

UNITED ARAB EMIRATES MINISTRY OF CLIMATE CHANGE & ENVIRONMENT

# National Climate Change Adaptation Program

# Adaptation of the UAE's Public Health to Climate Change

Risk Assessment & Options for Action

2019

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# **Executive Summary**

As part of the National Climate Change Adaptation Program, this report presents the findings of the climate change risk assessment of the UAE's public health sector. The assessment was conducted by the Ministry of Climate Change and Environment (MOCCAE) according to a framework developed from global best practices. The UAE Sectoral Climate Risk Assessment Framework consists of five steps: 1) take stock of climate trends and relevant sectoral issues; 2) identify potential impacts of climate change on the sector; 3) evaluate the magnitude and likelihood of impacts to understand the risks; 4) assess and prioritize the risks; and 5) identify potential adaptation actions.

### Climate change and public health

Climate change will result in higher temperatures across the UAE. Climate projections show a 2–3°C increase in average temperatures in the summer months of 2060–2079, although the changes may vary across the emirates. Humidity is expected to increase along the coast, while rainfall patterns are projected to change, with the Northern Emirates expected to have more intense rainfall episodes. Sea level rise is expected to increase the threat of inundation along the coastline. Furthermore, the probability of extreme weather events is projected to increase in both frequency and magnitude.

Climate change will pose a challenge to public health in the UAE and around the world. While the UAE is making significant progress in providing highquality health care in line with UAE Vision 2021, the impacts of climate change — such as increased heat stress