires have also been recorded since the end of the 20th century, phenomena that were poignantly absent in the last half of that century.

FIGURE 18. Number of natural disasters in the EMME region, by disaster type (top) and by country (bottom), 1930-2020.



Source: Author's compilation with data from (CRED/UCLouvain 2020).

Note: Biological, man-made and technological disasters were excluded, as well as earthquakes, since they are not directly linked to climate change.

Aside from their coastal location, exposure can be considerable within cities as well, due to poor urban planning. Zones already associated with hazards are witnessing continued expansion, and alteration to ecological areas includes removing layers of natural protection (UN Habitat 2011). When coastal communities reach wetlands, sand dunes and forested areas, the prospect of flooding is increased, and so are the associated destructive impacts upon infrastructure and services (Ruth and Gasper 2008). The impacts of climate change are especially harshly felt by residents of urban slums, which already have fragile infrastructures, further afflicted by global warming and hazard events.

Urban flooding

Short-lived, but intense, precipitation events in cities often leads to accumulated floodwater, causing urban flooding, as a result of greater inflow of rainwater in relation to the drainage capacity of a city's system. This happens when rainwater can neither permeate into the soil nor can it be carried away from the urban area. The reduced drainage capacity due to the increased coverage of urban areas with non-permeable surfaces (e.g. concrete and asphalt), the lack of urban water management infrastructure and the non-optimal maintenance of river beds (which can cause pluvial and river floods) are conditions that increase the risks of urban flooding, leading to substantial damages and dangers to local communities. According to the international disasters database, EM-DAT,[3] in the EMME region, Turkey is the most exposed country to flooding events with a total of 122 832 people affected between 2000 and 2010, followed by Iraq with 96 386 people, Saudi Arabia with 23 480 people, Lebanon with about 17 000 people and Egypt with 4 370 people. Physical damages and impacts on public health are further aggravated by the various downstream effects of flooding, such as faulty transmission and distribution of electricity, which may in turn disable transportation systems and sanitation facilities, accelerating the spread of waterborne diseases (Ruth and Rong 2006).

Coastal flooding and erosion

The absolute sea level has risen in all coastal areas, with variations across regions. Model projections estimate that sea levels will rise at a higher rate during the 21st century, relative to the period 1971-2015. The rise in sea levels is expected to reach over 1 m (high-emissions scenario), with some values higher at the regional level (IPCC 2019); some assessments even suggest that the upper bound range would be between 1.5 and 2.5 m (EEA 2020). Unless adequate adaptation measures are taken, this will increase coastal floods substantially. Coastal zones are an essential element of the EMME region's vibrant cultural heritage, as centres of historical importance are often found along the banks of the Mediterranean. Rising sea levels can contribute to saltwater intrusion into coastal aquifers,

3. https://public.emdat.be (accessed on 2 February 2021).

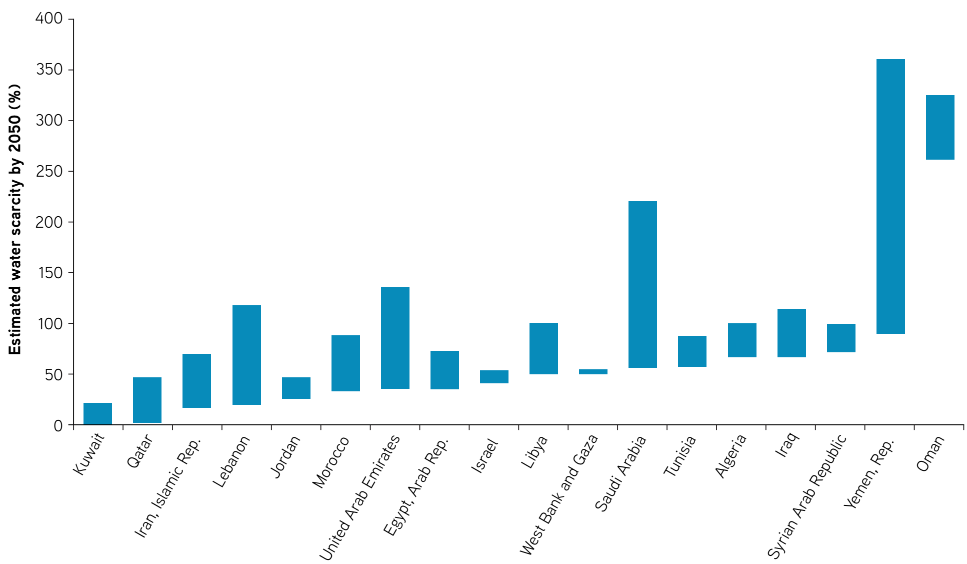
affecting fresh water supply for coastal cities. Flooding and storm surges can have physical and socio-economic repercussions on livelihoods, as well as cause destruction of natural habitats. According to projections from 2030 to 2050 (Bigio 2009), up to 25 million residents of Egypt's coastal cities, including Port Said and Alexandria, could be exposed to flooding as a result of increases in temperature and the subsequent rise in sea levels, with the poorly planned informal settlements around the Nile Delta being especially vulnerable.

Droughts and water scarcity

In general, the entire region faces water scarcity, with the MENA countries being described as the most water-stressed nations on earth (Hofste, Reig, and Schleifer 2019). The World Bank (Borgomeo et al. 2018) estimates that this will worsen in the years to come due to climate change (Figure 19).

In periods of intense heat, which occur every year during the extremely hot summers of the EMME region, water demands are higher. In addition to increased water needs of the public, the agriculture and tourism sectors are also major drains of water supplies. The combined effects of reduced precipitation and enhanced evapotranspiration lead to future projections of longer and more severe droughts for this region. Water demand across the EMME region has been steadily increasing in the past half of the century, especially due to population growth depleting renewable water resources per capita by more than half

FIGURE 19. Estimated water scarcity in the Middle East and North Africa by 2050.



Source: Reproduced from (Borgomeo et al. 2018).

overall across the MENA region (Roudi-Fahimi, Creel, and de Souza 2002). The over-exploitation of existing water resources, exacerbated during dry weather periods, has increased water scarcity. Furthermore, in urban areas, fewer quantities of water can infiltrate into the soil to replenish groundwater supplies. The wellbeing and livelihoods of residents of urban centres is endangered by extended periods of water shortage, as economic activities and lifestyles often require adjustments. When public water supply must be limited, residents of cities are not the only ones who have to conform to regulations; infrastructure essential to the city's functions are also dependent on water. For example, water is used to cool down power plants and ensure smooth operation and uninterrupted power supply.

Limited water supplies also cause disturbances in ecosystem services, impacting on the functioning of green infrastructure, as well as essential systems of cities such as sewerage networks. In times of drought, where water availability is reduced in the pipe system, the reduced water flow results in odour development (Sofoulis 2015) and higher, more corrosive concentrations of pollutants in wastewater discharges (Novický, Mrkvičková, and Kašpárek 2009).

In the island of Cyprus, where over thirty wastewater treatment plans manage a little over twenty million cubic metres of effluent water, treated wastewater is discharged into the sea. This practice is expected to change, increasing the amount of greywater that is used for alternative purposes, such as farming and tourism facilities (e.g. golf courses) and closing the cycle of water use in the urban context. All urban wastewater should be re-directed to services such as irrigation of green urban spaces and replenishment of groundwater reserves. In fact, a coastal city of Cyprus (Limassol), has already began the transition to a more sustainable urban drainage system, employing retention ponds with a large capacity to replenish urban water supplies and at the same time protect against flooding events (Papadaskalopoulou et al. 2015; Nicos Neocleous 2018).

Wind and dust storms

High variability has been observed in the spatial distribution, frequency and severity of windstorms during the 20th century (EEA 2017), with more extreme events being recorded in a period spanning the end of the 20th century and beginning of the 21st (1986-2016) (Spinoni et al. 2020). Windstorm impacts have been especially damaging for coastal cities (Koks and Haer 2020), something which increases cities' exposure to wind hazards, given the concentration of urban environments in coastal areas. Research on the reported damage resulting from windstorms has shown that due to urbanization and transformation of cities into hubs of economic activity, valuable assets and people are now concentrated in cities. Reported damages of windstorms have therefore likely increased due to the concentration of population in urban centres, as well as high-value assets (Spinoni et al. 2020).

The built environment has a role in the shaping of wind patterns in urban centres, as densely built tall structures can create wind tunnels where wind velocity is higher than other parts of the city. This type of urban development, with areas populated by tall buildings, leads to overall lower wind pressure, but higher fluctuations and exposure for certain elements, such as cladding, to natural hazards (Elshaer, Bitsuamlak, and El Damatty 2017). Windstorms and increased precipitation consequently result in lower durability of building facades, with green urban infrastructure being more exposed than rural counterparts, due to a range of existing stressors (e.g. poor air and soil quality) and higher fluctuations not met in sparsely populated areas (Lopes et al. 2009).

3.2.2. Local climate change and the urban heat island

The rapid urbanisation in the past century has far-reaching consequences for sustainability and has profoundly changed the ambient urban environment and everyday activities. At this time, there are more than 25 megacities, each with over 10 million inhabitants (National Geographic Society 2021), and more than 460 cities each inhabited by 1-5 million people (UN 2018a), while the urban population is growing at a rate of 1.5% per year. The UHI phenomenon alters the local urban climate, which is observed to be warmer than the non-urbanised, rural areas surrounding it. Although urban heat can be extreme during the day in built-up centres of the EMME region, it has been estimated that the intensity of the UHI effect is significantly higher during the night than during daytime (Giannaros and Melas 2012).

Under global climate change, the UHI phenomenon intensifies the expected mean temperature rise in urban environments. To determine and design local mitigation and adaptation strategies in the face of climate change, it is important to be aware that the phenomenon depends on several factors such as regional meteorology, topography, urban morphology, land use and population. Furthermore, there is no standard protocol that exists to measure the UHI effect, that is, the temperature difference between the urban core and its surrounding rural areas, which prevents direct comparisons among different UHI studies.

Many cities in the EMME are located on complex terrain, particularly the foothills of mountains, open terrain (e.g. coastal) or wide valleys. In the latter case, microclimates are strongly influenced by factors such as topography, thermal forcing and wind patterns, which under certain conditions might provide natural cooling in the city and diminish the actual manifested UHI effect. Nevertheless, the UHI effect induced by the city itself is mainly influenced by urban design, the geometry of urban canyons, physical properties of

TABLE 5. Field experiment studies of the UHI phenomenon in EMME cities

Region of study	Examined parameters (and aims)	Reference
Athens, Greece	Temperature and type of land surface (to compare the effects of different materials).	(Livada et al. 2002)
Hania, Crete, Greece	Temperature, relative humidity, wind speed and direction, barometric pressure, sunlight and precipitation (to consider the correlation of the UHI with local meteorological conditions).	(Kolokotsa, Psomas, and Karapidakis 2009)
Lefkosia, Cyprus	Multiscale air and material surface temperature measurements, wind velocity, humidity, turbulence and radiation over an intensive observation period in July 2010 (to inform the design of architectural and urban planning parameters)	(Neophytou et al. 2013)
Muscat, Oman	Temperature (to detect its fluctuation as a function of time).	(Charabi and Bakhit 2011)
Tel-Aviv, Israel	Air temperatures at roof, street and surface levels (to compare the temperature difference between scales).	(Saaroni et al. 2000)
Thessaloniki, Greece	Near-surface temperature data measured at seven sites (to investigate how moisture availability and wind speed affects the development of UHIs).	(Giannaros and Melas 2012)

the materials used in the urban fabric and anthropogenic heat. During daytime, incident solar radiation is stored as sensible heat in the city's built environment, and at night this heat is released, preventing substantial cooling of urban centres.

To determine the optimal strategies for mitigation and adaptation to the future local climate, it is important to consider the specific manifested features of local UHIs in the EMME region. In the past two decades, several field experiments have been conducted to study the influence of UHIs to identify some of the commonalities and differences in their various manifestations (see Table 5).

There are numerous social, economic and environmental concerns related to the UHI effect. Epidemiological studies have indicated that people living in urban areas are exposed to higher morbidity and mortality risks, relative to those living in thinly populated areas, due to the increased temperatures. City public health authorities have been caught unawares by heatwaves on numerous occasions, something more pronounced in the northern countries unaccustomed to extreme heat (Russo, Sillmann, and Fischer 2015). UHIs also has indirect impacts. For instance, higher temperatures often lead to higher ozone concentrations at the ground level, because they accelerate certain chemical cycles naturally occurring in the atmosphere (see e.g. section 2.2.4) Also, there is substantial increase in energy demand for cooling to combat the thermal heat stress and discomfort, and thus of energy bills. There may be unexpected infrastructure adjustments needed in areas that are traditionally cold. Strategies for abating UHI should be combined with energy conservation measures and the integration of renewable energy.

3.2.3. Energy poverty

Energy poverty is the lack of access or affordability of essential energy services in homes, such as lighting, cooking, space heating and cooling. A recent definition states that it is "the inability to attain a socially and materially necessitated level of domestic energy services" (Bouzarovski and Petrova 2015). The main factors driving energy poverty are low incomes, high energy prices and inefficient building design and construction.

In the European Union, energy poverty has been slowly progressing on the political agenda to a point where Member States are obliged to identify, monitor and address it within their territories (Thomson, Snell, and Liddell 2016; European Union 2018). A European Energy Poverty Observatory has also been established to deliver essential information on indicators and mitigating measures across the EU countries (European Commission 2018). Through this regulatory framework and general guidelines, the European Union assigns each Member State with specific tasks and responsibilities. Based on these, Greece and Cyprus have acknowledged energy poverty and provided for mitigation actions, such as defining "vulnerable consumers" who may benefit from certain measures (e.g. protection from electricity disconnection, subsidies for energy efficiency refurbishments, among others) (Korovesi et al. 2017; I Kyprianou and Serghides 2020) In other countries of the EMME region, energy poverty does not appear to be high on the political agenda – at least not in a formal acknowledgment of energy poverty or co-ordinated mitigating actions. Even those nations committing to increase investments in energy infrastructure are not addressing non-structural barriers to energy justice, including legislative action that allows and promotes energy expansion projects (Olawuyi 2020).

Several studies have taken an explicit look at indoor environmental pollution and its link to energy-poverty-related morbidity and mortality, as many Greek households turned to biomass as their preferred heating fuel during the cold season (D. A Sarigiannis, Karakitsios, and Kermenidou 2015; Boemi, Panaras, and Papadopoulos 2017; D. A. Sarigiannis et al. 2015). A number of Greece-focused studies found that burning of biomass created indoor and outdoor atmospheric pollution, as particulate matter (PM) is emitted via the combustion process, but did not explicitly link their findings to energy poverty (D. A Sarigiannis et al. 2014; Grivas et al. 2018; Saraga et al. 2019; Kanellopoulos et al. 2021; Pateraki et al. 2020). Similar findings related to biomass and other "unclean" fuel such as kerosene were reported for the Middle East in general (Tsiouri, Kakosimos, and Kumar 2015), as well as in specific studies for Turkey (Bozkurt et al. 2015, 2018), Lebanon (Saliba et al. 2010), Jordan (Jaber and Probert 2001), Egypt (W. Li et al. 2019), Iran (Akhbarizadeh et al. 2021), Iraq (Grmasha et al. 2020), Qatar (Javed et al. 2019) and Saudi Arabia (Dossing, Khan, and Al-Rabiah 1994), indicating that most countries in the EMME are concerned with indoor environmental quality, even if it is not placed under the energy poverty umbrella. In addition, more specialised research exists on energy poverty in the EMME region. For example, in Cyprus, there have been assessments on the indoor thermal comfort of low-income households (Pignatta et al. 2017; Chatzinikola, Serghides, and Santamouris 2015), the satisfaction with the thermal environment of dwellings (I Kyprianou and Serghides 2020) as well the current policies and measures for mitigating energy poverty (I Kyprianou et al. 2019). In Turkey, a negative relationship has been observed between energy poverty and self-reported health status (Kose 2019), and the potential benefits of renewable energy have been explored for alleviating energy poverty in the state of Palestine (Hamed and Peric 2020). Moreover, a recent study explored a largely ignored aspect of energy poverty – the one related to informal housing conditions (e.g. Bedouin settlements in Israel) – coining the term extreme energy poverty (Meir and Stavi 2011; Teschner et al. 2020). This terminology is used to reflect situations where access to affordable grid-based energy seems to be an impossibility due to factors other than the common mix of poor infrastructure, high fuel costs and low incomes.

Energy poverty is thus observed in every possible variation within the EMME region. However, very limited research (Santamouris, 2016) has been carried out linking climate change and extreme weather phenomena with energy poverty and mortality. Typically, energy-poor populations adapt to their own realities and resort to unhealthy lifestyles. The result is similar, whether due to a lack of space cooling or heating, inefficient homes or indoor air pollution from biomass burning. All this comes at a time when economic and refugee crises and national and international conflicts are either part of everyday life or just around the corner. All countries in the EMME are thus concerned with certain aspects of energy poverty and largely consider similar measures for its mitigation: development of adequate public awareness, citizen action and political will.

3.2.4. Health implications

Among its various effects, climate change is anticipated to compromise people's health in both urban and rural areas. Several processes need to be considered within the framework of climate uncertainty and public health, ranging from the macro to the micro scales.

Starting with temperature variations, August 2020 was the second-warmest August on record since 1880 and the summer of 2020 was the warmest for the Northern Hemisphere (NOAA 2020). Temperature maxima in September in many countries surpassed 100-year-old records reaching the upper 40s and lower 50s (Nicosia, Cyprus, 46.2°C[4]; Eilat, Israel, around 49°C; Iraq and Kuwait, above 53°C). Furthermore, minimum air temper-

4. https://cyprus-mail.com/2020/09/04/highest-ever-recorded-temperature-46-2c-clocked-at-athalassa-eac-consumption-also-hits-all-time-high/.

atures and minimum (relative) humidity are also rising, especially during summer nights, alongside a drop in wind velocity during the same hours (Ben Shalom, Potchter, and Tsoar 2009). Such combined events may prove lethal in cases where heating, ventilation and air conditioning (HVAC) is not an option, as they exacerbate thermal discomfort, as was evident in the 2003 heatwave in South Europe, particularly in France (Fouillet et al. 2006; Keller 2015). Moreover, climatic extremes can negatively affect building structures and envelopes, further deteriorating indoor air quality and environmental conditions (Yau and Hasbi 2013).

Aridisation and desertification are severely affecting the region as annual precipitation seems to be constantly diminishing compared to the long-term averages (Kafle and Bruins 2009), albeit with more violent downpours causing floods. According to the Arab Centre for the Study of Arid Zones and Dry Lands, most of the MENA region is defined as arid, with dry land degradation affecting some 70% of the land in the Arab region. It is estimated that almost half of the land in the Mashreq, more than a quarter in the Nile Valley and the Horn of Africa, more than 15% in North Africa and almost 10% in the Arabian Peninsula are threatened by desertification. Libya, Egypt and Jordan (in the MENA region), and Bahrain, Kuwait, Qatar and the United Arab Emirates (in the Arabian Peninsula) are the most endangered countries (EcoMENA 2020). They are expected to witness severe impacts on their vegetative cover and, consequently, an increase in the intensity of dust storms and sandstorms, leading to prolonged droughts and danger to the lives of people. A growing number of studies support a connection between the increase in sandstorms and dust storms and the rise in morbidity and mortality, though often the source of the former is hundreds and thousands of kilometres from the affected populations (e.g., Chen et al. 2004).

On a more local scale, the UHI effect seems to be continuously exacerbated due to many factors (see Section 3.2.2), such as expanding urbanisation and the densification of urban centres, growing numbers of privately owned vehicles demanding ever-wider roads in and around city centres, the increasing height of new buildings (D. Li et al. 2019; CTBUH 2020; Meir et al. 2012) and a gradual eradication of significant green open spaces. Such urban changes could intensify the UHI effect under more extreme weather conditions. The UHI effect directly contributes to the ever-increasing demand for energy to cool buildings in urban areas. Simultaneously, people's ability and willingness to walk in urban areas are compromised by higher temperatures, with negative implications for their health.

There seems to be no consensus on the potential inter-relations between climate change, UHI and pollution. Though some studies indicate a potential mitigating effect on UHI caused by particles filtering solar radiation (not unlike global dimming), there seems to be a general agreement that the combination of all three can only worsen the living conditions of urbanites and jeopardise public health, primarily in the less affluent countries and cities. Excessive heat and air pollution have been documented to increase mortality and morbidity in cities worldwide (Harlan and Ruddell 2011). Dense urban downtowns may well experience micro-climatic stability, which may encourage the concentration of pollutants at high levels. These include, but are not limited to, sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), PM10 and PM2.5 (Hassan, Hashim, and Hashim 2016). Many of the relevant studies have been undertaken in specific climatic regions (e.g. tropical or subtropical, or mid and north latitude, colder and rainier regions), which are significantly different from climates in the EMME region. It is therefore vital that research efforts are extended to cover dry subhumid, semi-arid, arid and hyper-arid regions. Such actions need to be undertaken soon since fast population growth and urbanisation, which characterise much of the EMME, will draw ever-growing numbers of people into the climate change–UHI–pollution nexus. Issues such as socio-economic gaps, education differences, housing standards and access to energy should also be considered within such research (O'Neill et al. 2003; Harlan et al. 2007).

Under these circumstances, public health is continuously being compromised and higher rates of morbidity and mortality are becoming real threats. Primarily, people in the various risk groups are expected to suffer the most, such as the elderly, pregnant women, babies or people with chronic health conditions (e.g. cardiovascular and respiratory). Lower-income groups, who tend to live, study or work in older buildings that do not comply with current and future standards are also at risk. Energy poverty is another critical characteristic (see Section 3.2.3). Poorly designed and constructed buildings and the urban clusters they create may prove lethal for such groups. Yet, in the exacerbating climatic and environmental conditions that are anticipated, buildings should be considered as a potential refuge from the outdoor extremes and designed accordingly (Meir 2014).

3.3. Outlook and needs of the built environment

In a nutshell, the building sector in the EMME region is facing a series of challenges. Current trends include a decrease in second- and third-tier small-to-medium cities (compared to the expansion of ever-growing metropolitan areas), an abandonment of historic centres and the ageing of building stock, a spread of urban sprawl and unplanned peri-urbanisation, a rise in poverty and informality of the built environment accompanied by a lack of public space and of opportunities for socially resilient, inclusive spaces. Furthermore, rootlessness and a lost sense of belonging affect people's well-being.

Possible ways to invert this trajectory may lay in the development of new models of urban governance and the establishment of urban growth planning and management, and housing programmes, together with the establishment of disaster management schemes for both preventive and reactive purposes. Related plans should be clear, inclusive (especially with respect to the disabled, elderly and other minority groups), comprehensive and pragmatic. The challenge is to define a new role for cities in a global context: as territories of emerging futures supported and facilitated by open-data access and new data-sharing opportunities.

In short, the opportunities identified include:

- Promoting sustainable urban development;
- Enhancing data, research and innovation;
- Increasing the resilience of vulnerable communities;
- Ensuring policy integration at the local and regional scale;
- Increasing access to finance; and
- Creating inclusive, integrated and bottom-up opportunities for governance.

4. Policy landscape

Laws and regulations regarding mitigation and adaptation measures vary widely across the EMME. While some countries are already implementing such regulations, others have not yet started to draft them. Moreover, such regulations, if they exist, are often scarce and difficult to find. To identify laws and regulations that strive to improve the adaptive and mitigative capacity of the building sector in the EMME region, countries were grouped according to the classification presented in Section 2.1:

- EU countries: Cyprus and Greece
- North Africa: Egypt
- Middle East: Israel, Jordan, Lebanon, Palestine, the Syrian Arab Republic and Turkey
- Arabian Peninsula: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates
- Western Asia: Iran and Iraq

In the following sections, a summary of relevant measures and regulations is provided for each of these sub-regional groups.

4.1. International policies on climate change adaptation and mitigation

The adoption of international agreements, led by the United Nations in 2015, introduced new agendas for climate change adaptation for urban regions, considerably altering the policy landscape. These various policies, plans and measures were intended to reinforce one another, and it was hoped that stakeholders would find synergies between them. The Paris Agreement, agreed upon and adopted in 2015, detects the urgency for adaptive and mitigating actions in response to climate change, highlighting that local action is needed, within the international cooperation framework (Magnan and Ribera 2016). Prior to adoption of the Paris Agreement, the UN's Sustainable Development Goals (SDGs) were established within the 2030 Agenda for Sustainable Development. This initiative forms the groundwork to "make cities and human settlements inclusive, safe, resilient and sustainable" (UN 2015b), aiming to significantly increase resilient cities globally (UN

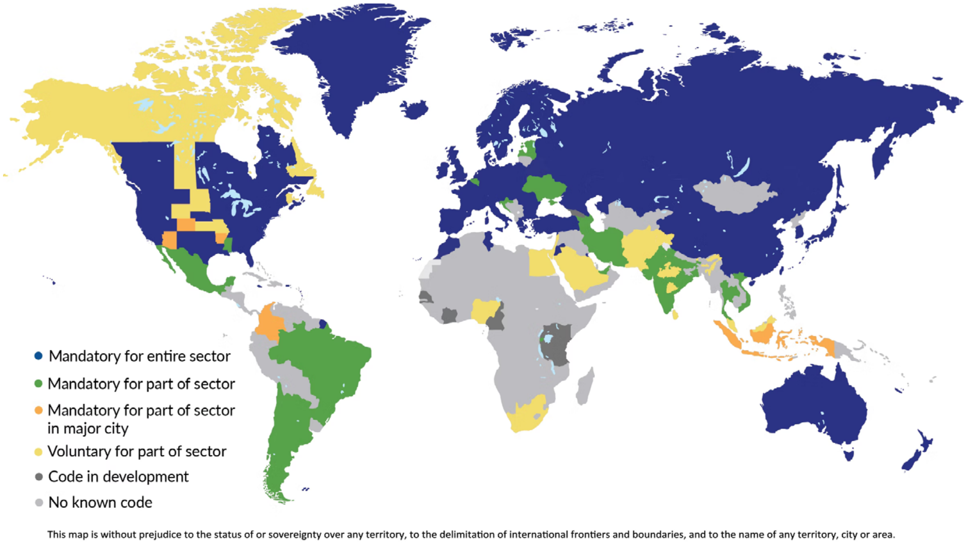
2015a). The unprecedented pledge of global leaders to participate in this initiative and take urgent action has been welcomed by the scientific community and the public, with specific objectives being detailed and ratified in the New Urban Agenda in late 2016 (UN 2017). The world leaders agreed to develop investigations of urban vulnerability and adaptation actions at the city level, integrating facets of climate change into their planning processes.

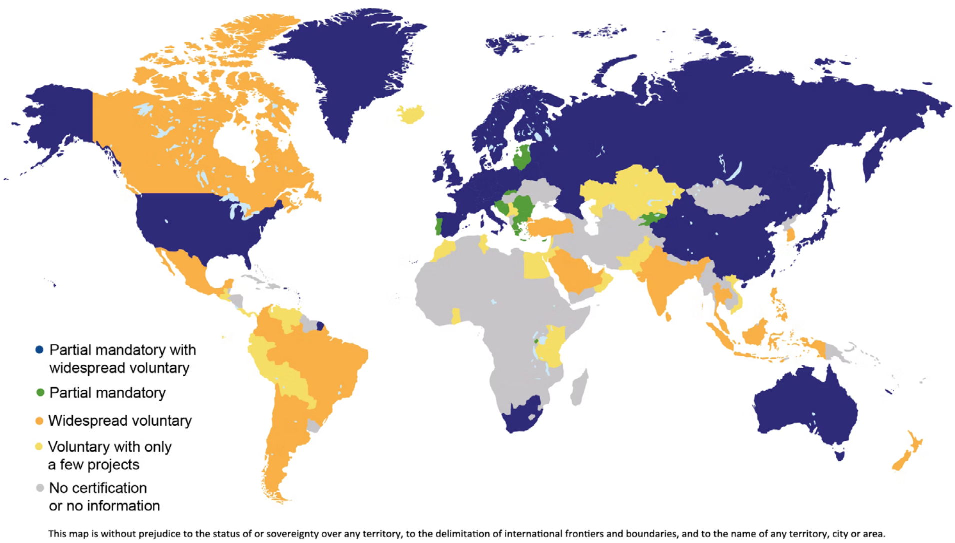
The Global State of National Urban Policy (UN-Habitat 2018) first monitored and evaluated national urban policies (NUPs) from 150 countries. The report builds on previous work by the UN-Habitat and the Organisation for Economic Co-operation and Development (OECD) and defines a common methodology. It is a noteworthy contribution to the monitoring and implementation of the SDGs and the New Urban Agenda that represents an attempt to conceive better and more sustainable cities where all citizens "have equal rights and access to the benefits and opportunities that cities can offer" (UN-Habitat 2017). Moreover, it contributes to the National Urban Policy Programme (NUPP), a global initiative launched by the UN-Habitat, OECD and Cities Alliance at the Habitat III Conference in 2016, which aims to expedite the development of NUPs across the globe.

While scientists and the public has welcomed the pledge of world leaders to urgently address the challenges of climate change, such promises are accompanied by reservations, as adopting an international framework is not automatically translated to city-level action. This is evident by findings of an analysis on the development of 147 local adaptation plans in Europe, indicating that that the UNFCCC process had prompted the development of only 21 of these (Aguiar et al. 2018). Moreover, in the EMME region, most of the countries lacked mandatory building energy codes in 2018 (Figure 20), signalling the build-up of large areas that did not meet any minimum performance requirements. To meet the conditions of the SDS by 2030, mandatory building energy codes must be implemented in all countries, new construction should be highly energy efficient and existing stock should undergo deep energy efficiency renovation, to achieve at least a 30-50% improvement in energy intensity (IEA 2020a).

These challenges can relate to the legislation (e.g. poor enforcement of regulatory policies and insufficient financing solutions), implementation (e.g. lack of institutional co-ordination among different agencies or ministries) and monitoring of the programmes, as well as the behaviours of investors and consumers.

FIGURE 20. Building energy codes by country (top) and building energy certification adoption worldwide (bottom).





Source: (IEA 2020a).

4.2. Policies and regulations in European countries

The EU countries of Cyprus and Greece had to implement the European Directives in their national laws and regulations. Specifically, two directives address the building sector: Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency. Recently, these two directives were amended as part of the Clean Energy for all Europeans package (Directorate-General for Energy 2019) in 2019 and later in October 2020, as a part of the Renovation Wave strategy (European Commission, 2020) included in the European Green Deal (European Commission, 2019). Furthermore, some general information relevant in assessing their basic characteristics in terms of adaptive and mitigative capacity can be found in the EU Buildings Factsheets on the EU website.[5]

4.2.1. Cyprus

Cyprus implements both the EU directives: Directive 2012/27/EU and Directive 2010/31/EU (Department of Environment, 2018). In addition, to achieve certain energy-saving targets it has prepared a National Energy Efficiency Programme. The programme includes measures relevant to the built environment, such as an increased annual renovation rate of 3% of the surface of mechanically ventilated public buildings, energy refurbishment of existing residential and commercial buildings, in compliance with the minimum energy efficiency requirements, and promotion of roof thermal insulation on dwellings. More recently, Cyprus has adopted Law 155 (I) on the Regulation of the Energy Efficiency of Buildings, which governs the regulation of new constructions and renovation of existing ones according to the updated Directive 2018/844 (Ministry of Energy Commerce and Industry, 2020). A number of schemes have been announced at regular intervals, promoting subsidised energy refurbishments for entire buildings, or individual elements such as roof insulation and renewable energy technologies (Republic of Cyprus, 2020).

4.2.2. Greece

Greece has adopted several laws and regulations based on current EU directives. The National Energy Efficiency Action Plans include horizontal measures focusing on the residential and tertiary sector (both public and private), industries outside of the European emission trading systems and the transport sector (Ministry of Environment and Energy, 2018). The plans developed according to Directive 2002/91/EC are incorporated into Greek legislation by Law 3661/08 (Official Gazette 89/A 3661, 19/5/2008) and the Joint Ministerial Decision D6/B/14826 (Official Gazette 1122B, 17/6/2008). They include the following measures for residential and tertiary private sector buildings: 1) Regulation on the Energy Performance of Buildings; 2) the "Saving Energy at Home" programme; 3)

5. https://ec.europa.eu/energy/eu-buildings-factsheets_en.

mandatory installation of solar thermal systems in new residential buildings; 4) energy refurbishment of social housing dwellings through the Green Pilot Urban Neighbourhood programme and 5) obligatory installation of solar thermal systems in tertiary sector buildings.[6] Furthermore, Section 6.1.5.11 of the 7th National Communication and the 3rd Biennial Report under the UNFCCC explains the role of cities as agents addressing the most urgent environmental and climate changes (Ministry of Environment and Energy, 2018: 253-54).

4.3. Policies and regulations in North Africa – Egypt

Among the North African countries, Egypt is also part of the EMME region. Energy efficiency is an important component of Egypt's Strategy for Integrated Sustainable Energy 2035. In 2012, Egypt adopted the National Energy Efficiency Action Plan for the electricity sector for 2012-15. The plan was updated between 2018 and 2020 in the context of the Integrated Sustainable Energy Strategy 2035. It reinforces existing standards of energy efficiency, expands appliance labelling, indicating energy efficiency, and promotes application of building energy efficiency codes as well as energy-efficient lighting. Green building standards and codes to secure long-term energy conservation across residential, commercial and public buildings have already been developed in Egypt. However, there are no concrete policies and measures to enforce these (Bampou, 2016). Fuel poverty, institutional barriers, economic constraints, an underdeveloped market and weaknesses of local governance are some of the hurdles to achieving indoor thermal quality and exploiting the potential of energy conservation. Egypt's Third National Communication under the UNFCCC (EEAA, 2016: 107-11) presents actions and policy instruments for mitigation of GHG emissions in the building sector. It also includes revisions of building codes and infrastructure standards, but there is no mention of any rules, regulations or laws enabling such measures. Additional measures are also presented in Egypt's National Strategy for Adaptation to Climate Change and Disaster Risk Reduction (IDSC, 2011).

4.4. Policies and regulations in the Middle East

4.4.1. Israel

Israel has paid significant attention to GHG emissions from the built environment, as it is responsible for 60% of electricity consumption and 33% of total GHG emissions (Ministry of Environmental Protection, 2020). In 2010, the government issued the first National Plan for the Reduction of Greenhouse Gas Emissions in the context of Government Resolution 2508 (Ministry of Environmental Protection, 2019; The Government Secretariat, 2010). In this plan, budgetary resources were set aside for a number of measures, including: 1)

6. For additional details, see Ministry of Environment and Energy (2018: Tables 4.10 and 4.11).

support for investments to reduce GHG emissions; 2) a pilot project for a green building (Figure 21); 3) trainings on green buildings; 4) a pilot project for the retrofit of existing buildings and 5) standards for energy efficiency (including enforcement). Meanwhile, Government Decision 1403 issued on 10 April 2016 (Ministry of Environmental Protection, 2019) formulated the long-term goals of reducing energy consumption in buildings and GHG emissions through energy regulations and the labelling of new buildings as well as existing buildings that had been maintained and renovated. It also outlined the promotion mechanisms and the steps required to meet the green building standards, and discussed the feasibility of creating best-practice examples of green buildings in the educational and public sectors (Ministry of Environmental Protection, 2018a). To enforce and implement Decision 1403, Israel's Cabinet approved Government Decision 1806 on the Promotion of Green Building in Israel on 3 July 2014, which deals specifically with four key points: awareness, training, a knowledge centre and national standards (Ministry of Environmental Protection, 2019).

Green buildings have been one of the main pillars of Israel's policies to reduce GHG emissions and raise energy efficiencies in the building sector. They feature prominently in Israel's Third National Communication on Climate Change (Ministry of Environmental Protection, 2018b), which states that the potential reduction in GHGs by decreasing electricity

FIGURE 21. The Porter School of Environmental Studies building at Tel Aviv University

Source: https://www.gov.il/en/Departments/Guides/standards_in_israel?chapterIndex=4.

consumption in buildings and industries is estimated at 7.1 million tCO_2eq relative to the business-as-usual scenario in 2030. This would correspond to 29% of the total reduction needed to comply with the target. Furthermore, these measures would bring about significant direct savings to the economy (Ministry of Environmental Protection, 2018b). Israel's National Plan for Implementation of the Paris Agreement (Proaktor et al., 2016) refers to Government Decision 1403 and the Green Building Standards promoting energy efficiency in the building sector.

Israel's main green building standards are SI 5281: Sustainable Building; SI 5282: Energy Rating of Buildings and SI 1045: Thermal Insulation of Buildings. They establish minimum requirements for various green building components including the design, choice of construction materials and heating and cooling systems.

In 2011, the Standards Institution of Israel launched a major revision of SI 5281 motivated by the fact that while the Israeli standard had become increasingly established, it was not uncommon for buildings to seek certification from other international rating systems, particularly the US Green Building Council's Leadership in Energy & Environmental Design (LEED) (Ben-Hur, 2014). In 2016, the standards were revised for a second time and divided into a series of chapters dealing with new and existing industrial structures, core and shell buildings (Ministry of Environmental Protection, 2020).

4.4.2. Jordan

Jordan faces two main challenges as regards its energy situation: the growing energy demand and the very limited domestic resources to fulfil this demand (energypedia, 2018a). Energy use and GHG emissions in the building sector are summarised under "other sectors" in Jordan's Third National Communication on Climate Change (Ministry of Environment and United Nations Development Programme, 2014). Emissions from the "other sectors" category were 2 883 $GtCO_2$-eq in 2006, accounting for 13.8% and 10% of the energy GHG emissions and of Jordan's total GHG emissions, respectively. Though this represents a moderate contribution to the country's GHG emissions, the building sector accounts for more than 50% of total electricity consumption. The final energy consumption in Jordan's residential sector in 2012 amounted to 1 200 kilotonnes of oil equivalent (ktoe), which accounted for 23.9% of the total energy consumption (energypedia, 2018a). Jordan is highly reliant on imports of energy resources (more than 96%), with very little deployment of renewables (less than 1% of electricity generation). Energy is central to the growth of the Jordanian economy, but its reliance on energy imports strains the economy and poses energy supply security risks. These vulnerabilities drove the development of the Master Energy Strategy 2007-20, which called for greater utilisation of domestic resources, including renewable energy. The share of electricity from renewables in

Jordan grew from 0.7% in 2014 to over 14% in 2020. The updated Master Strategy for the Energy Sector 2020-30, calls for a sustainable future energy supply, diversification of the national energy mix and increased dependency on domestic energy resources. The strategy targets a 31% share for renewables in total power generation capacity and 14% of the total energy mix by 2030. As regards mitigation strategies, a proposed project dealing with energy conservation, foresees the insulation of walls and roofs in 35 000 new houses (Ministry of Environment and United Nations Development Programme, 2014). However, these are just general policy recommendations without any specific requirements. The National Energy Efficiency Action Plan for Jordan is equally limited in terms of proposed measures (Bhar and Tawalbeh, 2013). It only includes the installation of 30 000 solar water heaters and a survey of energy consumption in the residential sector. In summary, the energy efficiency challenges in Jordan's building sector are mainly related to unclear responsibilities in the implementation of these measures, a lack of capacity building and a lack of compliance measures for the existing building codes (meetMED, 2020b).

4.4.3. Lebanon

The issue of energy efficiency in the light of GHG mitigation was addressed in Lebanon's Second National Communication to the UNFCCC (Ministry of Environment, 2011). The report refers to the standards for energy-efficient buildings as outlined in the "Capacity Building for the Adoption and Application of Thermal Standards for Buildings" project initiated in 2005 by the General Directorate of Urban Planning (DGUP) and the United Nations Development Programme; however, these standards are not mandatory. The report also states that a full implementation of these standards would lead to substantial energy savings estimated at around 7 million tCO_2-eq between 2010 and 2029, or around 343 500 tCO_2-eq per year (Ministry of Environment, 2011). Retrofitting of the existing building stock has also been identified as a priority.

The second National Energy Efficiency Action Plan (NEEAP) states that the share of energy consumption of residential buildings in the total final energy consumption was estimated to be less than 25% in 2010 (Lebanese Center for Energy Conservation (LCEC), 2016). The Lebanese Standards Institution has issued several guidelines on the thermal performance of buildings (particularly related to the demand for space cooling during summer months) and thermal insulation as well as the calculation methodology of building components and elements (LCEC, 2016). Another measure proposed was the implementation of a dual-purpose testing facility: to test the thermal properties of different components of a building and offer certification, and to promote research and development of novel materials with higher energy efficiencies (LCEC, 2016). Moreover, the following measures have been proposed in the NEEAP 2016-20 Measures B01–B09 (LCEC, 2016): 1) the drafting and implementation of a building code; 2) the extensive use of energy-efficient equipment in buildings; 3) the introduction of an Energy Performance Certificate for buildings; 4) energy audits for public buildings; 5) the implementation of energy efficiency measures in selected public buildings; 6) the conduction of a pilot project in energy efficiency measures and 7) an enhanced capacity building for refurbishment. With regard to end-use measures in the public sector, the NEEAP 2016-20 Measures recommend the adoption of green procurement for new and existing public buildings to reduce their energy consumption through an increased uptake of energy-efficient products (LCEC, 2016).

4.4.4. Palestine

Rapid population growth and urbanisation are contributing to the sensitivity of Palestinian cities to climate conditions and climate change. Palestine represents a very complex area divided into two administrative regions, with a population of 4.7 million inhabitants, which causes various limitations to the development of infrastructures and policies in the energy sector. In 2018, final energy consumption among Palestinian households was about 45%, which included energy use for space heating and cooling (meetMED, 2020a). The energy sector in Palestine depends almost entirely on energy imports, with 89% of total electricity supply coming from Israel and 3% from Egypt and Jordan. Energy capacity is largely fossil fuel based; however, Palestine is striving to achieve the target of 12% domestic electricity generation from renewable energy sources by 2030 (meetMED, 2019).

In 2012, the first National Energy Efficiency Action Plan for Palestine was published through the EU-Project MED-ENC (Khatib and Becker, 2012). It listed actions such as: 1) the preparation of national green building guidelines and associated codes, 2) a national awareness programme on energy efficiency and renewable energies in buildings, 3) the promotion of energy efficiency and renewable energies in buildings through Energy Performance Certificates and 4) human resources capacity building in energy efficiency in the building sector. In the same year, the Palestinian Energy and Natural Resources Authority launched the Palestine Solar Initiative in order to promote the installation of photovoltaic panels and to install on-grid residential rooftop solar systems with a nominal installed capacity between 1 and 5 kWp in 1 000 houses. While there are plans to build an energy-efficient demonstration building near Bethlehem, at present, there are no energy-efficient buildings to be found in Palestine (meetMED 2020a). A second National Energy Efficiency Action Plan was adopted in 2016 with and ambitious energy efficiency target to reduce total electricity consumption by 500 MWh per (Worldbank 2016).

There is currently no independent entity responsible for defining and implementing energy efficiency measures in buildings. Specifying such measures is hampered by limited data availability and the absence of a dedicated survey that can collect information on the status of energy efficiency in buildings, and the current requirements. Moreover, implementing a follow-up and monitoring mechanism to evaluate the impact of these measures is largely missing (meetMED, 2020b). Mitigation measures addressing the energy consumption in the built environment are scarce, and include only strategies oriented to "implement energy efficiency measures to reduce consumption and hence imported energy" (Smithers et al., 2016). The energy dependency on neighbouring countries, the weak enforcement of existing regulations and the low knowledge and capacity of public and private stakeholders are some of the main barriers that Palestine faces to successfully promote energy efficiency in the building sector (meetMED, 2020b).

4.4.5. The Syrian Arab Republic

While currently undergoing major transitions in the context of the ongoing (armed) conflict, the Syrian Arab Republic issued its first regulations towards energy efficiency in the built environment prior to these challenging times (Meslmani, 2010). Although the building sector's GHG emissions comprised a modest 13% of the total emissions in the energy sector in 2005, the final energy consumption attributable to the building sector amounted to 24% of the total. The country identified a number of measures to address the impacts of climate change on energy needs and the improvement of energy efficiencies in the built environment (Meslmani, 2010), including: 1) conservation measures in all residential areas including behavioural changes; 2) development of alternative heating devices, like solar water heating systems; 3) increase in the share of solar energy for water and residential heating; 4) reflective roofs for buildings; 5) use of efficient lighting; 6) increased thermal insulation in buildings to reduce energy consumption for space heating and cooling and 7) improved efficiency of air conditioners and refrigerators. However, as a consequence of the devastating war in the country, little progress has been made and information on ongoing measures and activities enhancing energy efficiency are limited. The share of renewables in the energy supply remains minimal (contribution of hydropower in 2018 was 65 ktoe), while fossil fuels provide the major shares (in 2018, natural gas was 2 982 ktoe and oil was 7 372 ktoe) (IEA, 2020).

4.4.6. Turkey

Plans for new regulations addressing the building sector were introduced in 2010 in Turkey (Ministry of Environment and Urbanisation, 2010). Specific measures include: 1) the introduction of an "Energy Identity Certificate" for new buildings; 2) the creation of the infrastructure for introduction of the "Energy Identity Certificate" also for existing buildings, and the deployment of thermal isolation and other energy efficiency measures and 3) the introduction of energy management in compliance with international standards, for both the industrial and building sectors, carried out by certified energy managers. In terms of sectoral energy consumption, the buildings and services sector accounts for 37% of the total energy consumption in Turkey (Ministry of Environment and Urbanisation, 2013). This high consumption is primarily for space heating and cooling, since 90% of the buildings in Turkey do not have sufficient thermal insulation (energypedia, 2018b). Regulations and laws pertaining to energy efficiency standards in Turkey include the following (energypedia 2018b):

- Standard TS 825 regulates the reduction of energy needed for space heating and cooling by thermal insulation of housing and commercial buildings, both new and renovated, and built after 14 June 2000.
- The Regulation on Energy Performance in Buildings (published on 5 December 2008, effective on 5 December 2009 and amended on 1 April 2010) states that buildings with more than 2 000 m^2 of usable floor area will have to be equipped with a central heating system, but for buildings having more than 20 000 m^2 floor area space heating and cooling will have to be driven through renewable energies and co-generation facilities.
- Regulations have been specified in the National Climate Change Action Plan 2011-23 of the Ministry of Environment and Urbanisation (2011).
- Several additional regulations have been specified in the Energy Efficiency Strategy Paper 2012-23.

Despite these laws and regulations, there are presently no incentives to support energy efficiency measures in buildings. Based on the fact that fossil fuels provide most of the energy requirements in the building sector (Ministry of Environment and Urbanisation, 2011), it is not surprising that Turkey's Nationally Determined Contributions are classified as "critically insufficient" in the context of the UNFCCC Paris Agreement (Climate Action Tracker, 2021).

4.5. Policies and regulations in the Arabian Peninsula

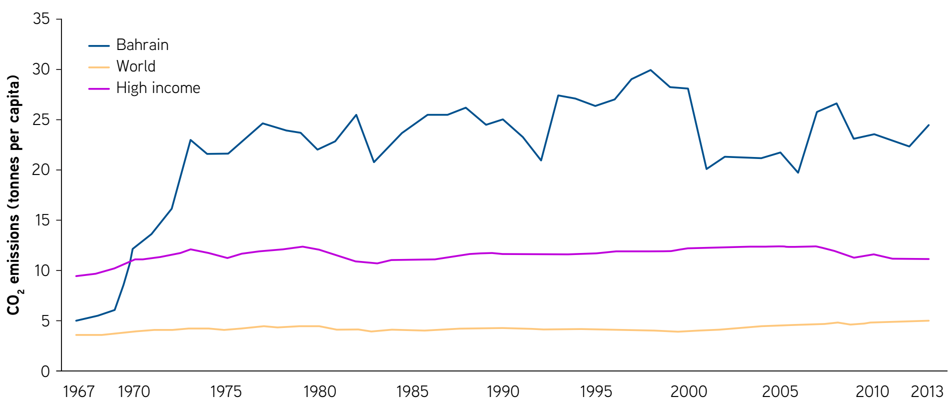
4.5.1. Bahrain

The Kingdom of Bahrain is the smallest oil producer among all the members of the Gulf Cooperation Council (GCC), and its oil and natural gas resources are governed by the National Oil and Gas Authority (U.S. Energy Information Administration, 2020). Oil comprises about 85% of Bahrain's revenues. Bahrain employs nearly 4 GW of installed electricity generating capacity, consisting mainly of five relatively efficient natural-gas-fired units. The demand for electricity is fast growing, fuelled mainly by population growth (about 7.0% per year between 2002 and 2012), the need for electricity for seawater desalination and the expansion of the industrial sector. The annual per capita electricity consumption, about 12.8 MWh/cap, is one of the highest in the world and is expected to rise. Moreover, it has one of the highest population densities globally – 1 461 persons per km^2 (Kingdom of Bahrain, 2012; 2020; U.S. Energy Information Administration, 2020).

Meanwhile, total GHG emissions rose from 22 374 $GtCO_2$-eq in 2000 to 29 153 $GtCO_2$-eq in 2006 with the energy sector accounting for a major share, about 77% and 67% in 2000 and 2006, respectively (Kingdom of Bahrain, 2012, 2020). The per capita GHG emissions for Bahrain are among the highest globally and are projected to continue their upward trend. In 2013, Bahrain had double the per capita CO_2 emissions relative to that of high-income countries, and approximately five-fold emissions relative to the world average, as observed in Figure 22 (Kingdom of Bahrain, 2017).

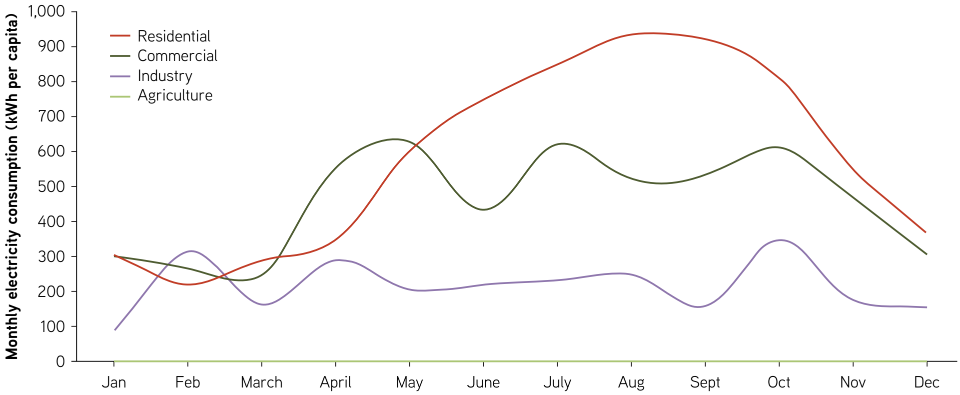
Most of Bahrain's housing stock is comprised of residential buildings (76%), with commercial buildings accounting for around 17%. Consequently, the household sector is the largest consumer of electricity. In 2014, Bahrain's consumption of electricity was 24 705 GWh, of which 46% was used by the residential sector. More than half of the residential sector's annual electricity consumption is related to space cooling. This is illustrated in Figure 23 (Kingdom of Bahrain, 2017), which shows a significant increase in electricity consumption during the summer months, a phenomenon typically observed in the EMME. This increase in electricity use during the extreme summer months also reflects the inadequacy of building envelopes (walls, windows, doors, etc.) to reduce the intake of heat into the interior of a building.

FIGURE 22. Comparison of per capita CO_2 emissions in Bahrain, 1967-2013.



Source: Kingdom of Bahrain, 2017.

FIGURE 23. Monthly electricity consumption by sector, 2014.



Source: Kingdom of Bahrain, 2017.

In November 2014, the government established the Sustainable Energy Unit (SEU) under the Minister of Energy with the support of the United Nations Development Programme. The SEU launched two major initiatives: the National Renewable Energy Action Plan (NREAP) and the National Energy Efficiency Action Plan (NEEAP) in 2017. The NEEAP identifies 22 new initiatives across all sectors to achieve a 6% reduction in energy use by 2025, relative to the average energy use over the period 2009-13 (Kingdom of Bahrain, 2017). Energy savings are anticipated to amount to 5800 GWh, on a primary energy equivalent basis in the year 2025.

Thermal insulation regulations were introduced in 1999 (Ministerial Order No. 8/1999), mandating all new construction over four stories to be insulated and providing minimum energy efficiency requirements for the envelopes of residential and commercial buildings, which were later expanded to include all buildings (Ministerial Order No. 63/2012). The government introduced a Minimum Energy Performance Standard and energy efficiency labelling of small retail air-conditioning units to improve their efficiency (Ministerial Order No. 70/2015) (Kingdom of Bahrain, 2017). The NEEAP introduced seven initiatives to improve energy efficiency in the residential and commercial sectors, including (Kingdom of Bahrain, 2017):

- Green building initiatives targeting reduction of building energy demand.
- Bahrain's Building Energy Efficiency Code initiative, which was responsible for evolving the existing regulations on thermal insulation and introducing additional requirements for various systems.

- The Renewable Energy Mandate for New Buildings, and the National Renewable Energy Action Plan.
- The Building Energy Labelling initiative, which would serve as an energy performance label for buildings.
- The Green Building Certification initiative, a formal certification scheme to promote the construction of resource-efficient buildings.

The SEU has been entrusted with co-ordinating the implementation of the NEEAP and has the capacity to provide technical expertise throughout its design and implementation. Monitoring, guidance and support will be provided by a follow-up committee, to ensuring that the NEEAP will move forward (Kingdom of Bahrain, 2017).

4.5.2. Kuwait

Kuwait is a global leader in the production of petroleum and oil products among the members of the Organization of the Petroleum Exporting Countries. It relies heavily on oil for electricity generation, and less so on natural gas (U.S. Energy Information Administration, 2020). Buildings are the biggest consumers of primary energy and electricity. While Kuwait had an installed electric generation capacity of 15.7 GW, this was insufficient to meet the high summer demand for extensive space cooling in residential and public buildings. Multiple factors, such as the growing population and GDP levels, as well as low energy prices, are responsible for a rise in electricity demand within the residential sector. As a result, in 2013, Kuwait was the world's sixth-largest electricity consumer on a per capita basis (U.S. Energy Information Administration, 2020). The country's electricity consumption has tripled in the past 30 years, and is expected to rise by 20% by 2027 and to double by 2040, with most of the usage coming from space cooling (Alajmi, 2019).

Residential and commercial buildings were responsible for 16% of national GHG emissions in 1994. Potential mitigation options, other than strengthening and/or enforcing building energy codes that have been largely ignored, also include introducing energy efficiency standards for appliances. A number of measures are being implemented in Kuwait in order to minimise energy consumption and improve overall energy efficiency (State of Kuwait, 2012). In 1983, the government launched the Energy Conservation Code of Practice R-6 to provide minimum requirements for the energy-efficient design of government and commercial buildings. The code was later updated to provide minimum requirements for the design and construction of new energy-efficient buildings, as well as new portions of existing buildings, including specifications for insulation of the building envelope, lighting systems, fenestration as well as HVAC systems (Ministry of Electricity and Water, 2016). The enforcement of the code is being carried out by the Ministry of Electricity and Water, the Kuwait Municipality and the Ministry of Public Works (Ministry of Electricity and Water, 2016).

4.5.3. Oman

Oman is the largest producer of oil and natural gas in the Middle East (EIA, 2019). The total primary energy supply in the country since the 1970s to the present day has therefore relied exclusively on diesel oil and natural gas, generated predominantly by natural-gas-fired power plants (i.e. about 97%). Electricity generation increased significantly between 2000 and 2015 from 8.6 TWh to 31.9 TWh, or at a rate of about 9.1% per year. The country does not use coal, biofuel/waste, renewable or nuclear resources as part of its energy portfolio.

Urbanisation mainly along the coast has increased dramatically over the past five decades in Oman. The urbanisation rate was 78.1% in 2016 (Sultanate of Oman, 2019), with the residential sector accounting for 8.7% of this growth rate. Electricity consumption between 2006 and 2016 grew at a fast rate, tripling from 10 TWh to 29 TWh. The peak in power demand is observed during the summertime, coinciding with extreme heat and consequently increased demand for energy for cooling purposes, reaching more than double the demand during the winter months (Charabi et al., 2014). Air conditioning makes about 75% of the total annual energy end use in residential buildings (Krarti and Dubey, 2017). The sultanate adopted a comprehensive National Strategy for Adaptation and Mitigation to Climate Change, 2020-40 in October 2019, but, unfortunately, this report is not available. The potential of energy efficiency measures, including improved energy management, labelling systems and strict building codes, has been investigated. A scenario analysis for the period 2010–35 shows that such measures can lead to substantial electricity savings amounting to roughly 25% of electricity consumption by the end of this period (Sultanate of Oman, 2019). Depending on the level of measures/investments applied, savings of 957 GWh/year to a significant level of 6 000 GWh/year in electricity consumption and 214 MW to 1 300 MW in peak power demand could be achieved (Krarti and Dubey, 2017).

4.5.4. Qatar

Qatar is another country that is rich in fossil fuels and is considered to be the largest exporter of liquefied natural gas (LNG) globally. This country's economy is heavily reliant on fossil fuels, as it obtains significant revenues from exports of petroleum products (EIA, 2015). The expansion of LNG production and economic growth have resulted in steadily rising electricity demand – between 2000 and 2012, Qatar's electricity consumption increased from about 8 TWh to 32.7 TWh (U.S. Energy Information Administration, 2020).

While the Qatar National Plan for Energy Efficiency and Resource Utilisation has been launched, it says little about achieving energy efficiency in the built environment and focuses more on the gas and oil industry (Ministry of Environment and The State of Qatar, 2011). A strong increase in energy demand is largely driven by population growth, changes in lifestyle and low electricity tariffs. Especially the residential sector requires substantial amounts of electricity for space cooling and appliances (Ministry of Environment and The State of Qatar, 2011); for example, air conditioning is responsible for up to 80% of buildings' energy bills.

There are many compelling reasons to reduce energy use and adopt renewable sources, including:

- Reducing the environmental impacts of voracious energy consumption, especially since Qatar has very high carbon emissions and increasing levels of energy and water use globally.
- Exporting the energy generated but not consumed in Qatar and generating profit.
- Reducing waste of capital on the operation and maintenance of unused power plants and other energy infrastructure.

This notwithstanding, relatively few efforts have been made in the past to enhance energy efficiency in the country (Meier, Darwish and Sabeeh, 2013). The overall strategies have been presented in two documents: the Qatar National Vision 2030 and in more detail in the Qatar National Development Strategy. Nevertheless, only a few mandatory energy efficiency regulations in the building sector have actually been implemented (Meier, Darwish and Sabeeh, 2013). However, the more recent Qatar Second Development Strategy 2018-22 (Planning and Statistics Authority, 2018) states that the enforcement of the Green Building Code by the end of 2022 will significantly reduce per capita and household energy consumption. This is expected to enhance energy efficiency in the building environment (Planning and Statistics Authority, 2018), but only limited progress has been made so far.

Qatar introduced the Global Sustainability Assessment System (GSAS) in 2007, leading the way in the MENA region for performance-based assessments and the rating of green buildings and their related infrastructure. The primary objective of GSAS is to create a sustainable built environment that minimises ecological impacts and reduces the consumption of resources, while addressing the local needs and environmental conditions specific to the region. It addresses 5 major environmental challenges for the Gulf Cooperation Council: climate change/air pollution, fossil fuel depletion, material depletion/land contamination, water pollution and water depletion (GORD 2020). The system adopts an integrated life-cycle approach for the assessment of the built environment, and its application has addressed several significant environmental challenges in the GCC countries. The GSAS is carried out through the planning, execution and operation stages of a building project and ensures adherence to sustainability standards (GORD 2020). On successful completion of the two stages of design and certification, the project qualifies for the final GSAS certificate (further details are available in GORD 2019). However, Ferwati et al. (2019) claim that the GSAS needs to be extended to the neighbourhood level in urban areas, which has led to the introduction of the Qatar Sustainability Assessment System–Neighborhood Development (QSAS-ND) assessment model.

4.5.5. Saudi Arabia

The Kingdom of Saudi Arabia is the largest country (by area) in the Arabian Peninsula and is home to about 34.3 million inhabitants and two major cities: the capital, Riyadh, has 7.2 million and Jeddah, 4.6 million inhabitants. Because of its copious oil and gas deposits, Saudi Arabia relies almost entirely on fossil fuels for energy. Renewables are expected to be developed rapidly and are projected to supply 54 GW by 2032. While the present per capita energy consumption in the Kingdom is already higher than most industrial and developed nations, the residential sector accounts for 68% of its total consumption (Al-Douri, Waheeb and Voon, 2019). Of the total consumption of 193 472 GWh in 2009, 70% was consumed by HVAC in buildings (Babelli, 2012). The government announcement on the country's Intended Nationally Determined Contributions to be submitted to the UNFCCC (Kingdom of Saudi Arabia, 2015) stated that three main sectors, namely industry, building and transportation, collectively account for over 90% of the energy demand in the Kingdom. Therefore, the Saudi Energy Efficiency Program (SEEP) – which is also called the National Energy Efficiency Program, NEEP – is of high priority to the country. Some of SEEP's measures include updated standards for thermal insulation products, development of regulations for thermal insulation in new buildings, better control over the implementation process, updated efficiency standards for small air conditioners to match those of ASHRAE[7] and development of efficiency standards for larger-capacity air conditioners (Saudi Energy Efficiency Center, 2015). SEEP defines a three-pronged approach for the erection of new buildings (Saudi Energy Efficiency Center, 2015): it specifies building material standards, defines requirements for buildings that are achievable and applicable in the Saudi context and establishes short- and long-term enforcement mechanisms employing current capabilities and international best practices.

New regulations specifying the minimum thermal insulation requirements (i.e. U-values) for new low-rise residential buildings have already been established and defined for

7. The American Society of Heating, Refrigerating and Air-Conditioning Engineers.

three distinct climatic zones in Saudi Arabia (Saudi Energy Efficiency Center, 2015). Even though the SEEP measures were introduced in the early 2000s (see, e.g. Alyousef and Varnham, 2010), concrete progress is still limited. Mosly (2015) identified 14 obstacles to the development of green buildings in Saudi Arabia, including a lack of skilled personnel and unaccommodating government policies and regulations. A previous study found that the Saudi building industry has yet to understand the importance of sustainability largely due to insufficient education and training in the construction sector, leading to a lack of appreciation for sustainability practices (Alrashed and Asif, 2014).

4.5.6. United Arab Emirates

The United Arab Emirates (UAE) is also one of the largest producers of petroleum and oil products globally, and reached a daily output of 4 million barrels in 2019 (U.S. Energy Information Administration, 2020). Almost all electricity generated in the United Arab Emirates in 2018 (98%) came from natural gas (U.S. Energy Information Administration, 2020). The UAE's building sector is among the largest contributors to national energy and demand. In particular, residential and commercial buildings are estimated to consume 65% of the generated electricity, resulting in significant carbon footprints and economic implications (IEA, 2021). As a result of a rapid demographic and economic growth, the UAE's electricity grid was pushed to its limits and the installed generation capacity is being increased to meet the high demand.

The UAE's Energy Strategy 2050, launched in January 2017, aims to diversify the country's energy mix to include clean coal (12%), natural gas (38%), nuclear energy (6%) and renewable energy (solar power, wind power and biofuels, amounting to 44%). The strategy includes an ambitious target of a 40% reduction in energy consumption across three main sectors, namely, the built environment, transport and industry (United Arab Emirates, 2018b).

The United Arab Emirates has taken critical steps to reduce the energy intensity of its built environment such as promoting green construction practices through local green building certifications/codes in Abu Dhabi and Dubai. The National Green Building Codes set out specific regulations that address minimum envelope performance requirements (comprising external walls, roofs and floors as well as glazed elements such as fenestration; air conditioning design parameters, including the outdoor and indoor condition of the building; air loss from entrance and exit; and air leakage) as well as energy efficiency measures for HVAC equipment and systems (Government of Dubai, 2020). Other measures include district cooling, wastewater reuse, and standards and labels for appliances and lighting systems. Key pilot projects that combine a number of efficiency measures in building design and landscape architecture include Masdar City in Abu Dhabi and the Sustainable City in

Dubai. A number of federal buildings are also compliant with the UAE's Green Building Guidelines (United Arab Emirates, 2018a).

In 2008, the Abu Dhabi Urban Planning Council started an initiative called "Estidama", which is the Arabic translation for "sustainability". Its goal was to promote sustainable communities and cities that balance the four main pillars of Estidama: environment, economy, culture and society. In 2010, Estidama released its Pearl Rating, a green building rating system that considers projects at different life-cycle stages, namely design, construction and operation (Abu Dhabi Urban Planning Council (UPC), 2010). It offers three types of certifications depending on the nature of the project: villa, building (non-villa) and community. The Estidama system builds on the five-point ("pearl") system modelled on the LEED certification scheme, and is based on the accumulated number of points earned: Pearl 1 (minimum requirements), Pearl 2, Pearl 3, Pearl 4 and Pearl 5 (highest achievable level) (UPC, 2010). According to an executive order, all new buildings in Abu Dhabi must meet the minimum Pearl 1 rating from September 2010, and all government buildings must meet the Pearl 2 rating (Meltzer, Hultman and Langley, 2014).

Meanwhile, the Dubai Integrated Energy Strategy 2030 aims to decrease energy and water use by 30% in the emirate by 2030. By 2017 its implementation had shrunk per capita electricity consumption by 9% (Dubai Supreme Council of Energy, 2017). Addressing the inefficient operation of existing buildings, the Dubai government aims to retrofit 25% of its building stock by 2030. This has been pursued vigorously across the emirates, and in 2017, the UAE government commenced the retrofit program for about 5 000 government buildings (United Arab Emirates, 2018b).

In 2010, the Dubai Municipality issued the Dubai Green Building Regulations and Specification, mandating minimal building efficiency requirements. In 2016, the code was updated, and the "Al'Safat" green building rating system was issued, which applied to residential and commercial buildings, public buildings and industrial facilities. The certification requirements cover five categories: ecology and planning, building vitality, resource effectiveness for energy, resource effectiveness for water, and resource effectiveness for materials and waste. In contrast to Estidama's Pearl Rating System, Al Sa'fat is not a points-based system. A building is certified upon fulfilling the requirements of one of its four possible certification levels: bronze (minimum requirements)", silver, gold, and platinum (highest achievable level) (Dubai Municipality 2016).

Today, both the Pearl Rating System and the Al Sa'fat system are mandatory (at different levels) for all newly constructed buildings and illustrate the UAE government's pro-active approach towards a more sustainable building sector. Currently, the performance of building stock certified with both these systems is not publicly available. Such a step would help illustrate the benefits of green rating mechanisms in the region, encouraging other countries to follow suit.

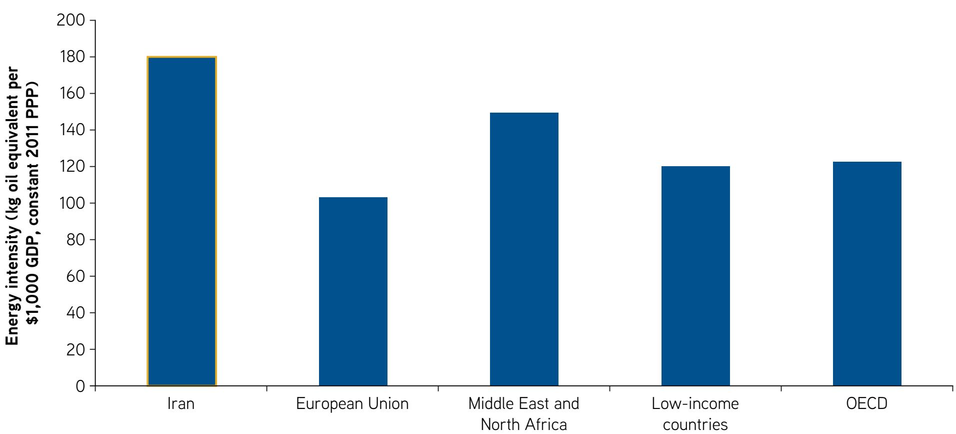
4.6. Policies and regulations in Western Asia

4.6.1. Iran

Iran holds some of the world's largest proven deposits of oil and natural gas reserves and consumed more than 270 000 ktoe of primary energy in 2016. Natural gas is the primary fuel source for electricity generation (70% of total generation). Iran generated almost 276 GWh of electricity in 2016, of which 93% was from fossil fuel sources (U.S. Energy Information Administration, 2020). The total GHG emissions for all sub-sectors changed from 491 052 gigagrammes (Gg) in 1994 to 417 012 Gg in 2000 to 832 043 Gg in 2010, with the energy sector accounting for roughly 80% of the emissions (Islamic Republic of Iran, 2003, 2010, 2017). Yet, the GHG mitigation potential is relatively high in Iran, and is projected to amount to 179.5 million tonnes in 2025 (Islamic Republic of Iran, 2017). Energy-efficient central heating systems in residential and commercial buildings, energy efficiency standards as well as information measures such as labelling programs are some of the mitigation measures that have been proposed (Islamic Republic of Iran 2017).

Iran's energy intensity is almost twice as high as that of the European Union and greater than that of the MENA and low-income countries, as observed in Figure 24. During the past decades energy expenditure is increasing, in part due to high levels of inefficiency. An annual growth rate of about 4% in terms of energy use per capita was estimated

FIGURE 24. Energy intensity in Iran and selected regions, 2010.



Source: Moshiri and Lechtenböhmer, 2015.

during 2001-10 (Moshiri and Lechtenböhmer, 2015). Subsidisation policies as well as the availability of vast energy resources have led to alarming rise in energy consumption, with very little consideration given to matters of energy efficiency and environmental impacts.

The building sector consumes about 35% of the energy used in Iran (Khodamoradi and Sojdei, 2017). The average energy use in buildings is 310 kWh/m^2 per year, which is 2.6 times more than that of developed countries (120 kWh/m^2 per year). Energy demand in households is met by about 20% of total oil products, 46% of natural gas and 28% of total electricity consumption. Households are mainly consuming fuel towards space heating (71%), heating water (22%) and cooking (7%). As a result of the government's policy of substituting natural gas for oil products, the energy mix of households in Iran has changed considerably since 1990 (Moshiri and Lechtenböhmer, 2015). Potential areas for improvement are the advancement of energy-efficient heating systems and proper insulation techniques and materials, both for new and existing buildings, which would lead to significant energy savings (Moshiri and Lechtenböhmer, 2015).

While the Government of Iran has introduced a number of laws and regulations (Khodamoradi and Sojdei, 2017), one of the most important ones was the General Policies of Consumption Reform (2011) which aimed to halve energy intensity by the year 2021. However, it failed to achieve its objective due to economic difficulties including sanctions and a lack of finance, technology and expertise. Moreover, Chapter 19 of the National Regulations for Buildings, which was passed in 1991 and amended in 2000, introduced new building codes for energy savings in buildings; its further amendment in 2014 covered new government buildings and all private buildings (Omrany and Marsono, 2016; Moshiri and Lechtenböhmer, 2015). The regulation covers several issues, including higher levels of insulation for exterior walls, windows (double-glazed), pipes and plumbing as well as installation of control systems for temperature monitoring. Based on these regulations, energy labelling has been introduced for new buildings, and they will be certified only if they adopt the minimum energy efficiency measures (Moshiri and Lechtenböhmer, 2015).

In the 2000s, the Iran Energy Efficiency Organisation (SABA) and the Iranian Fuel Conservation Organisation (IFCO) were founded for education and training, as well as for raising public awareness relating to energy efficiency. In addition, the long-overdue energy price reform was introduced (Moshiri and Lechtenböhmer, 2015). However, the notion of energy efficiency is still new to the building and construction industry in Iran, and efforts to introduce appropriate regulations and laws have had, so far, only limited success. Relatively small agencies such as the SABA and IFCO with restricted authority and a tight budget are unable to cope with the scale of Iran's energy efficiency problems. This leaves energy price reforms as the principal component of any energy efficiency policy, particularly in a country such as Iran, where energy prices are heavily subsidised (Moshiri and Lechtenböhmer, 2015). However, the potential to save about 44% of the current energy consumption in buildings still exists and can even be increased (Khodamoradi and Sojdei, 2017). The national status of energy efficiency thus needs more attention and increased efforts.

4.6.2. Iraq

The Federal Iraq and Kurdistan Regional Government is the second-largest crude oil producer in the Organization of the Petroleum Exporting Countries, also holding the world's fifth-largest proven crude oil reserves. Its economy depends heavily on export revenues from crude oil – in 2018 they amounted to more than 90% of total government revenues. Between 2008 and 2018, Iraq's electricity generation grew by an average of about 8% annually reaching an estimated 78 billion kWh, of which more than 97% was generated from oil and natural gas (U.S. Energy Information Administration, 2020).

Energy efficiency, in general, and in the built environment, in particular, has been mentioned in Iraq's initial NDCs to the UNFCCC (Republic of Iraq, 2016) as part of its national mitigation strategy. It is also briefly addressed in the National Environmental Strategy and Action Plan for Iraq (2013-17) (Republic of Iraq, 2012). However, the aspect of improving buildings' energy efficiency, as a part of a demand-side strategy for energy savings, has received less attention than supply-side issues. The government's limited efforts to improve energy efficiency are not enough to alleviate the severe power crisis (Istepanian, 2020) Iraq has been facing since 2003, which is projected to surge in the long run. Technical and commercial losses of energy exceed about 50% of the generated power, with most of them stemming from the residential sector, which is the greatest energy consumer on the demand side. While Iraq's peak demand for electricity has grown from 6 721 MW in 2003 to 27 346 MW in 2018, the residential sector accounts for 48.3% of the consumption (Istepanian, 2020). The potential to improve energy efficiency in Iraq could reach 210.15 GWh per annum by 2025, mostly in the electricity sector (73.3%) (World Bank, 2016).

The role of the government is pivotal in developing an effective strategy to reduce energy usage in general and lessen the country's dependence on fossil fuel power generation. However, Iraq does not have a building code regulating the energy efficiency of design, construction and operation of new and existing buildings, and measures such as wall insulation and double-glazed windows are rarely applied in the built environment (Istepanian, 2020). The Ministry of Electricity is currently the only federal authority promoting and providing guidelines for energy efficiency and conservation measures in households (Ministry of Electricity, n.d.).

However, given the current situation of Iraq's government and the general state of the country, progress can only begin by the elimination of the various barriers to energy efficiency (Istepanian, 2020). Reforming the current electricity tariffs and energy subsidy systems will be a necessary first step, since the current systems offer few incentives to implement and practice energy efficiency measures in the building sector (Istepanian, 2020).

4.7. Identified open gaps

From this policy summary, it emerges that the current implementation of degree to which climate mitigation and adaptation actions in national legislation and building regulations have been implemented varies. There are countries with a high standardisation of the built sector (i.e. buildings are designed and constructed respecting/complying with thermal comfort and energy standards with strong enforcement of comfort and energy efficiency measures), which are already implementing requirements to respond to climate change impacts, whereas some countries are characterised by a middle standardisation grade. Other countries have standards or building codes, but their implementation or reinforcement are still in progress or are not mandatory.

Furthermore, this policy summary shows gaps in the degree to which climate change mitigation and adaptation actions are being implemented across cities. Regulatory inertia hinders the smooth enactment of mitigation and adaptation measures, and, when available, climate policies. This is possibly due to the lack of institutional co-ordination among different agencies or ministries (e.g. in Egypt, Lebanon) or non-obligatory regulations (e.g. in Jordan or Palestine) (meetMED, 2020b). Also, decarbonisation is not always a political priority. However, overcoming a technocratic approach and moving towards a people-centred approach with seamless integration of the built environment and natural resources require greater awareness among both citizens and policy makers about environmental issues, together with more state and private investments to support the deployment of mitigation strategies (meetMED, 2020b). The Global Sustainability Assessment System is an example of an instrument aiming to improve the built environment in the region. It has already been adopted by some GCC countries and could serve as a blueprint for a region-wide body of rules and regulations to achieve energy efficiency in the built environment across the EMME (GORD, 2019).

5. Lessons learned and research directions

As witnessed in the EMME region, the process of urbanisation can take different routes: in Jordan, it occurred in outbursts, in Egypt it has progressed slowly and in oil-rich countries like the United Arab Emirates, cities did not develop – they emerged. Although driven by different processes and national circumstances, urbanisation commonly causes irreversible changes in water, energy and land management. It creates dense pollution as a result of transportation, industrial and residential activities, directly affecting the health of local and surrounding environments, as well as the physical and mental health of urban dwellers (UN-Habitat, 2006a).

Keeping the above challenges in mind, the EMME's urban environments still have diverse opportunities for sustainable development (Elgendy, 2011). First, dense urban centres may cause infrastructural pressure, but they also hold the potential for cost-efficient decentralised energy systems, like those present in established energy communities across the world. In this regard, the region's abundant renewable energy resources can be exploited by integrating solar and wind technologies into the fabric of the built environment. Moreover, the vernacular architecture of the EMME region can provide lessons for energy-efficient building models, bridging the gap between urban development and the preservation of cultural heritage.

Decarbonisation of urban centres and the simultaneous reduction of GHG emissions are urgent policy challenges, whose solution may be encapsulated in the very cities that are most burdened. First, the processes responsible for high emissions in cities – transportation, energy generation and use, land-use planning and waste management – are under the jurisdiction of the cities themselves. Therefore, desegregated regulation of these polluting aspects could reduce the carbon footprints of cities. Second, by definition, urban centres are associated with concentrated populations and businesses, which allow for the scaling up of mass transit and energy-saving solutions in office spaces. Finally, these hubs of human and economic activity foster alliances between local authorities, private stakeholders and the civil society, making them ideal catalysts for other levels of climate change action (UN-Habitat, 2011). To fulfil sustainability objectives, cities of the EMME region need to address the following characteristics of the built environment:

- Urban sprawl – manage urban land pressures on agricultural and natural land and to deal with the soil-sealing trend due to urban sprawl, especially in coastal areas;
- General co-ordination – promote information and communications technology (ICT) readiness and open access to city data (monitoring of infrastructure operations);
- Port cities – manage environmental, cultural, spatial, economic and social peculiarities;
- Coastal cities – manage soil erosion, urbanisation and industrialisation of coastal areas;
- Lowland, continental cities – overcome insularity.

Providing open access to secure, high-quality, time-relevant and consistent demographic and environmental monitoring data is essential for planning and implementing the 2030 Agenda for Sustainable Development. Improvements in real-time monitoring of civil data and information systems, state-of-the-art capacity for analytics of urban "big data", remote-sensing technologies, satellite observations and georeferencing are necessary actions to manage pressing urbanisation challenges and provide grounds for the development of timely responses. An example of an ICT application combining information from various governmental services, as well as external resources, is the National Statistical Data Program "Masdar". This programme aims to create a comprehensive database, with information that can be accessed through an interactive data portal and also through smartphone applications (UN, 2018b).

Lessons learned can be aggregated on several thematic axes: integration and co-ordination of mitigation and adaptation measures; regulatory inertia and carbon lock-in; new forms of co-ordinated management of city-regions; alignment between national and local levels on climate response and institutional co-ordination in the development of climate responses. Moreover, based on current knowledge, five main directions may drive advances in research on climate change mitigation and adaptation in the built environment: urban planning and design, built infrastructure, sustainable consumption and production, finance and informality.

5.1. Integration and co-ordination of mitigation and adaptation measures

While the deployment of climate change mitigation and adaptation measures is of prime importance, these measures are commonly implemented independently. Indeed, early climate response planning carried out in cities in developed countries showed that city administrations and urban stakeholders found it challenging to develop integrated and

TABLE 6. Typical features of mitigation and adaptation strategies

Dimension	Mitigation	Adaptation
Impact scale	Global (national or regional)	Local (e.g. city, region, basin)
Focal sectors	GHG emitters (e.g. economic sectors)	Activities, infrastructure, population cohorts sensitive to given impacts, etc.
Time lag	Longer term (years to decades)	Nearer term (months to years)
Action timeline	Urgent	Continuous process

co-ordinated climate pathways addressing the sustainable development goals. Rather, they focused on distinct measures addressing either mitigation or adaptation. Definitely, the complexity posed by a co-ordinated and integrated approach is much larger than of a sectorial approach, possible reasons being the structural differences (National Research Council, 2010) characterising mitigation and adaptation strategies and their alignment with political horizons and administrative tools (Table 6). We observe that mitigation actions are urgent and if they do not suffice to stabilise and reduce GHG emissions as soon as possible, climate-induced impacts are expected to surge exponentially.

This siloed approach does not consider the possible trade-offs between conflicting measures, which can lead to unexpected results and impacts below expectations (Bai et al., 2016; Rosenzweig et al., 2018).In addition, simultaneously addressing both adaptation and mitigation, despite its complexity, can yield even greater benefits (Dodman et al., 2010). In this regard, Di. Ürge-Vorsatz et al. (2018) developed a useful and fit-for-purpose interaction matrix that relates mitigation and adaptation measures and shows the strength of their mutual relationships.

In general, mitigation and adaptation options offering synergies and complementary pathways should be highlighted. For example, in the context of the EMME region, the preservation of urban green spaces, tree-planting or forest preservation – where present – can be an important adaptation measure to mitigate the UHI effect, which can also alleviate a series of cascading negative effects such as heat-related health conditions, mudslides and air pollution, etc. It is therefore necessary to consider such mutual relationships to design an effective climate action plan that can help meet the Paris Agreement's goals.

5.2. Regulatory inertia and carbon lock-in

The deployment of mitigation or adaptation actions in cities is particularly hindered by the inertia inherently inbuilt into certain infrastructures, technologies, institutions and behavioural norms, which can undermine their effectiveness for long periods. It is thus important to clearly define objectives and targets to create an effective climate action plan. In some cases, to overcome the inertia of the building sector, there has been a tendency to prioritise specific, technically simple and economically affordable interventions, which eventually prevented the exploitation of systemic and deep mitigation opportunities. These resulted in lost opportunities and created what is called a "carbon lock-in" (Di. Ürge-Vorsatz et al., 2018). This term is used to indicate the tendency of certain legacy infrastructure and carbon-intensive technologies to persist over time due to a combination of economic, institutional and technical factors, which de facto hinder the reduction of energy intensity and the penetration of low-carbon technological alternatives (Erickson et al., 2015). To avoid this trap, co-ordinated and strategic actions plus innovative financing measures need to be implemented.

However, in the EMME region, there are also some examples of positive carbon lock-in. For instance, in some areas, a limited and unstable energy network has stimulated the containment of energy demand and has facilitated the penetration of local and decentralised renewable energy generation systems such as portable PV panels, resulting in a lower need for both high-capacity centralised generation plants and power transmission networks. Therefore, when planning mitigation and adaptation strategies we should keep in mind that the solutions we design and implement today will affect the development of our cities and have long-lasting impacts on our communities over the following decades.

5.3. New forms of co-ordinated management of city-regions

Because of demographic growth and urbanisation also pushed by climate-induced phenomena, cities in the EMME regions are increasing in size. Metropolitanisation is, hence, becoming a progressively prevalent mode of urbanisation, particularly in megacities and newly emerging metacities (defined as massive conurbations that exceed the scale of megacities, hosting more than 20 million people) (UN-Habitat, 2006b). Similar to urbanisation, metropolitanisation can also occur in various forms: settlements whose residents commute to work in nearby cities may procure their own production and service activities; residents of declining urban centres may relocate to secondary cities to reduce their living expenses or city-regions could be created as a result of inter-connected systems linked to manufacturing or other activities (UN-Habitat, 2006b). This shift of urban-like populations calls for new and innovative forms of governance, which can afford independence to local authorities through a decentralised framework. Local authorities and municipalities with a higher competence level should employ more efficient inter-municipal co-ordination and alternative modes of governance, aiming for larger participation from civil society and higher autonomy for the various parts of this new organism called the metacity. An aspect that should not be overlooked is the environmental impact of these metacities. The shift from urbanisation to metropolitisation should evoke appropriate changes in environmental, economic and socio-political sustainability strategies, calling for more polycentric forms of governance, legislation that secures environmental protections and localised approaches to planning and managing human settlements.

5.4. Alignment between the national and local levels on climate response

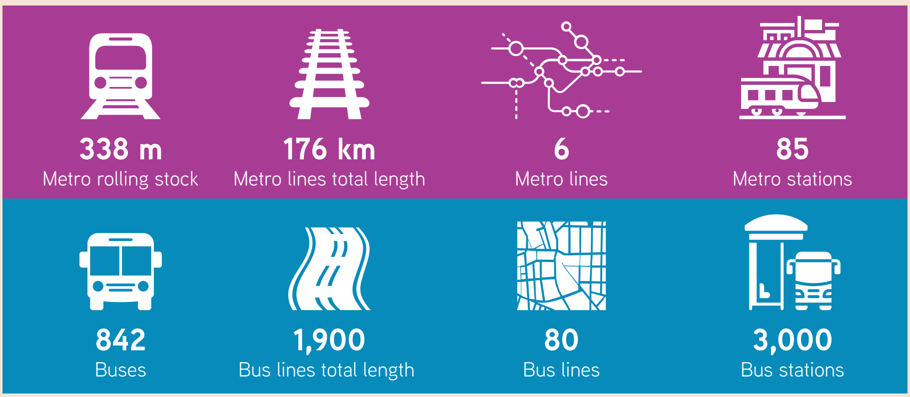
In order for local authorities to effectively plan and implement adaptation actions, a framework of governance is needed to ensure a smooth operation; this is achieved by means of national adaptation strategies (NASs) and national adaptation plans (NAPs). Evidence of this can be found in Heidrich et al. (2016), where it was shown that countries with long-standing national climate change plans have a large proportion of cities implementing coordinated local actions, in relation to countries that have developed NASs and NAPs later. The prominence of local authorities is recognised in most NASs and NAPs and on some occasions, the engagement of local governments is secured via national planning legislation. For instance, in Israel, National Master Plans are supplemented with local comprehensive plans and in Greece, the NAS foresees the development of adaptation plans at the regional and local scales, prioritising actions in accordance to local specificities.

Co-ordination among the different governmental levels can be achieved in various ways: for example, in Israel, implementation of the NAP was shaped after dialogues with relevant stakeholders from urban centres. Here, three levels of public involvement exist: citizen information, citizen consultation, and citizen participation and empowerment (Ministry of Construction and Housing, 2019). In terms of financing, regional authorities are often responsible to manage their own finances but on some occasions funds are provided by national governments. Several countries use revenues from auctioning carbon allowances, for instance, in Cyprus, auction revenues were used to fund research work for the Adaptation of Agriculture to Climate Change initiative in 2014 (Ramboll, 2017). Management of such national revenues and state-funded programmes is usually in the hands of ministries related to environmental protection, as well as funds specifically tasked to support green initiatives. For instance, in Greece, the Ministry of Environment and Energy and the Green Fund, a public legal entity, are in charge of creating green urban spaces and supporting relevant adaptation initiatives (EEA, 2019).

Box 5. Future Saudi Cities Programme

This programme is a result of a collaboration between the Ministry of Municipal and Rural Affairs of Saudi Arabia and UN-Habitat. It aims to tackle the major challenges resulting from the region's rapid growth. Its main objective is to "develop cities that are prosperous, productive, fair, socially inclusive and environmentally sustainable, with sufficient and adequate infrastructure and high-level of life quality" (UN, 2018b). To achieve this, the current situation in Saudi cities should be assessed and their challenges analysed, to develop relevant plans and pilot projects. One such example is the Metropolitan Development Strategy for Riyadh (MEDSTAR), a framework that regulates the development of the city and governs its growth. MEDSTAR encapsulates different strategies, including economic and environmental development, public utility and services, housing, transport, land use plans and urban development. The Riyadh Metro Project, included in MEDSTAR, will be the first citywide metro system in Saudi Arabia and it aims to minimise traffic accidents and congestion, as well as the related traffic emissions (UN, 2018b). The project is set to be launched in 2021 and aspires to be a best-practice example for the entire EMME region.

FIGURE 25. Characteristics of the Riyadh Metro Project covering metro and bus public transport.



5.5. Institutional co-ordination in the development of climate responses

In general, national multilevel urban planning is needed, as well as regulations that promote climate adaptation and the development and implementation of mandatory codes that set a minimum efficiency for new buildings and deep renovations. It would also be important to achieve a net-zero energy target and, if possible, even a zero-emissions one thanks to the solid implementation of energy conservation measures and the substantial integration of systems exploiting renewable energy into new and existing buildings.

Measures that could increase knowledge on the topic of climate change adaptation range from the development of training modules on climate adaptation and mitigation, the enhancement of stakeholder engagement at multiple local levels, the promotion of public access to insurance-related data for an effective climate risk assessment and management and the development of guidelines for the design of toolkits for the economic analysis of adaptation and mitigation projects. These measures would allow municipalities to get access to tools and resources to concretise informed and evidence-driven urban adaptation projects. There is a need for newer funding schemes to mobilise financing for the sustainable construction sectors, which would increase access to/use of financing, sanctioning of private capital and facilitation of comprehensive designing, construction and deep renovation to create sustainable buildings. Research findings from developed countries underscore the role of grassroots organisations and housing co-operatives towards successful projects. For instance, a group of buyers in Israel announced the launch of an ecological housing project in 2009, located in Tel Aviv (Pauzner, 2009), which follows the recent national "Green Building" Standard 5281. This standard aims to reduce the negative impact of the construction process on the environment. While the original standard only referred to residential and office buildings, the revised standard also includes educational institutes, hotels and youth hostels, health-care institutions, commercial and public buildings, industrial structures and residential neighbourhoods. This is an example of synergistic alliances addressing overlapping issues of climate change in the built environment, and social and environmental justice, through innovative forms of collaborations. The role of private capital (e.g. developers) should not be overlooked in the promotion and implementation of sustainable technologies.

5.6. Moving forward with mitigation and adaptation strategies

5.6.1. Urban planning and design

As urbanisation intensifies, there are two critical challenges to be addressed in urban development: urban sprawl and informal settlements' growth. Urban sprawl has been a major challenge for cities in the EMME region; one that has not been successfully addressed. Traditionally oil-rich countries have always had private vehicles as their preferred mode of transportation, and with increasing distances among home and places of work, education and leisure activities, this preference is amplified. In some cases, sprawl is accompanied by the development of middle-class suburban districts, with larger dwelling sizes and increased per capita carbon footprints. On the other hand, the growth of informal settlements could lead to sprawl on the fringes of urban centres. The challenge to limit uncontrolled urban expansion, reduce transportation needs and improve the energy efficiency of the urban built environment has been met by strategies such as land-use planning and zoning, mixed-use development and the implementation of design standards. Moreover, it seems that large-scale regeneration projects are a common response in climate change mitigation, relative to small regeneration projects (UN-Habitat, 2011).

Urban form and density are a third factor to consider with reference to urbanisation. These are associated to a cascade of social and environmental impacts, for instance, suburban areas with very low densities are linked to increased consumption of energy at the household level, and high emissions resulting from an augmented reliance on cars for transportation. On the other hand, cities with extremely high densities are prone to higher vulnerability to climate change, extreme events and, hence, health risks due to prolonged exposure to polluted environments. There are three broad categories of urban mitigation actions related to the design and use of the built environment: economic incentives, regulatory requirements and information programmes. In recent developments, voluntary public-private partnerships have merged, adopting fusions of these approaches. For instance, projects have been steered by grassroots organisations, civic society and housing co-operatives, joining forces to simultaneously tackle climate change and social and environmental justice. These approaches could address complex structural and social phenomena such as energy poverty (see Section 3.2.3).

5.6.2. Built infrastructure

Beyond the social and economic revolutions, structural change is needed in the way the building sector operates, creates new buildings and maintains and renovates existing constructions. Circular economy models can be applied to salvage vast amounts of reusable material and mitigate GHG emissions. Low-carbon and environmentally harmless technologies could develop transformative solutions that go beyond traditionally dominant grey infrastructure. At the same time, the relevant stakeholders and policy makers should examine and understand the co-benefits of blue/green infrastructure and ecosystem-based adaptation strategies, and integrate mitigation actions in future infrastructure priorities. Therefore, the urban fabric and built infrastructure should reflect the most urgent locality needs, whether that is water scarcity, the UHI phenomenon, thermal comfort of pedestrians, flood protection or combinations of more than one urban vulnerability. Another main issue in urban infrastructure is effective and efficient urban mobility. Transportation in the EMME region, particularly in oil-rich countries, relies heavily on personal vehicles. A shift should be envisioned, from an individual mode of transport to a collective one, employing sustainability principles and considering the needs of urban and metropolitan populations.

Box 6. Eskişehir's building efficiency policies and projects

A case study of excellent ecological restoration of an urban area can be found in the Eskişehir Urban Development Project in Turkey, where the local authorities and relevant stakeholders joined forces to develop and implement a suite of policies and projects focusing on the energy efficiency of buildings (IEA, 2019). The agenda for this project includes greening of public buildings, conducting energy audits, conducting work training and raising public awareness. To effectively maintain progress and integrate energy efficiency of buildings into the city's energy master plans, local authorities are considering different ways to manage the project, such as establishing dedicated management divisions.

FIGURE 26. The transformed urban area of Eskişehir, Turkey.

Source: Galvin and Maassen, 2019

5.6.3. Sustainable consumption and production

Present patterns of consumption and production are unsustainable and harmful to the environment and human health and well-being. To limit this, the full life-cycle implications of various modes and patterns of production, including the associated carbon lock-in, should be considered. Moreover, stakeholder engagement and participation should be considered through the development and implementation of community-based strategies. People can thus participate and contribute to the transformation of their cities to foster the less-resource-intensive choices and enhance their well-being. The sense of personal responsibility towards a sustainable life should be cultivated, while enabling and promoting appropriate lifestyle options to achieve sustainability goals. Finally, the role of urban consumption should be explored further to improve current methodological innovations in calculating GHG emissions to reflect what is called urban metabolism.

5.6.4. Finance

Climate considerations should be incorporated into fiscal and financial tools to effectively support decision making at the urban scale. While investment recovery via real estate instruments is a viable option for the private sector, the public sector can benefit through tax instruments such as parking fees, property taxes and betterment levies (UN-Habitat and Ministry of Municipal and Rural Affairs, 2019). The first two instruments are long-term sources of revenue, renewed on an annual basis, whereas betterment levies could be a one-off option, generating capital towards expenditures on public infrastructure.

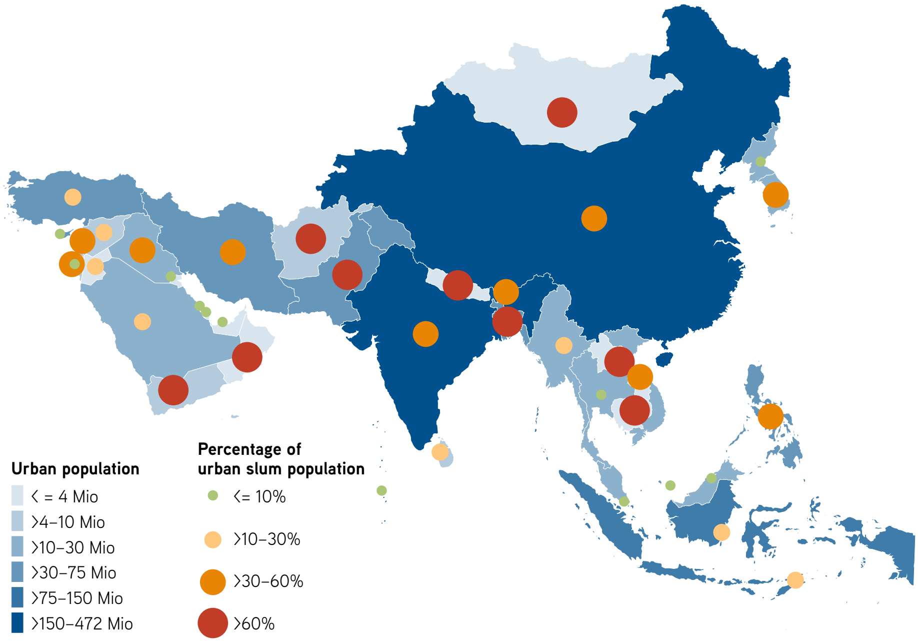
Aside from these, public-private partnerships could prove pivotal in financing services and sectors that can benefit local populations while boosting touristic profiles, thus creating a more sustainable economy. To protect the most vulnerable populations, low-income and other marginalised urban residents should be included in this type of decision making. Moreover, authorities should explore the use of public funds and the activation of private investments to address the shortfall in investments for sustainable urban infrastructure. The role of novel insurance strategies, including coalitions of multiple areas, should be investigated, as these can empower cities to address disaster risk better.

5.6.5. Informality

A slum household is defined by the United Nations as a home whose inhabitants are lacking one or more of the following five conditions: access to improved potable water, sanitation facilities, adequate living area, durable housing and secure tenure (UN-Habitat, 2018b). Figure 27 shows the concentration of slums in relation to urban population density across some of the Asian countries, including most of the EMME region. It is observed that in places such as Palestine, Lebanon and the Syrian Arab Republic –characterised by political instability – the plight of slums is considerably worse.

Countries of the western Asian continent made little progress towards the Millennium Development Goals, possibly because many of them had been engulfed in political turmoil for decades, exacerbating refugee crises and worsening conditions. For example, in Jordan, slum growth rates are pacing annually, a trend that has also emerged in Lebanon (Table 8). Since the population of both countries is relatively small, these numerical changes in slums might not have a significant impact on overall figures. Still, this should not be overlooked, as a reduction in slums could induce greater stability in the subregion

FIGURE 27. Urban population and proportion of slums in some Asian countries, 2001



Source: From UN-Habitat (2006b).

and better social indicators. An example to be followed is Turkey, where slum growth declined radically between 1990 and 2001, primarily because of an effective decentralising policy. This shift in competencies empowered municipal authorities to build or upgrade essential infrastructure such as water and sanitation networks (UN-Habitat, 2006b).

One of the main lessons to be learned regarding informality is understanding the extent and nature of the challenges and opportunities it poses, providing evidence for policy interventions that enhance living conditions while responding to climate change impacts. In this respect, the link between the informal economy and climate change should be probed, to identify and develop low-carbon solutions benefiting informal sectors and climate change mitigation efforts alike.

5.7. Facilitating initiatives

Cities of the EMME region are called to take inspiration from international notable existing initiatives facilitating local adaptation. For example, the *European Covenant of Mayors for Climate and Energy* (European Commission, 2021) gathers local governments of all sizes and from all countries around three main objectives: reducing CO_2 emissions, increasing their

TABLE 7. Urban population and slum proportion in selected countries, 2001

Country	Slum annual growth rate	% slums, 1990	% slums, 2005	Slum population, 1990	Slum population, 2005
Lebanon	3.1	50	50	1 142 000	1 811 000
Jordan	4.3	16.5	15.4	388 000	741 000
Iran	1.6	51.9	41.6	17 094 000	21 763 000
Saudi Arabia	3.8	19.8	19.8	2 385 000	4 196 000
Syrian Arab Republic	3.2	10.4	10.4	629 000	1 012 000
Turkey	0	23.3	16.3	7 997 000	8 016 000

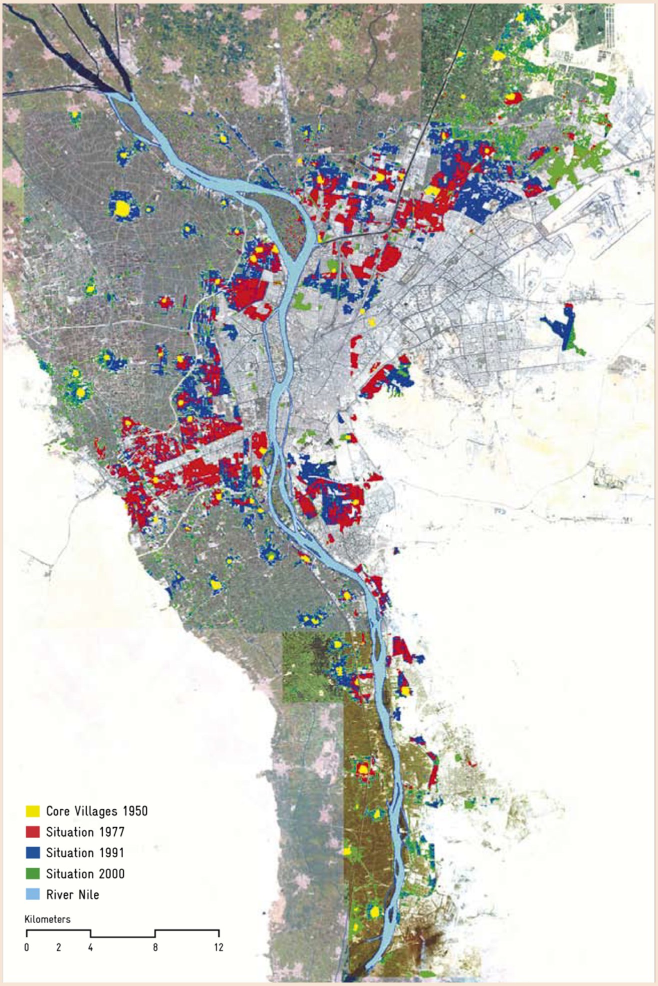
resilience to climate change and ensuring access to sustainable, secure and affordable energy to all. Another example is the *Making Cities Resilient Campaign* (2010-20) (UNDRR, 2010), which aims to increase the overall resilience to disasters of cities and towns by implementing risk reduction strategies. In October 2020, the initiative *Making Cities Resilient 2030* was launched with the same objective (UNDRR, 2020). Furthermore, the work of the *100 Resilient Cities* initiative (The Rockefeller Foundation, 2020), originating in 2013, has been followed up by the *Resilient Cities Network* (Resilient Cities Network, 2021) Partnerships among the global community of cities it encompasses allow continued knowledge sharing and collective collaboration that offers inspiration worldwide, with the invaluable support of chief resilience officers. Its mission is to connect cities and foster partnerships to advance urban resilience solutions globally and help urban communities suffering acute shocks or chronic afflictions to rebound and flourish. Meanwhile, the *C40 Cities* (C40, 2020) convening networks support climate change adaptation efforts of cities by offering a range of services, including workshops, trainings and development of repositories of available tools and best practices.

The C40 global organisation encompasses a variety of initiatives and international collaborations, including the *Connecting Delta Cities Network*, which aims to bring together twelve delta cities (such as London and Venice) in a knowledge and experience exchange, the Cool Cities Network, steered by Athens in partnership with the Global Cool Cities Alliance, which aspires to reduce impacts of UHI effects in cities, and the *Urban Flooding Network*, with nine European cities addressing the impacts of floods. Finally, another prominent global network of cities is the *Local Governments for Sustainability* (ICLEI) initiative, with more than 2500 cities, towns and regions all over the world. This initiative regularly promotes news on the latest developments regarding climate adaptation and urban resilience, and hosts the European Urban Resilience Forum on an annual basis (ICLEI, 2019).

Box 7. Growth of informal settlements in Egypt

Informal settlements along with squatter areas are estimated to accommodate between 12-16 million inhabitants, or about 40-50% of Egypt's urban population and over 20% of its total population.

FIGURE 28. Informal settlements in Cairo, Egypt.



An informal housing unit is a structure in violation of relevant urban planning legislation and building codes in Egypt and is often encountered when legally owned agricultural land is converted to serve urban use without adherence to national regulations. Illegalities arise when building permits are not obtained, land subdivision procedures are not followed and the required registered property titles are lacking (World Bank, 2007).

Source: Howeidy et al., 2009; Madbouly, 2009.

Box 8. Informal settlements in Lebanon: The case of Beirut

Slum identification in Beirut is complex and formalizing slums is difficult due to a suite of factors, including limited property rights and a widespread violation of building codes. For this reason, Azab et al. (2018) identify slums as areas where the majority of residents are found in vulnerable economic and/or political situations, with lower levels of living conditions and city services, compared to other parts of Beirut.

FIGURE 29. Image of Syrian women and girls in an informal settlement in the Bekaa Valley, Lebanon.

In summary, city-level policies should develop a vision of the future and expand the scope of community participation and action. Furthermore, participatory risk assessments should be conducted, and these assessments should be used to prepare action plans, paying particular attention to the importance of investment in major infrastructure.

Source: Russell Watkins/DFID, 2017.

6. Conclusions and good practices

Intense urbanisation and climate change in the EMME region put millions of people at risk, with the most vulnerable having to endure the greatest impacts. This report aims to summarise the existing knowledge on climate- and weather-related hazards and the current and projected climate-related impacts that cities of the EMME region are facing and will be exposed to in the future. Geographic, socio-economic and socio-political conditions affect the vulnerability of urban centres and their residents or commuters. However, cities of the region also can be major catalysts of change in mitigation and adaptation actions against climate change; they typically attract most of a country's population and, therefore, offer sustainable living conditions for a significant share of the EMME's population. Moreover, cities can become nuclei of change through modifications in the built environment, infrastructure and transport systems, facilitating reductions in GHG emissions and meeting international sustainability goals.

This report identifies political and geographical features unique to the EMME region, linking them to socio-economic conditions. In general, higher living conditions are encountered in the urban centres, relative to rural areas, with a stark contradiction in individual and national prosperity between the oil-rich countries of the Middle East and those with no significant hydrocarbon reserves. The cultural diversity in terms of ethnicity, religion and language, often results in warfare, although competition for natural resources is possibly one of the underlying causes of conflict. This report also lists the main characteristics of the building stock, highlighting the diverse materials, densities, constructed areas and building typologies encountered in the different settings.

All these characteristics are inter-linked with prevailing socio-economic conditions, for example, highly developed urban and economic hubs such as Dubai feature high-rise and tall buildings made of steel and reinforced concrete. On the other hand, cities of Cyprus, Greece, Jordan, Lebanon and the Syrian Arab Republic (among others) with lower economic activities, feature low-rise masonry buildings or multistory reinforced concrete frame constructions. A different geographical divide is observable here, where the EU countries (i.e. Cyprus and Greece) have readily available detailed data on their building stocks and related energy consumption. In contrast, information on building stocks in the Middle Eastern countries is scarce and hard to locate. An exception is the case of implementation of renewable energy technologies, where the IEA offers information on solar PV generation, which has been observed to increase dramatically over the past two decades.

The energy intensity of the building sectors across Middle Eastern countries has been on a declining trend and is projected to decrease even further up to 2030.

Environmental quality monitoring and augmented urban resilience have also been identified as crucial elements of a well-functioning city, providing healthy and safe environmental conditions within and outside buildings. Waste management and urban pollution of air, soil and water resources are the main man-made challenges, whereas natural disasters such as storms, floods, extreme heat, drought and dust events are making cities in the EMME more difficult to live in.

Mitigation strategies to address the abovementioned challenges include the creation of low-energy, sustainable and resilient buildings and neighbourhoods, while applying circular economy principles in the construction sector. In addition, urban design and land-use planning are focal in the mitigation of excessive heat and the UHI phenomenon, whereas sustainable mobility technologies will aid in the decarbonisation of local environments. As for climate change adaptation strategies, four approaches have been recognised and briefly presented: technology-, ecosystem-, community- and policy-based strategies. Sustainable cities require a mix of these approaches, in conjunction with local circumstances and tailored needs.

In the policy landscape, international efforts such as the Paris Agreement, the UN's SDGs or the Sendai Framework for Disaster Risk Reduction act as roadmaps for adaptation and mitigation actions. However, national and local governments are responsible for the adoption of these proposed strategies. The engagement of public and private stakeholders has been mentioned throughout this report, recognising the fundamental role of political willingness to turn words into actions. The poor transposition of international agreements into national laws and policies is also reflected in the building sector, with two-thirds of the region lacking mandatory building energy codes in 2018. At the national level, each country has advanced on its own terms. There is a lack of homogeneity in the greater EMME region, which is why international co-operation and common frameworks and ambitions should be established across the region.

Within this wider context of international co-operation, the lessons learned from this work can be applied both at the international and the national levels. Mitigation and adaptation actions should be more efficiently integrated and co-ordinated, identifying synergies that could offer immediate alleviation of climate change impacts and boost cities' resilience against future hazards. Moreover, these actions should be planned considering the long-term horizon, avoiding regulatory inertia and carbon lock-ins – representatives of ineffective systems that should be gradually eliminated and replaced by flexible, responsive ones. The need for such adaptable approaches is becoming increasingly evident in the metacities of the EMME region, where shifting populations and their needs are changing the shapes and services of urban centres. New forms of city-regions call for novel forms of co-ordinated management, inclusive of the cultural diversity they encompass and promoting a participatory approach, especially between the national and local levels. Engagement of stakeholders is also pertinent to institutional co-ordination in developing climate responses, including funding schemes towards the renovation of building stocks, elaboration and adoption of building codes and fostering of grassroots activities. Finally, adaptation and mitigation strategies should focus on five main aspects, while integrating the discussed multidimensional knowledge: urban planning and design, built infrastructure, sustainable consumption and production, finance and informality.

The EMME region is in urgent need of holistic and co-ordinated actions, developing consolidated evidence-based strategies for cities that aspire to be resilient in the near and far future, cities able to absorb environmental shocks induced by climate change and offer safe and equitable lives for urban dwellers and commuters. Co-operation among the countries and cities of this region is vital, and harmonisation of activities is indispensable. Practical policy recommendations are presented below, addressed to policy makers and relevant stakeholders.

This report acknowledges that human settlements and the built environment of our cities are facing unprecedented pressures from climate change and its associated threats, challenging any efforts to sustainable development. Based on the current metropolitan areas' demographic trends and the central role cities play in the global economy, as well as in any effort to apply mitigation and adaptation strategies, the built environment requires major actions to respond to climate change. This need is further intensified by the primary role of metropolitan areas in the consumption of resources; their interrelation with ecosystems and the way they are designed, financed, operated, constructed and administrated, all of which have a direct influence on the successful implementation of sustainability and resilience measures. In this context, inspired by the "Drive Urban Transitions towards a Sustainable and Livable Future" initiative (JPI Urban Europe, 2020), specific steps towards developing and implementing mitigation and adaptation strategies in urban environments are presented and organised in five groups.

6.1. Urban design, planning and sustainable development

- Encourage stimulation of a more comprehensive grasp of the nexus between urban planning, design and infrastructure and mitigation and adaptation to climate change.

- Ensure integration of urban microclimates into the overarching urban planning and design, to tackle several urban challenges simultaneously: improve urban environment and services, reduce risks stemming from natural and human-made hazards and address the need to adapt to, and mitigate, climate change.
- Facilitate the sustainable management of natural resources, safeguarding the urban ecosystem and its services.
- Implement waste management practises that protect and enhance the urban natural habitat, mitigating water, air and soil pollution.
- Reduce vulnerability of both formal and informal settlements to climate change by promoting urban and spatial planning.
- Follow a systemic approach to consolidating energy demand and supply needs and capacity at the district level to deliver more efficient and tailored low-carbon solutions.
- Create public green open spaces to reinforce human well-being and health and improve urban resilience.
- Develop and apply strategies to protect and promote urban life, while preserving territorial equity and the well-being of people living in the rural areas.

6.2. Governance and policy integration

- Develop and implement mandatory building codes in the context of an Energy Efficiency Action Plan (EEAP). Transition from voluntary to mandatory building codes that set minimum performance requirements for new buildings and renovations.
- Encourage sustainable use of resources in construction within the context of a circular economy.
- Strengthen building codes and EEAPs and establish an improvement cycle every three to five years to strengthen performance requirements, with the aim of achieving a zero-energy target and, possibly, a zero-emissions one.
- Connect climate action, energy transition targets and urban environment quality.
- Afford regional governmental bodies the authority to act independently towards the development of sustainable cities, while maintaining some form of central regulation and safeguarding transparency in public expenditure.
- Implement territorial development through multidisciplinary approaches, experts and policy makers, connecting urban development to research and innovation strategies.

- Establish incubators of innovation at the city level, drawing from different pools of expertise, including different authority levels, academia and research centres, private entities and civic groups.

6.3. Economic support and access to finance

- Mobilise sustainable and affordable building financing. Facilitate the design, construction and renovation of sustainable buildings by creating incentives through enhanced access to/use of financing to enable private investment.
- Conceive financial mechanisms for raising renovation/retrofitting rates to an average of 2% of existing stock per year by 2025, and to 3% by 2040 by increasing access to/use of financing to enable private investment in renovations.
- Facilitate and incentivise deep renovations for enhanced energy efficiency and reduced energy consumption of existing buildings by 50%, or more.
- Foster sustainable consumption and production.
- Capitalise on own-source revenue, integrating urban planning and infrastructure development to boost the urban economy and public finances, while ensuring that vulnerable populations will not be disproportionally affected.
- Develop and strengthen public-private partnerships to enhance the attractiveness of urban centres for locals and non-locals alike.
- Employ a diverse portfolio of revenue generation via different fiscal instruments.
- Empower local businesses to become drivers of innovation in the sustainable development of cities, create jobs and attract private investments.
- Operate within stable financial systems that are governed by appropriate legal and regulatory frameworks for sustainable national and municipal borrowings and all related fiscal activities.
- Work in synergy with various national and international financial institutions and funds, such as regional development banks and the Green Climate Fund.

6.4. Technology-enabled and data-driven communities

- Take actions in the context of digitisation, clean energy and innovative transport options to materialise smart cities and allow for digital governance.
- Design and build new buildings to be responsive and adaptable to the site-specific and changing geo-climatic conditions. Countries of the EMME represent a laboratory for assessing such challenges due to their extreme climatic variations.

- Retrofit the existing building stock to reduce carbon emissions, while reducing the need for new buildings that require a significant amount of energy and materials for their construction.
- Demand the integration of renewable energy into new building design to achieve a net-zero energy goal (possibly zero emissions).
- Integrate current methodological innovations in GHG emissions calculations by exploring the concept of urban metabolism.
- Consider the full life-cycle implications of various urban economic structures, modes and patterns of production and their associated carbon lock-in effects.
- Support and enhance national and regional data collection, analysis and dissemination and promote evidence-based governance, offering open and user-friendly participatory data platforms to facilitate knowledge transfer.

6.5. Resilient and equitable communities

- Document and quantify climate change impacts on human health and extrapolate the full range of health benefits of adaptation and mitigation to support future urban planning.
- Educate communities on the risks of climate change, and natural and man-made hazards; develop and acquaint communities with early warning systems; support disaster-stricken communities with immediate relief plans.
- Foster people's participation in the transformation of cities in ways that are less resource intensive and enhance human well-being.
- Leverage co-design and co-production.
- Empower cities and their citizens, acknowledging the potential and effectiveness of voluntary collaborative initiatives and coalitions.
- Foster the creation of city-to-city networks.
- Concentrate efforts and support to local communities and their urban neighbourhood.
- Empower minorities and eliminate any type of discrimination, by promoting capacity development among disadvantaged groups (women and girls, youth, elderly, persons with disabilities).
- Allow space and create opportunity for a diversity of approaches and socio-technological experimentation.

References

Abu-Ismail, Khalid. 2018. "Poverty and Vulnerability in Arab States." Beirut, Lebanon.

Abu-Lughod, Janet L. 1987. "The Islamic City – Historic Myth, Islamic Essence, and Contemporary Relevance." *International Journal of Middle East Studies*. https://doi.org/10.1017/s0020743800031822.

Abu Dhabi Urban Planning Council (UPC). 2010. "Pearl Building Rating System: Design & Construction, Version 10." Abu Dhabi, UAE.

Aguiar, Francisca C, Julia Bentz, João M N Silva, Ana L Fonseca, Rob Swart, Filipe Duarte Santos, and Gil Penha-Lopes. 2018. "Adaptation to Climate Change at Local Level in Europe: An Overview." https://doi.org/10.1016/j.envsci.2018.04.010.

Akhbarizadeh, Razegheh, Sina Dobaradaran, Mehdi Amouei Torkmahalleh, Reza Saeedi, Roza Aibaghi, and Fatemeh Faraji Ghasemi. 2021. "Suspended Fine Particulate Matter (PM2.5), Microplastics (MPs), and Polycyclic Aromatic Hydrocarbons (PAHs) in Air: Their Possible Relationships and Health Implications." *Environmental Research* 192 (January): 110339. https://doi.org/10.1016/j.envres.2020.110339.

Al-Delaimy, Wael K. 2020. "Vulnerable Populations and Regions: Middle East as a Case Study." In *Health of People, Health of Planet and Our Responsibility*, 121–33. Springer International Publishing. https://doi.org/10.1007/978-3-030-31125-4_10.

Al-Douri, Y, S A Waheeb, and C H Voon. 2019. "Review of the Renewable Energy Outlook in Saudi Arabia." *Journal of Renewable and Sustainable Energy* 11 (1): 15906. https://doi.org/10.1063/1.5058184.

Alajmi, Turki Rakan M J. 2019. "Kuwait Residential Energy Outlook - Modeling the Diffusion of Energy Conservation Measures." Tempe, AZ, USA: Arizona State University.

Alawadi, Khaled, and Ouafa Benkraouda. 2019. "The Debate over Neighborhood Density in Dubai: Between Theory and Practicality." *Journal of Planning Education and Research* 39 (1): 18–34. https://doi.org/10.1177/0739456X17720490.

Alrashed, Farajallah, and Muhammad Asif. 2014. "Saudi Building Industry's Views on Sustainability in Buildings: Questionnaire Survey." *Energy Procedia* 62. https://doi.org/10.1016/j.egypro.2014.12.400.

Alsabbagh, Maha. 2019. "Mitigation of CO_2 e Emissions from the Municipal Solid Waste Sector in the Kingdom of Bahrain." https://doi.org/10.3390/cli7080100.

Alyousef, Yousef, and Abdulhadi Varnham. 2010. "Saudi Arabia's National Energy Efficiency Programme: Description, Achievements and Way Forward." *International Journal of Low-Carbon Technologies* 5 (4): 291–97. https://doi.org/10.1093/ijlct/ctq017.

Attia, Shady, Arnaud Evrard, and Elisabeth Gratia. 2012. "Development of Benchmark Models for the Egyptian Residential Buildings Sector." Applied Energy 94 (June): 270–84. https://doi.org/10.1016/j.apenergy.2012.01.065.

Attia, Shady, and Omar Wanas. 2012. "The Database of Egyptian Building Envelopes (DEBE): A Database for Building Energy Simulations."

Aw-Hassan, Aden, Fadel Rida, Roberto Telleria, and Adriana Bruggeman. 2014. "The Impact of Food and Agricultural Policies on Groundwater Use in Syria." *Journal of Hydrology* 513 (May): 204–15. https://doi.org/10.1016/j.jhydrol.2014.03.043.

Azab, Nader, Kareem Jalal, and Osama Omar. 2018. "Ouzai Road Slumsan Exploratory Study for Social and Environmental Problems." *BAU Journal-Health and Wellbeing* 1.

Babelli, I. 2012. "Saudi Arabia's Renewable Energy Strategy and Solar Energy Deployment Roadmap." *Saudi Solar Energy Forum 2012*. Riyadh, Kingdon of Saudi Aarabia.

Bai, Xuemei, Alyson Surveyer, Thomas Elmqvist, Franz W. Gatzweiler, Burak Güneralp, Susan Parnell, Anne Hélène Prieur-Richard, et al. 2016. "Defining and Advancing a Systems Approach for Sustainable Cities." *Current Opinion in Environmental Sustainability*. https://doi.org/10.1016/j.cosust.2016.11.010.

Bairoch, Braider. 1988. *Cities and Economic Development: From the Dawn of History to the Present*. https://press.uchicago.edu/ucp/books/book/chicago/C/bo5971175.html.

Bampou, P. 2016. "Green Buildings for Egypt: A Call for an Integrated Policy." https://doi.org/10.1080/14786451.2016.1159207.

be'ah. 2019. "Striving for Sustainability." www.beah.om.

Becker, Daniel, and Muhieddin Tawalbeh. 2013. "Jordan Energy Efficiency Action Plan." *MED-ENEC Support on National Energy Efficiency Action Plans (NEEAPs)*. Vol. ENPI/2009/. Bonn, Germany: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

Ben-Hur, M. 2014. "Green Building Rating Systems - A Comparison of LEED 2009 and SI5281." Jerusalem/Tel Aviv, Israel: Israel Ministry of Environmental Protection and Porter School of Environmental Studies & Institute for Business, Environment and Society, Tel-Aviv University.

Bigio, Anthony G. 2009. "Adapting to Climate Change and Preparing for Natural Disasters in the Coastal Cities of North Africa." In *Urban Research Symposium, Cities and Climate Change: Responding to an Urgent Agenda*. Marseilles, France.

Boemi, Sofia-Natalia, Giorgos Panaras, and Agis M. Papadopoulos. 2017. "Residential Heating under Energy Poverty Conditions: A Field Study." *Procedia Environmental Sciences* 38: 867–74. https://doi.org/10.1016/j.proenv.2017.03.173.

Borgomeo, Edoardo, Anders Jagerskog, Amal Talbi, Marcus Wijnen, Mohamad Hejazi, and Fernando Miralles-Wilhelm. 2018. *The Water-Energy-Food Nexus in the Middle East and North Africa*. Washington DC, USA: World Bank, Washington, DC. https://doi.org/10.1596/29957.

Bouzarovski, Stefan, and Saska Petrova. 2015. "A Global Perspective on Domestic Energy Deprivation: Overcoming the Energy Poverty-Fuel Poverty Binary." *Energy Research and Social Science* 10: 31–40. https://doi.org/10.1016/j.erss.2015.06.007.

Bozkurt, Zehra, Güray Doğan, Demet Arslanbaş, Beyhan Pekey, Hakan Pekey, Yetkin Dumanoğlu, Abdurrahman Bayram, and Gürdal Tuncel. 2015. "Determination of the Personal, Indoor and Outdoor Exposure Levels of Inorganic Gaseous Pollutants in Different Microenvironments in an Industrial City." *Environmental Monitoring and Assessment* 187 (9): 590. https://doi.org/10.1007/s10661-015-4816-8.

Bozkurt, Zehra, Eftade O. Gaga, Fatih Taşpınar, Akif Arı, Beyhan Pekey, Hakan Pekey, Tuncay Döğeroğlu, and Özlem Özden Üzmez. 2018. "Atmospheric Ambient Trace Element Concentrations of PM10 at Urban and Sub-Urban Sites: Source Apportionment and Health Risk Estimation." *Environmental Monitoring and Assessment* 190 (3). https://doi.org/10.1007/s10661-018-6517-6.

BSO. 2020. "EU Buildings Database." 2020. https://ec.europa.eu/energy/eu-buildings-database_en.

Build_ME. 2021. "Towards a Low-Carbon Building Sector in the MENA Region." 2021. https://www.buildings-mena.com/.

C40. 2020. "C40 Cities." 2020. https://www.c40.org/.

CAPMAS. 2020. "Total Number of Housing Units in Egypt." Cairo, Egypt.

CBS. 2021. "Central Bureau of Statistics Israel." 2021. https://www.cbs.gov.il/EN/pages/default.aspx.

Charabi, Yassine, Abdullah Al-Badi, Erik Sorensen, and IRENA. 2014. "Sultanate of Oman, Renewables Readiness Assessment." https://doi.org/10.13140/2.1.2109.2166.

Charabi, Yassine, and Abdelhamid Bakhit. 2011. "Assessment of the Canopy Urban Heat Island of a Coastal Arid Tropical City: The Case of Muscat, Oman." *Atmospheric Research* 101 (1–2): 215–27. https://doi.org/10.1016/j.atmosres.2011.02.010.

Châtel, Francesca De. 2014. "The Role of Drought and Climate Change in the Syrian Uprising: Untangling the Triggers of the Revolution." *Middle Eastern Studies* 50 (4): 521–35. https://doi.org/10.1080/00263206.2013.850076.

Chatzinikola, C, D Serghides, and M Santamouris. 2015. "Effect of the Orientation on the Winter Indoor Temperatures and on the Energy Consumption of Low-Income Dwellings in the Mediterranean Region." In *International Conference with Exhibition S.ARCH - Environment and Architecture*, 1–9. Montenegro.

Chen, Yong Shing, Pai Ching Sheen, Eng Rin Chen, Yi Kuen Liu, Trong Neng Wu, and Chun Yuh Yang. 2004. "Effects of Asian Dust Storm Events on Daily Mortality in Taipei, Taiwan." *Environmental Research* 95 (2): 151–55. https://doi.org/10.1016/j.envres.2003.08.008.

Choi, Hi Sun, Goman Ho, Leonard Joseph, Neville Mathias, and Ctbuh. 2020. "CTBUH Height Criteria." In *Outrigger Design for High-Rise Buildings*. https://doi.org/10.1201/9781315661971-13.

Climate Action Tracker. 2021. "Turkey: Update 30 July 2020." 2021.

Climate Adaptation Partnership. 2018. "Urban Agenda for the EU."

Cramer, Wolfgang, Joël Guiot, Marianela Fader, Joaquim Garrabou, Jean Pierre Gattuso, Ana Iglesias, Manfred A. Lange, et al. 2018. "Climate Change and Interconnected Risks to Sustainable Development in the Mediterranean." *Nature Climate Change*. https://doi.org/10.1038/s41558-018-0299-2.

CRED/UCLouvain. 2020. "EM-DAT, the International Disaster Database." Brussels, Belgium. 2020. www.emdat.be.

CTBUH. 2018. "The Middle East: 30+ Years of Building Tall."

———. 2020. "Tall Building Criteria." Council of Tall Buildings and Urban Habitat. 2020.

Dabbeek, Jamal, and Vitor Silva. 2020. *Modeling the Residential Building Stock in the Middle East for Multi-Hazard Risk Assessment. Natural Hazards*. Vol. 100. Springer Netherlands. https://doi.org/10.1007/s11069-019-03842-7.

Department of Economic and Social Affairs. 2019. *World Urbanization Prospects: The 2018 Revision*. Edited by United Nations. World Urbanization Prospects: The 2018 Revision. https://doi.org/10.18356/b9e995fe-en.

Department of Environment. 2018. "Cyprus - Seventh National Communication & Third Biennial Report under the United Nations Framework Convention on Climate Change." Nicosia, Cyprus: Ministry of Agriculture, Rural Development and Environment.

Directorate-General for Energy. 2019. "Clean Energy for All Europeans." https://doi.org/http://doi.org/10.2833/9937.

Dodman, David, Bernhard Barth, Iole Issaias, Robert Kehew, Christophe Lalande, Laids Mamonong, John Mwaura, et al. 2010. *Developing Local Climate Change Plans*. Edited by Bernhard Barth, Fernando Cabrera Diaz, Thierry Naudin, Tom Osanjo, and Cora Denhartigh. Cities And. Nairobi, Kenya: United Nations Human Settlements Programme.

Dossing, M, J Khan, and F Al-Rabiah. 1994. "Risk Factors for Chronic Obstructive Lung Disease in Saudi Arabia." Vol. 88.

Dubai Municipality. 2016. "Al Sa'fat—Dubai Green Buildings Evaluation System." 2016. www.dm.gov.ae.

Dubai Supreme Council of Energy. 2017. "Dubai Demand Side Management Strategy - 2017 Annual Report." Dubai, UAE. https://etihadesco.ae/taqati/report/2017.pdf.

EcoMENA. 2020. "Knowledge Bank ." 2020. https://www.ecomena.org/blog-index/.

EEA. 2017. *Climate Change Adaptation and Disaster Risk Reduction in Europe. Enhancing Coherence of the Knowledge Base, Policies and Practices*. EEA Report.

———. 2018. *Air Quality in Europe — 2018 Report No 12/2018*. Air Quality in Europe -2018 Report.

———. 2019. "EIONET." 2019. http://cdr.eionet.europa.eu/gr.

———. 2020. "Global and European Sea Level Rise." 2020. https://www.eea.europa.eu/data-and-maps/indicators/sea-level-rise-7/assessment.

Egypt's Cabinet Information and Decision Support Centre (IDSC). 2011. "Egypt's National Strategy for Adaptation to Climate Change and Disaster Risk Reduction ." Cairo, Egypt.

Egyptian Environmental Affairs Agency (EEAA). 2016. "Egypt Third National Communication Under the United Nations Framework Convention on Climate Change." Cairo, Egypt: Ministry of State for Environmental Affairs Agency.

EIA. 2015. "Qatar Summary Energy Statistics."

———. 2019. "Background Reference: Oman." 2019. https://www.eia.gov/international/content/analysis/countries_long/Oman/background.htm.

Elgendy, Karim. 2011. "Sustainable Development and the Built Environment in the Middle East: Challenges and Opportunities." Carboun | Middle East Sustainable Cities. 2011. http://www.carboun.com/sustainable-design/sustainable-development-and-the-built-environment-in-the-middle-east-challenges-and-opportunities/.

Elgendy, Karim, and Natasha Abaza. 2020. "Urbanization in the MENA Region: A Benefit or a Curse?: Department for Middle East and North Africa." 2020. https://mena.fes.de/press/e/urbanization-in-the-mena-region-a-benefit-or-a-curse.

Elkabir, Yassin Ali. 1983. "The Study of Urbanization in the Arab World: A Theoretical Perspective." *Ekistics* 50 (300): 232–36.

Elshaer, Ahmed, Girma Bitsuamlak, and Ashraf El Damatty. 2017. "Enhancing Wind Performance of Tall Buildings Using Corner Aerodynamic Optimization." *Engineering Structures* 136 (October): 133–48. https://doi.org/10.1016/j.engstruct.2017.01.019.

energypedia. 2018a. "Jordan Energy Situation." 2018.

———. 2018b. "Turkey- Energy Efficiency in Buildings." 2018.

Erickson, Peter, Sivan Kartha, Michael Lazarus, and Kevin Tempest. 2015. "Assessing Carbon Lock-In." *Environmental Research Letters*. https://doi.org/10.1088/1748-9326/10/8/084023.

European Commission. 2018. "EU Energy Poverty Observatory (EPOV)." 2018. https://ec.europa.eu/energy/en/events/launch-eu-energy-poverty-observatory-epov.

———. 2019. "The European Green Deal." https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019DC0640&from=EN.

———. 2020. "A Renovation Wave for Europe - Greening Our Buildings, Creating Jobs, Improving Lives." Brussels.

———. 2021. "Covenant of Mayors." 2021. https://www.covenantofmayors.eu/en/.

European Environmental Agency. 2014. "Horizon 2020 Mediterranean Report - Toward Shared Environmental Information Systems." Luxembourg.

European Union. 2018. "Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 Amending Directive 2010/31/EU on the Energy Performance of Buildings and Directive 2012/27/EU on Energy Efficiency." *Official Journal of the European Union* 2018 (May): 75–91. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0844&from=EN.

Eurostat. 2001. "Dwellings by Type of Ownership, Type of Building and Occupancy Status." 2001. https://ec.europa.eu/eurostat/databrowser/view/cens_01ndbuild/default/table?lang=en.

Ferwati, M Salim, Mahmoud Alsaeed, Arezou Shafaghat, and Ali Keyvanfar. 2019. "Qatar Sustainability Assessment System (QSAS)-Neighbourhood Development (ND) Assessment Model: Coupling Green Urban Planning and Green Building Design." *Journal of Building Engineering* 22: 171–80. https://doi.org/https://doi.org/10.1016/j.jobe.2018.12.006.

Fouillet, A., G. Rey, F. Laurent, G. Pavillon, S. Bellec, C. Guihenneuc-Jouyaux, J. Clavel, E. Jougla, and Denis Hémon. 2006. "Excess Mortality Related to the August 2003 Heat Wave in France." *International Archives of Occupational and Environmental Health* 80 (1): 16–24. https://doi.org/10.1007/s00420-006-0089-4.

Galvin, Madeleine, and Anne Maassen. 2019. "Urban Transformations: The Reinvention of Eskisehir, Turkey from Dump to Destination | World Resources Institute." World Resources Institute. 2019. https://www.wri.org/blog/2019/03/urban-transformations-reinvention-eskisehir-turkey-dump-destination.

Giannakopoulos, C, P Le Sager, M Bindi, M Moriondo, E Kostopoulou, and C M Goodess. 2009. "Climatic Changes and Associated Impacts in the Mediterranean Resulting from a 2 °C Global Warming." *Global and Planetary Change*. https://doi.org/10.1016/j.gloplacha.2009.06.001.

Giannaros, Theodore M, and Dimitrios Melas. 2012. "Study of the Urban Heat Island in a Coastal Mediterranean City: The Case Study of Thessaloniki, Greece." *Atmospheric Research* 118 (November): 103–20. https://doi.org/10.1016/j.atmosres.2012.06.006.

Giorgi, F. 2006. "Climate Change Hot-Spots." *Geophysical Research Letters*. https://doi.org/10.1029/2006GL025734.

GlobalABC/IEA/UNEP. 2020. "GlobalABC Roadmap for Buildings and Construction Towards a Zero-Emission, Efficient, and Resilient Buildings and Construction Sector." www.iea.org.

Google Earth. 2022. "EMME Region." 2022. https://earth.google.com.

GORD. 2019. "GSAS Technical Guide 2019 - Issue 2." *GSAS PUBLICATION SERIES*. Gulf Organisation for Research and Development (GORD). https://www.gord.qa/admin/Content/Link2722020122828.pdf.

———. 2020. "Global Sustainability Assessment System (GSAS)." www.gord.qa.

Government of Dubai. 2020. "Green Building Regulations and Specifications in the Emirate of Dubai." Dubai, United Arab Emirates. https://www.dewa.gov.ae/~/media/Files/Consultants and Contractors/Green Building/Greenbuilding_Eng.ashx.

Grivas, Georgios, Stavros Cheristanidis, Archontoula Chaloulakou, Petros Koutrakis, and Nikos Mihalopoulos. 2018. "Elemental Composition and Source Apportionment of Fine and Coarse Particles at Traffic and Urban Background Locations in Athens, Greece." *Aerosol and Air Quality Research* 18 (7): 1642–59. https://doi.org/10.4209/aaqr.2017.12.0567.

Grmasha, Ruqayah Ali, Osamah J. Al-sareji, Jasim M. Salman, and Khalid S. Hashim. 2020. "Polycyclic Aromatic Hydrocarbons (PAHs) in Urban Street Dust within Three Land-Uses of Babylon Governorate, Iraq: Distribution, Sources, and Health Risk Assessment." *Journal of King Saud University - Engineering Sciences*, November. https://doi.org/10.1016/j.jksues.2020.11.002.

Grübler, Arnulf, and David Fisk. 2012. *Energizing Sustainable Cities: Assessing Urban Energy. Energizing Sustainable Cities: Assessing Urban Energy*. https://doi.org/10.4324/9780203110126.

Hamed, Tareq Abu, and Kristiana Peric. 2020. "The Role of Renewable Energy Resources in Alleviating Energy Poverty in Palestine." *Renewable Energy Focus* 35. https://doi.org/10.1016/j.ref.2020.09.006.

Harlan, Sharon L., Anthony J. Brazel, G. Darrel Jenerette, Nancy S. Jones, Larissa Larsen, Lela Prashad, and William L. Stefanov. 2007. "In the Shade of Affluence: The Inequitable Distribution of the Urban Heat Island." *Research in Social Problems and Public Policy*. https://doi.org/10.1016/S0196-1152(07)15005-5.

Harlan, Sharon L., and Darren M. Ruddell. 2011. "Climate Change and Health in Cities: Impacts of Heat and Air Pollution and Potential Co-Benefits from Mitigation and Adaptation." *Current Opinion in Environmental Sustainability*. Elsevier. https://doi.org/10.1016/j.cosust.2011.01.001.

Hassan, Noor Artika, Zailina Hashim, and Jamal Hisham Hashim. 2016. "Impact of Climate Change on Air Quality and Public Health in Urban Areas." *Asia Pacific Journal of Public Health* 28 (2_suppl): 38S-48S. https://doi.org/10.1177/1010539515592951.

Hawksworth, John, Hannah Audino, and Rob Clarry. 2017. "The Long View: How Will the Global Economic Order Change by 2050?" *Price Waterhouse and Coopers*.

Heidrich, O., D. Reckien, M. Olazabal, A. Foley, M. Salvia, S. de Gregorio Hurtado, H. Orru, et al. 2016. "National Climate Policies across Europe and Their Impacts on Cities Strategies." *Journal of Environmental Management* 168 (March): 36–45. https://doi.org/10.1016/j.jenvman.2015.11.043.

Hellenic Republic: Ministry of Environment and Energy. 2018. "7th National Communication and 3rd Biennial Report Under the United Nations Framework Convention on Climate Change."

Hofste, Rutger Willem, Paul Reig, and Leah Schleifer. 2019. "17 Countries, Home to One-Quarter of the World's Population, Face Extremely High Water Stress." World Resources Institute. 2019. https://www.wri.org/insights/17-countries-home-one-quarter-worlds-population-face-extremely-high-water-stress.

Horowitz, Cara A. 2016. "Paris Agreement." *International Legal Materials* 55 (4): 740–55. https://doi.org/10.1017/S0020782900004253.

Howeidy, Amira, Dina K. Shehayeb, Edgar Göll, Khaled Mahmoud Abdel Halim, Marion Séjourné, Mona Gado, Elena Piffero, et al. 2009. *Cairo's Informal Areas Between Urban Challenges and Hidden Potentials*. Edited by Regina Kipper and Marion Fischer. Cairo: © GTZ Egypt Participatory Development Programme in Urban Areas (PDP). www.gtz.de.

Hungate, B.A., and G.W. Koch. 2015. "GLOBAL CHANGE | Biospheric Impacts and Feedbacks." In *Encyclopedia of Atmospheric Sciences*, 132–40. Elsevier. https://doi.org/10.1016/B978-0-12-382225-3.00472-2.

Ibrahim, Saad E. M. 1975. "Over-Urbanization and under-Urbanism: The Case of the Arab World." *International Journal of Middle East Studies*. Vol. 6. https://www.jstor.org/stable/162733.

ICLEI. 2019. "Local Governments for Sustainability." 2019. https://www.iclei.org/.

IEA. 2019. *2019 Global Status Report for Buildings and Construction Towards a Zero-Emissions, Efficient and Resilient Buildings and Construction Sector*. www.iea.org.

———. 2020a. "Building Envelopes." 2020.

———. 2020b. "Countries and Regions." Paris, France. 2020.

———. 2020c. "Data & Statistics." 2020. https://www.iea.org/data-and-statistics?country=WORLD&fuel=CO2 emissions&indicator=CO2PerCap.

———. 2020d. "Tracking Buildings 2020." Paris. https://www.iea.org/reports/tracking-buildings-2020.

———. 2021. "World Energy Balances and Statistics ." 2021. https://www.iea.org/subscribe-to-data-services/world-energy-balances-and-statistics.

IPCC. 2007. "Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change ." Geneva. https://www.ipcc.ch/report/ar4/syr/.

———. 2018. "Summary for Policymakers." In *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*, edited by V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, et al.

———. 2019. "Special Report on the Ocean and Cryosphere in a Changing Climate ." https://www.ipcc.ch/srocc/.

IRENA. 2020. "Trends in Renewable Energy." 2020. https://public.tableau.com/views/IRENARETimeSeries/Charts?:embed=y&:showVizHome=no&publish=yes&:toolbar=no.

Islamic Republic of Iran. 2003. "Initial National Communication to United Nations Framework Convention on Climate Change (UNFCCC)." National Climate Change Office at the Department of Environment. https://unfccc.int/sites/default/files/resource/Iran INC.pdf.

———. 2010. "Second National Communication to United Nations Framework Convention on Climate Change (UNFCCC)." National Climate Change Office at the Department of Environment. https://unfccc.int/resource/docs/natc/iranc2.pdf.

———. 2017. "Third National Communication to United Nations Framework Convention on Climate Change (UNFCCC)." National Climate Change Office at the Department of Environment. https://unfccc.int/sites/default/files/resource/Third National communication IRAN.pdf.

Istepanian, H H. 2020. "Towards Sustainable Energy Efficiency in Iraq." Amman, Jordan: Friedrich Ebert Stiftung. http://library.fes.de/pdf-files/bueros/amman/16449.pdf.

Jaber, J. O., and S. D. Probert. 2001. "Energy Demand, Poverty and the Urban Environment in Jordan." Applied Energy. Vol. 68. https://doi.org/10.1016/S0306-2619(00)00054-4.

Jaffar, B, T Oreszczyn, and R Raslan. 2014. "A Framework to Evaluate the Energy Efficiency Potential of Kuwaiti Homes." https://doi.org/10.2495/ESUS140031.

Javed, Wasim, Minas Iakovides, Euripides G. Stephanou, Jack M. Wolfson, Petros Koutrakis, and Bing Guo. 2019. "Concentrations of Aliphatic and Polycyclic Aromatic Hydrocarbons in Ambient PM2.5 and PM10 Particulates in Doha, Qatar." *Journal of the Air and Waste Management Association* 69 (2): 162–77. https://doi.org/10.1080/10962247.2018.1520754.

JPI Urban Europe. 2020. "Drive Urban Transitions towards a Sustainable and Livable Future."

Kafle, Hemu Kharel, and Hendrik J. Bruins. 2009. "Climatic Trends in Israel 1970-2002: Warmer and Increasing Aridity Inland." *Climatic Change* 96 (1): 63–77. https://doi.org/10.1007/s10584-009-9578-2.

Kanakidou, Maria, Nikolaos Mihalopoulos, Tayfun Kindap, Ulas Im, Mihalis Vrekoussis, Evangelos Gerasopoulos, Eirini Dermitzaki, et al. 2011. "Megacities as Hot Spots of Air Pollution in the East Mediterranean." *Atmospheric Environment* 45 (6): 1223–35. https://doi.org/10.1016/j.atmosenv.2010.11.048.

Kandeel, Amal. 2019. "Freshwater Resources in the MENA Region: Risks and Opportunities ." https://www.mei.edu/publications/freshwater-resources-mena-region-risks-and-opportunities.

Kanellopoulos, Panagiotis Georgios, Eleni Verouti, Eirini Chrysochou, Konstantinos Koukoulakis, and Evangelos Bakeas. 2021. "Primary and Secondary Organic Aerosol in an Urban/Industrial Site: Sources, Health Implications and the Role of Plastic Enriched Waste Burning." *Journal of Environmental Sciences (China)* 99 (January): 222–38. https://doi.org/10.1016/j.jes.2020.06.012.

Keller, Richard C. 2015. *Fatal Isolation: The Devastating Paris Heat Wave of 2003. Fatal Isolation*. University of Chicago Press. https://doi.org/10.7208/chicago/9780226256436.001.0001.

Kenway, S. J., P. A. Lant, A. Priestley, and P. Daniels. 2011. "The Connection between Water and Energy in Cities: A Review." *Water Science and Technology* 63 (9): 1983–90. https://doi.org/10.2166/wst.2011.070.

Khan, Mohammed, Muhammad Asif, and Edgar Stach. 2017. "Rooftop PV Potential in the Residential Sector of the Kingdom of Saudi Arabia." Buildings 7 (4): 46. https://doi.org/10.3390/buildings7020046.

Khatib, Imad, and Daniel Becker. 2012. "National Energy Efficiency Action Plan - Palestine." Cairo, Egypt: MED-ENEC.

Khodamoradi, Ali, and Faraz Sojdei. 2017. "Energy Efficiency Potentials in Iran: A Precise Look to One of the Biggest Energy Producers." In *ECEEE 2017 Summer Study – Consumption, Efficiency & Limits*, 23–27.

Kingdom of Bahrain. 2012. "Bahrain's Second National Communication under the United Nations Framework Convention on Climate Change." Manama, Kingdom of Bahrain: Public Commission for the Protection of Marine Resources, Environment and Wildlife. https://unfccc.int/resource/docs/natc/bhrnc2.pdf.

———. 2017. "National Energy Efficiency Action Plan." Manama, Kingdom of Bahrain: Sustainable Energy Unit. http://www.sea.gov.bh/wp-content/uploads/2018/04/02_NEEAP_full-report.pdf.

———. 2020. "Bahrain's Third National Communication under the United Nations Framework Convention on Climate Change." Manama, Kingdom of Bahrain: Supreme Council for Environment. https://unfccc.int/sites/default/files/resource/9143680_Bahrain-NC3-2-SCE Third National Communication 2020.pdf.

Kingdom of Saudi Arabia. 2015. "The Intended Nationally Determined Contribution of the Kingdom of Saudi Arabia under the UNFCCC." Riyadh, Kingdom of Saudi Arabia. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Saudi Arabia First/KSA-INDCs English.pdf.

Klein Goldewijk, Kees, Arthur Beusen, and Peter Janssen. 2010. "Long-Term Dynamic Modeling of Global Population and Built-up Area in a Spatially Explicit Way: HYDE 3.1." *The Holocene* 20 (4): 565–73. https://doi.org/10.1177/0959683609356587.

Koks, E. E., and T. Haer. 2020. "A High-Resolution Wind Damage Model for Europe." *Scientific Reports* 10 (1): 1–12. https://doi.org/10.1038/s41598-020-63580-w.

Kolokotsa, D., A. Psomas, and E. Karapidakis. 2009. "Urban Heat Island in Southern Europe: The Case Study of Hania, Crete." *Solar Energy* 83 (10): 1871–83. https://doi.org/10.1016/j.solener.2009.06.018.

Korovesi, Alice, Kyriaki Metaxa, Eleftheria Touloupaki, and Nikos Chrysogelos. 2017. "Energy Poverty in Greece: Social Innovation Proposals to Address the Phenomenon (in Greek)." Thessaloniki.

Kose, Tekin. 2019. "Energy Poverty and Health: The Turkish Case." *Energy Sources, Part B: Economics, Planning, and Policy* 14 (5): 201–13. https://doi.org/10.1080/15567249.2019.1653406.

Krarti, Moncef, and Kankana Dubey. 2017. "Energy Productivity Evaluation of Large Scale Building Energy Efficiency Programs for Oman." *Sustainable Cities and Society* 29: 12–22. https://doi.org/https://doi.org/10.1016/j.scs.2016.11.009.

Kuglitsch, F. G., A. Toreti, E. Xoplaki, P. M. Della-Marta, C. S. Zerefos, M. Türkeş, and J. Luterbacher. 2010. "Heat Wave Changes in the Eastern Mediterranean since 1960." *Geophysical Research Letters* 37 (4). https://doi.org/10.1029/2009GL041841.

Kyprianou, I, and D Serghides. 2020. "Dealing with Energy Poverty in Cyprus–an Overview." *International Journal of Sustainable Energy* 39 (4). https://doi.org/10.1080/14786451.2019.1699560.

Kyprianou, I, D Serghides, A Varo, JP Gouveia, D Kopeva, and L Murauskaite. 2019. "Energy Poverty Policies and Measures in 5 EU Countries: A Comparative Study." *Energy and Buildings* 196 (August): 46–60. https://doi.org/10.1016/j.enbuild.2019.05.003.

Kyprianou, Ioanna, Despina Serghides, and Salvatore Carlucci. 2022. "Urban Vulnerability in the EMME Region and Sustainable Development Goals: A New Conceptual Framework." *Sustainable Cities and Society* 80 (May): 103763. https://doi.org/10.1016/j.scs.2022.103763.

Lange, Manfred A. 2019. "Impacts of Climate Change on the Eastern Mediterranean and the Middle East and North Africa Region and the Water-Energy Nexus." *Atmosphere* 10 (8). https://doi.org/10.3390/atmos10080455.

Lavalle, C., N. Pontarollo, F. Batista E Silva, C. Baranzelli, C. Jacobs, B. Kavalov, M. Kompil, et al. 2017. "European Territorial Trends - Facts and Prospects for Cities and Regions." https://doi.org/10.2760/28183.

Lebanese Center for Energy Conservation (LCEC). 2016. "The Second National Energy Efficiency Action Plan for The Republic Of Lebanon - NEAP 2016-2020." Beirut, Lebanon: Ministry of Energy and Water.

Lelieveld, J., P. Hadjinicolaou, E. Kostopoulou, C. Giannakopoulos, A. Pozzer, M. Tanarhte, and E. Tyrlis. 2014. "Model Projected Heat Extremes and Air Pollution in the Eastern Mediterranean and Middle East in the Twenty-First Century." *Regional Environmental Change* 14 (5): 1937–49. https://doi.org/10.1007/s10113-013-0444-4.

Lelieveld, J., Y. Proestos, P. Hadjinicolaou, M. Tanarhte, E. Tyrlis, and G. Zittis. 2016. "Strongly Increasing Heat Extremes in the Middle East and North Africa (MENA) in the 21st Century." *Climatic Change* 137 (1–2): 245–60. https://doi.org/10.1007/s10584-016-1665-6.

Lelieveld, Jos, Klaus Klingmüller, Andrea Pozzer, Ulrich Pöschl, Mohammed Fnais, Andreas Daiber, and Thomas Münzel. 2019. "Cardiovascular Disease Burden from Ambient Air Pollution in Europe Reassessed Using Novel Hazard Ratio Functions." *European Heart Journal* 40 (20): 1590–96. https://doi.org/10.1093/eurheartj/ehz135.

Li, Dan, Weilin Liao, Angela J Rigden, Xiaoping Liu, Dagang Wang, Sergey Malyshev, and Elena Shevliakova. 2019. "Urban Heat Island: Aerodynamics or Imperviousness?" *Science Advances* 5 (4): eaau4299. https://doi.org/10.1126/sciadv.aau4299.

Li, Wenzhao, Elham Ali, Islam Abou El-Magd, Moustafa Mohamed Mourad, and Hesham El-Askary. 2019. "Studying the Impact on Urban Health over the Greater Delta Region in Egypt Due to Aerosol Variability Using Optical Characteristics from Satellite Observations and Ground-Based AERONET Measurements." *Remote Sensing* 11 (17): 1998. https://doi.org/10.3390/rs11171998.

Lijó, Lucía, Nicola Frison, Francesco Fatone, Sara González-García, Gumersindo Feijoo, and Maria Teresa Moreira. 2018. "Environmental and Sustainability Evaluation of Livestock Waste Management Practices in Cyprus." *Science of the Total Environment* 634: 127–40. https://doi.org/10.1016/j.scitotenv.2018.03.299.

Livada, I, M Santamouris, K Niachou, N Papanikolaou, and G Mihalakakou. 2002. "Determination of Places in the Great Athens Area Where the Heat Island Effect Is Observed." *Theoretical and Applied Climatology* 71 (3–4): 219–30. https://doi.org/10.1007/s007040200006.

Lopes, A., S. Oliveira, M. Fragoso, J.A. Andrade, and P. Pedro. 2009. "Wind Risk Assessment in Urban Environments: The Case of Falling Trees During Windstorm Events in Lisbon." In *Bioclimatology and Natural Hazards*, edited by Katarína Střelcová, Csaba Mátyás, Axel Kleidon, Milan Lapin, František Matejka, Miroslav Blaženec, Jaroslav Škvarenina, and Ján Holécy, 55–74. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-1-4020-8876-6_5.

Madbouly, Mostafa. 2009. "Revisiting Urban Planning in the Middle East North Africa Region Regional." http://www.unhabitat.org/grhs/2009.

Magnan, Alexandre K., and Teresa Ribera. 2016. "Global Adaptation after Paris." *Science* 352 (6291): 1280–82. https://doi.org/10.1126/science.aaf5002.

MECIT. 2017. "Strategy for Mobilising Investment in the Field of Building Renovation."

meetMED. 2019. "Energy Efficiency and Renewable Energy Strategies and Policies ."

———. 2020a. "Country Report on Energy Efficiency And Renewable Energy Investment Climate - Palestinian Territories." MEDENER and RCREEE.

———. 2020b. "Energy Efficiency in Buildings." MEDENER and RCREEE.

Meier, A, M Darwish, and S Sabeeh. 2013. "Complexities of Saving Energy in Qatar." In ECEEE 2013 SUMMER STUDY – RETHINK, RENEW, RESTART, 41:41–46. ECEEE Summer STUDY Proceedings.

Meir, Isaac A. 2014. "Green Technologies: Planning and Design to Allow for Climate Uncertainty." In *Encyclopedia of Energy Engineering and Technology, Second Edition*. https://doi.org/10.1081/e-eee2-120051347.

Meir, Isaac A., Aviva Peeters, David Pearlmutter, Suleiman Halasah, Yaakov Garb, and John Michael Davis. 2012. "An Assessment of Regional Constraints, Needs and Trends." *Advances in Building Energy Research* 6 (2): 173–211. https://doi.org/10.1080/17512549.2012.740209.

Meir, Isaac A., and Ilan Stavi. 2011. "Evolution of the 'modern' Transitory Shelter and Unrecognized Settlements of the Negev Bedouin." *Nomadic Peoples*. https://doi.org/10.3167/np.2011.150204.

Meltzer, Joshua, Nathan Hultman, and Claire Langley. 2014. "Low-Carbon Energy Transitions in Qatar and The Gulf Cooperation Council Region." *Global Economy and Development Program*. Brookings Institution. https://www.brookings.edu/wp-content/uploads/2016/07/low-carbon-energy-transitions-qatar-meltzer-hultman-full.pdf.

Meslmani, Yousef. 2010. "Initial National Communication of the Syrian Arab Republic." Damascus, Syria: Ministry of State for Environment Affairs.

Metro, Riyadh. 2021. "Riyadh Metro." 2021. http://riyadhmetro.sa/en/.

Middle East Institute. 2011. "Sustainable Development and the Built Environment in the Middle East: Challenges and Opportunities ." 2011. https://www.mei.edu/publications/sustainable-development-and-built-environment-middle-east-challenges-and-opportunities.

Ministry of Constuction and Housing. 2019. "Implementation of SDG11 in Israel: Challenges and Future Prospects."

Ministry of Development, Planning and Statistics. 2015. "On the Occasion of Qatar Environment Day." Qatar. https://www.psa.gov.qa/en/statistics/Statistical Releases/Environmental/EnvironmentalStatistics/EnvDay2017En.pdf.

Ministry of Electricity and Water. 2016. "Code of Practice for Government and Commercial Buildings - MEW/R-6/2016." Energy Conservation Program.

Ministry of Energy Commerce and Industry. 2020. "Law 155(I)/2020 on the Energy Efficiency of Buildings."

Ministry of Environment. 2011. "Lebanon's Second National Communication to the United Nations Framework Convention on Climate Change." Beirut, Lebanon: Republic of Lebanon.

Ministry of Environment and United Nations Development Programme. 2014. "Jordan's Third National Communication on Climate Change - Submitted to the United Nations Framework Convention on Climate Change (UNFCCC)." Amman, Jordan: Ministry of Environment - The Hashemite Kingdom of Jordan.

Ministry of Environment and Urbanisation. 2010. "Climate Change Strategy 2010 2023." Republic of Turkey.

———. 2011. "National Climate Change Action Plan 2011-2023." Ankara, Turkey: The Republic of Turkey.

———. 2013. "Turkey's Fifth National Communication Under the UNFCCC." Republic of Turkey.

Ministry of Environmental Protection. 2018a. "Abstract: Israel's Preparations for Adaptation to Climate Change: Recommendations for a National Strategy and Action Plan." Jerusalem, Israel: The Government of the State of Israel.

———. 2018b. "Israel's Third National Communication on Climate Change - Submitted to the United Nations Framework Convention on Climate Change." Jerusalem, Israel: The Government of the State of Israel.

———. 2019. "Government Decisions Related to Green Building." Jerusalem, Israel: The Government of the State of Israel. 2019.

———. 2020. "Survey & Analysis of Green Building Requirements." Jerusalem, Israel: The Government of the State of Israel.

Moshiri, Saeed, and Stefan Lechtenböhmer. 2015. "Sustainable Energy Strategy for Iran." *Wuppertal Spezial* 51. Vol. 51. Wuppertal, Germany: Wuppertal Institute for Climate, Environment and Energy. https://epub.wupperinst.org/frontdoor/deliver/index/docId/6175/file/WS51.pdf.

Mosly, Ibrahim. 2015. "Barriers to the Diffusion and Adoption of Green Buildings in Saudi Arabia." *Journal of Management and Sustainability* 5: 104. https://doi.org/10.5539/jms.v5n4p104.

Municipality of Tel Aviv-Yafo. 2004. *Tel-Aviv's Modern Movement: The White City of Tel-Aviv, A World Heritage Site.* https://www.amazon.com/tel-Avivs-Modern-Movement-Tel-Aviv-Heritage/dp/B01D9CE4PW/ref=sr_1_8?dchild=1&keywords=tel+aviv+white+city&qid=1612878429&sr=8-8.

Nagabhatla, Nidhi, and Cameron Fioret. 2020. "The Water-Migration Nexus: An Analysis of Causalities and Response Mechanisms with a Focus on the Global South." In *Regional Integration and Migration Governance in the Global South*, 85–115. Springer, Cham. https://doi.org/10.1007/978-3-030-43942-2_4.

National Geographic Society. 2021. "The Age of Megacities." 2021. https://www.nationalgeographic.org/interactive/age-megacities/.

National Research Council. 2010. *Adapting to the Impacts of Climate Change. Adapting to the Impacts of Climate Change*. https://doi.org/10.17226/12783.

Neophytou, M., E. Tryphonos, P. Fokaides, M. Sandberg, E. Batchvarova, H. Fernando, J. Lelieveld, and G. Zittis. 2013. "Toward Designing Strategies for Urban Heat Island Mitigation Based on Multi Scale Flow Considerations." In *Proceedings of the 34th International AIVC Conference - Energy Conservation Technologies for Mitigation and Adaptation in the Built Environment: The Role of Ventilation Strategies and Smart Materials*. https://gnosis.library.ucy.ac.cy/handle/7/45758.

Nicos Neocleous. 2018. "Cyprus Water Management Case Experience with Desalination and Water Reuse ." Qwara.

NOAA. 2020. "Northern Hemisphere Just Had Its Hottest Summer on Record." 2020. https://www.noaa.gov/news/northern-hemisphere-just-had-its-hottest-summer-on-record.

Novický, Oldřich, Magdalena Mrkvičková, and Ladislav Kašpárek. 2009. "Improving Integrated Surface and Groundwater Resources Management in a Vulnerable and Changing World Examples of Possible Water Management Measures for Elimination of Climate Change Impacts on Water Resources OLDŘICH NOVICKÝ, MAGDALENA MRKVIČKOVÁ & LADISL." In *Improving Integrated Surface and Groundwater Resources Management in a Vulnerable and Changing World*, 330:247–53. IAHS Publ.

Nykjaer, Leo. 2009. "Mediterranean Sea Surface Warming 1985-2006." *Climate Research*. https://doi.org/10.3354/cr00794.

O'Neill, Marie S., Michael Jerrett, Ichiro Kawachi, Jonathan I. Levy, Aaron J. Cohen, Nelson Gouveia, Paul Wilkinson, et al. 2003. "Health, Wealth, and Air Pollution: Advancing Theory and Methods." *Environmental Health Perspectives* 111 (16): 1861–70. https://doi.org/10.1289/ehp.6334.

Olawuyi, Damilola S. 2020. "Energy Poverty in the Middle East and North African (MENA) Region." In *Energy Justice and Energy Law*, 254–70. Oxford University Press. https://doi.org/10.1093/oso/9780198860754.003.0015.

Omrany, Hossein, and Abdul Kadir Marsono. 2016. "National Building Regulations of Iran Benchmarked with BREEAM and LEED: A Comparative Analysis for Regional Adaptations." *British Journal of Applied Science & Technology* 16 (6): 1–15. https://doi.org/10.9734/BJAST/2016/27401.

Pacific Institute for Climate Solutions. 2020. "Energy Efficiency in the Built Environment." 2020.

PADCO. 2006. "Iraq Housing Market Study."

Papadaskalopoulou, C., E. Katsou, K. Valta, K. Moustakas, D. Malamis, and M. Dodou. 2015. "Review and Assessment of the Adaptive Capacity of the Water Sector in Cyprus against Climate Change Impacts on Water Availability." *Resources, Conservation and Recycling* 105 (December): 95–112. https://doi.org/10.1016/j.resconrec.2015.10.017.

Pateraki, Styliani, Kyriaki Maria Fameli, Vasiliki Assimakopoulos, Kyriaki Bairachtari, Alexandros Zagkos, Theodora Stavraka, Aikaterini Bougiatioti, Thomas Maggos, and Nikolaos Mihalopoulos. 2020. "Differentiation of the Athens Fine Pm Profile during Economic Recession (March of 2008 versus March of 2013): Impact of Changes in Anthropogenic Emissions and the Associated Health Effect." Atmosphere 11 (10): 1–11. https://doi.org/10.3390/atmos11101121.

Pignatta, G, C Chatzinikola, G Artopoulos, C Papanicolas, D Serghides, and M Santamouris. 2017. "Analysis of the Indoor Thermal Quality in Low Income Cypriot Households during Winter." Energy and Buildings 152: 766–75. https://doi.org/10.1016/j.enbuild.2016.11.006.

Planning and Statistics Authority. 2018. "Qatar Second National Development Strategy 2018~2022." Doha, Qatar: The State of Quatar - Ministry of Development, Planning and Statistics. https://www.psa.gov.qa/en/knowledge/Documents/NDS2Final.pdf.

Prieur-Richard, Anne-Hélène, Brenna Walsh, Marlies Craig, Megan L. Melamed, M'Lisa Colbert, Minal Pathak, Sarah Connors, et al. 2019. "Extended Version: Global Research and Action Agenda on Cities and Climate Change Science." https://doi.org/10.13140/RG.2.2.10315.44323.

Proaktor, Gil, Ronnie Cohen, Ayelet Rosen, Elah Weinstein, and Neta Alloul. 2016. "Israel National Plan for Implementation of the Paris Agreement." Jerusalem. Israel: Ministry of Environmental Protection.

Ramboll. 2017. "Analysis of the Use of Auction Revenues by the Member States Final Report."

Republic of Cyprus. 2020. "RES and Energy Conservation Fund." 2020. https://www.resecfund.org.cy/en.

Republic of Iraq. 2012. “The National Environmental Strategy and Action Plan for Iraq (2013 – 2017).” Ministry of Environment. https://wedocs.unep.org/bitstream/handle/20.500.11822/8726/-The National Environmental Strategy and Action Plan (2013 – 2017) for Iraq-2013National_Environmental_Strategy.pdf?sequence=4&amp%3BisAllowed=y%2C Arabic%7C%7Chttps%3A//wedocs.unep.org/bitstream.

———. 2016. “Lraq’s Initial National Communication to the UNFCCC.” Ministry of Health and Environment. https://unfccc.int/sites/default/files/resource/316947520_Iraq-NC1-2-INC-Iraq.pdf.

Republic of Iraq - Ministry of Electricvity. n.d. “Learn With Us Energy Saving.” https://www.moelc.gov.iq/home/page/energy_conservation?lang=ar&__cf_chl_jschl_tk__=b232f57666bed6cbd65ded2229653a83bb47e045-1616408483-0-Aah0U80Uzlj-Sbmqzgr29TPIIWkU01TvYpLnsgQmGnY65iwf9v1YjalENKemZMXelJ5hSWNOEqRVARyvRL4L0735dGwV7t35HkWqPR2ngR3sC4kHqkeF_s.

Resilient Cities Network. 2021. “Resilient Cities Network.” 2021. https://resilientcitiesnetwork.org/.

Ritchie, Hannah, and Max Roser. 2018. “Urbanization - Our World in Data,” 2018. https://ourworldindata.org/urbanization.

Romero, P. L., and P. D. Gnatz. 2011. “Urbanization and the Challenge of Climate Change.” In *Cities and Climate Change: Global Report on Human Settlements 2011*, 16. Nairobi, Kenya: United Nations Human Settlements Programme.

Roof, Karen MS, and Ngozi Oleru. 2008. “Public Health: Seattle and King County’s Push for the Built Environment.” *Journal of Environmental Health* 71 (1).

Rosenzweig, Cynthia, William Solecki, Patricia Romero-Lankao, Shagun Mehrotra, Shobhakar Dhakal, Tom Bowman, and Somayya Ali Ibrahim. 2018. “Climate Change and Cities: Second Assessment Report of the Urban Climate Change Research Network.” In *Climate Change and Cities*. https://doi.org/10.1017/9781316563878.007.

Roudi-Fahimi, Farzaneh, Liz Creel, and Roger Mark de Souza. 2002. “Finding the Balance: Population and Water Scarcity in the Middle East and North Africa – Population Reference Bureau.” 2002. https://www.prb.org/findingthebalancepopulationandwaterscarcityinthemiddleeastandnorthafrica/.

Russo, Simone, Jana Sillmann, and Erich M. Fischer. 2015. “Top Ten European Heatwaves since 1950 and Their Occurrence in the Coming Decades.” *Environmental Research Letters* 10 (12): 124003. https://doi.org/10.1088/1748-9326/10/12/124003.

Ruth, M., and R. Gasper. 2008. “Water in the Urban Environment: Meeting the Challenges of a Changing Climate.” Milan.

Ruth, M., and F. Rong. 2006. “Research Themes and Challenges.” In *M. Ruth (Ed) Smart Growth and Climate Change*. Cheltenham, UK: Edward Elgar Publishers.

Saaroni, Hadas, Eyal Ben-Dor, Arieh Bitan, and Oded Potchter. 2000. “Spatial Distribution and Microscale Characteristics of the Urban Heat Island in Tel-Aviv, Israel.” *Landscape and Urban Planning* 48 (1–2): 1–18. https://doi.org/10.1016/S0169-2046(99)00075-4.

Saliba, N. A., F. El Jam, G. El Tayar, W. Obeid, and M. Roumie. 2010. “Origin and Variability of Particulate Matter (PM10 and PM2.5) Mass Concentrations over an Eastern Mediterranean City.” *Atmospheric Research* 97 (1–2): 106–14. https://doi.org/10.1016/j.atmosres.2010.03.011.

Santamouris, M. 2007. “Heat Island Research in Europe: The State of the Art.” *Advances in Building Energy Research* 1 (1): 123–50. https://doi.org/10.1080/17512549.2007.9687272.

———. 2016. “Innovating to Zero the Building Sector in Europe: Minimising the Energy Consumption, Eradication of the Energy Poverty and Mitigating the Local Climate Change.” *Solar Energy* 128: 61–94. https://doi.org/10.1016/j.solener.2016.01.021.

Saraga, Dikaia E., Evangelos I. Tolis, Thomas Maggos, Christos Vasilakos, and John G. Bartzis. 2019. “PM2.5 Source Apportionment for the Port City of Thessaloniki, Greece.” *Science of the Total Environment* 650 (February): 2337–54. https://doi.org/10.1016/j.scitotenv.2018.09.250.

Sarigiannis, Denis A., Marianthi Kermenidou, Spyridoula Nikolaki, Dimitrios Zikopoulos, and Spyros P. Karakitsios. 2015. “Mortality and Morbidity Attributed to Aerosol and Gaseous Emissions from Biomass Use for Space Heating.” *Aerosol and Air Quality Research* 15 (7): 2496–2507. https://doi.org/10.4209/aaqr.2015.03.0149.

Sarigiannis, Dimosthenis A., Spyros P. Karakitsios, Marianthi Kermenidou, Spyridoula Nikolaki, Dimitrios Zikopoulos, Stauros Semelidis, Apostolos Papagiannakis, and Roxani Tzimou. 2014. “Total Exposure to Airborne Particulate Matter in Cities: The Effect of Biomass Combustion.” *Science of The Total Environment* 493 (September): 795–805. https://doi.org/10.1016/j.scitotenv.2014.06.055.

Sarigiannis, Dimosthenis A., Spyros P. Karakitsios, and Marianthi V. Kermenidou. 2015. “Health Impact and Monetary Cost of Exposure to Particulate Matter Emitted from Biomass Burning in Large Cities.” *Science of The Total Environment* 524–525 (August): 319–30. https://doi.org/10.1016/j.scitotenv.2015.02.108.

Saroglou, T., T. Theodosiou, and I.A. Meir. 2020. “Improving the Energy Efficiency of a Mediterranean High-Rise Envelope.” *CTBUH Journal*, 2020.

Saroglou, T., Theodoros Theodosiou, Baruch Givoni, and Isaac A. Meir. 2019. “A Study of Different Envelope Scenarios towards Low Carbon High-Rise Buildings in the Mediterranean Climate - Can DSF Be Part of the Solution?” *Renewable and Sustainable Energy Reviews*. https://doi.org/10.1016/j.rser.2019.06.044.

Saroglou, Tanya, Isaac A. Meir, Theodoros Theodosiou, and Baruch Givoni. 2017. “Towards Energy Efficient Skyscrapers.” *Energy and Buildings*. https://doi.org/10.1016/j.enbuild.2017.05.057.

Saudi Energy Efficiency Center. 2015. “Saudi Energy Efficiency Program.” *Green & Efficiency Building Workshop*. https://cdn.ymaws.com/www.linkme.qa/resource/resmgr/Presentations/Saudi_Energy_Efficiency_Prog.pdf.

Shalom, Hofit Ben, Oded Potchter, and Haim Tsoar. 2009. “The Effect of the Urban Heat Island and Global Warming on Thermal Discomfort in a Desert City - The Case of Beer Sheva, Israel.” In *The Secenth International Conference on Urban Climate*. Yokohama, Japan.

Shay Pauzner. 2009. “Tel Aviv to Get 1st Ecological Housing Project.” 2009. https://www.ynetnews.com/articles/0,7340,L-3683319,00.html.

Shomar, Basem. 2013. “Water Resources, Water Quality and Human Health in Regions of Extreme Stress: Middle East.” *Journal of Earth Science & Climatic Change* 4 (5). https://doi.org/10.4172/2157-7617.1000153.

Smithers, Richard, Mike Harrison, Ziad Mimi, Khaled Hardan, Sadiq Abdelall, and Afif Hasan. 2016. “National Adaptation Plan (NAP) to Climate Change.” Ramallah, Palestine: State of Palestine - Environment Quality Authority.

Sofoulis, Zoë. 2015. “The Trouble with Tanks: Unsettling Dominant Australian Urban Water Management Paradigms.” *Local Environment* 20 (5): 529–47. https://doi.org/10.1080/13549839.2014.903912.

Spinoni, Jonathan, Giuseppe Formetta, Lorenzo Mentaschi, Giovanni Forzieri, and Luc Feyen. 2020. “Global Warming and Windstorm Impacts in the EU.” Luxembourg. https://doi.org/10.2760/039014.

State of Kuwait. 2012. “Kuwait’s Initial National Communications under the United Nations Framework Convention on Climate Change.” Environment Public Authority.

Stocker, Thomas F., Dahe Qin, Gian Kasper Plattner, Melinda M.B. Tignor, Simon K. Allen, Judith Boschung, Alexander Nauels, Yu Xia, Vincent Bex, and Pauline M. Midgley. 2013. *Climate Change 2013 the Physical Science Basis: Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Climate Change 2013 the Physical Science Basis: Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. https://doi.org/10.1017/CBO9781107415324.

Sultanate of Oman. 2019. “Second National Communication.” Muscat, Sultanate of Oman: Ministry of Environment and Climate Affairs. https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/520417_Oman-NC2-1-Oman 2nd National Communication (17 November 2019) - Final.pdf.

Teschner, Naama, Anca Sinea, Andreea Vornicu, Tareq Abu-Hamed, and Maya Negev. 2020. “Extreme Energy Poverty in the Urban Peripheries of Romania and Israel: Policy, Planning and Infrastructure.” https://doi.org/10.1016/j.erss.2020.101502.

The Government Secretariat. 2010. “Government Resolution No. 2508 Dated November 28, 2010 - Formulation of a National Plan for the Reduction of Greenhouse Gas Emissions in Israel.” Jerusalem, Israel: The Government of the State of Israel.

The Rockefeller Foundation. 2020. “100 Resilient Cities.” 2020. https://www.rockefellerfoundation.org/100-resilient-cities/.

The Skyscraper Center. 2020. "Year in Review 2020 ." 2020. https://www.skyscrapercenter.com/year-in-review/2020.

The State of Quatar - Ministry of Environment, and The State of Quatar. 2011. "Initial National Communication to the United Nations Framework Convention on Climate Change." Doha, Qatar. https://unfccc.int/sites/default/files/resource/final climate change.pdf.

The World Bank. 2018. "What a Waste Global Database | Data Catalog." 2018. https://datacatalog.worldbank.org/dataset/what-waste-global-database.

Thomson, Harriet, Carolyn Snell, and Christine Liddell. 2016. "Fuel Poverty in the European Union: A Concept in Need of Definition?" *People, Place and Policy*, 5–24. https://doi.org/10.3351/ppp.0010.0001.0002.

Torgal, Fernando Pacheco, Marina Mistretta, Arturas Kaklauskas, Claes G. Granqvist, and Luisa F. Cabeza. 2014. *Nearly Zero Energy Building Refurbishment: A Multidisciplinary Approach. Nearly Zero Energy Building Refurbishment: A Multidisciplinary Approach*. Vol. 9781447155. https://doi.org/10.1007/978-1-4471-5523-2.

Tsimplis, M. N., F. M. Calafat, M. Marcos, G. Jordà, D. Gomis, L. Fenoglio-Marc, M. V. Struglia, S. A. Josey, and D. P. Chambers. 2013. "The Effect of the NAO on Sea Level and on Mass Changes in the Mediterranean Sea." *Journal of Geophysical Research: Oceans*. https://doi.org/10.1002/jgrc.20078.

Tsiouri, Vasiliki, Konstantinos E. Kakosimos, and Prashant Kumar. 2015. "Concentrations, Sources and Exposure Risks Associated with Particulate Matter in the Middle East Area—a Review." *Air Quality, Atmosphere and Health* 8 (1): 67–80. https://doi.org/10.1007/s11869-014-0277-4.

U.S. Energy Information Administration. 2020. "Analysis." 2020. https://www.eia.gov/international/analysis/world.

UN-Habitat. 2013. "Urbanization and Urban Risks in the Arab Region." In *1st Arab Region Conference for Disaster Risk Reduction*. Jordan. http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=3320.

———. 2017. "The New Urban Agenda." https://doi.org/10.18356/4665f6fb-en.

———. 2018. Global State of National Urban Policy. Global State of National Urban Policy. https://doi.org/10.1787/9789264290747-en.

———. 2020. "Informal Settlements in the Arab Region Arab Region." Giza, Egypt.

UN-Habitat, and Ministry of Municipal and Rural Affairs. 2019. "Future Saudi Cities Programme Demonstration Project: Al-Ahsa." www.momra.gov.sa.

UN. 2015a. "Sustainable Cities: Why They Matter." http://www.un.org/.

———. 2015b. "Transforming Our World: The 2030 Agenda for Sustainable Development."

———. 2017. New Urban Agenda. www.habitat3.org.

———. 2018a. "The World's Cities in 2018." https://www.flickr.com/photos/thisisin.

———. 2018b. "Towards Saudi Arabia's Sustainable Tomorrow." https://saudiarabia.un.org/en/35915-towards-saudi-arabias-sustainable-tomorrow.

UN Environment and International Energy Agency. 2017. *Towards a Zero-Emission, Efficient, and Resilient Buildings and Construction Sector. Global Status Report 2017*. www.globalabc.org.

UN Habitat. 2006a. "Cities, Slums and the Millennium Development Goals."

———. 2006b. *The State of the World's Cities Report 2006/2007: 30 Years of Shaping the Habitat Agenda*.

———. 2011. "Global Report on Human Settlements 2011: Cities and Climate Change." https://unhabitat.org/sites/default/files/download-manager-files/Cities and Climate Change Global Report on Human Settlements 2011.pdf.

———. 2018. "SDG Indicator 11.1.1 Training Module: Adequate Housing and Slum Upgrading." Nairobi.

UNDRR. 2010. "City Leaders Join UN Making Cities Resilient Campaign | UNDRR." 2010. https://www.undrr.org/news/city-leaders-join-un-making-cities-resilient-campaign-0.

———. 2020. "Launch of Making Cities Resilient 2030 (MCR2030) | UNDRR." 2020. https://www.undrr.org/event/launch-mcr2030.

UNEP. 2016. "Annual Report 2016." https://www.unep.org/annualreport/2016/index.php.

———. 2018. “Putting the Environment at the Heart of People’s Lives.”

UNGEGN Working Group on Country Names. 2011. “UNGEGN List of Country Names.”

United Arab Emirates. 2018a. “National Climate Change Plan of the United Arab Emirates 2017-2050.” Dubai, United Arab Emiates: Minister of Energy and Industry. https://www.moccae.gov.ae/assets/30e58e2e/national-climate-change-plan-for-the-united-arab-emirates-2017-2050.aspx.

———. 2018b. “United Arab Emirates 4th National Comunication Report.” Dubai, United Arab Emirates: Ministry of Energy and Industry. https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/213947805_United Arab Emirates-NC4-2-United Arab Emirates Fourth National Communication Report.pdf.

United Nations. 1998. “Principles and Recommendations for Population and Housing Censuses.” www.un.org/depts/unsd.

———. 2004. “World Urbanization Prospects The 2003 Revision.”

———. 2008. “Principles and Recommendations for Population and Housing Censuses Revision 2.”

University of Notre Dame. 2020. “ND-GAIN.” Notre Dame Global Adaptation Initiative. 2020. https://gain.nd.edu/our-work/country-index/methodology/sectors/.

Ürge-Vorsatz, Diana, Nick Eyre, Peter Graham, Danny Harvey, Edgar Hertwich, Yi Jiang, Christian Kornevall, et al. 2012. “Energy End-Use: Buildings.” In *Global Energy Assessment (GEA)*, edited by Thomas B. Johansson, Nebojsa Nakicenovic, Anand Patwardhan, and Luis Gomez-Echeverri, 649–760. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511793677.016.

Ürge-Vorsatz, DIana, Cynthia Rosenzweig, Richard J. Dawson, Roberto Sanchez Rodriguez, Xuemei Bai, Aliyu Salisu Barau, Karen C. Seto, and Shobhakar Dhakal. 2018. “Locking in Positive Climate Responses in Cities.” *Nature Climate Change* 8 (3): 174–77. https://doi.org/10.1038/s41558-018-0100-6.

Vandecasteele, Ine, Claudia Baranzelli, Alice Siragusa, Javier P. (Eds.) Aurambout, Valentina Alberti, Maria Alonso Raposo, Carmelo Attardo, et al. 2019. “The Future of Cities: Opportunities, Challenges and the Way Forward.” https://doi.org/10.2760/375209.

Waked, Antoine, Charbel Afif, and Christian Seigneur. 2012. “An Atmospheric Emission Inventory of Anthropogenic and Biogenic Sources for Lebanon.” *Atmospheric Environment* 50 (April): 88–96. https://doi.org/10.1016/j.atmosenv.2011.12.058.

WEF. 2021. *The Global Risks Report 2021*. http://wef.ch/risks2021.

Wilbanks, T.J., P. Romero Lankao, F. Berkhout M. Bao, S. Cairncross, J.-P. Ceron, M. Kapshe, R. Muir-Wood, and R. Zapata-Marti. 2007. “Industry, Settlement and Society. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.” In , edited by M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson. Cambridge: Cambridge University Press.

World Bank. 2016. “Delivering Energy Efficiency in the Middle East and North Africa - Achieving Energy Efficiency Potential in the Industry, Services and Residential Sectors.” International Bank for Reconstruction and Development. http://documents1.worldbank.org/curated/en/642001476342367832/pdf/109023-WP-P148222-PUBLIC-DeliveringEEinMENAMayEN.pdf.

Worldbank. 2007. “Arab Republic of Egypt: Analysis of Housing Supply Mechanisms.”

———. 2016. “West Bank & Gaza Energy Efficiency Action Plan for 2020-2030.” http://www.copyright.com/.

———. 2021. “World Bank Open Data .” 2021. https://data.worldbank.org/?year=2018.

Yau, Y. H., and S. Hasbi. 2013. “A Review of Climate Change Impacts on Commercial Buildings and Their Technical Services in the Tropics.” *Renewable and Sustainable Energy Reviews* 18: 430–41. https://doi.org/10.1016/j.rser.2012.10.035.

Zafar, S. 2020. “Solid Wastes in the Middle East.” 2020.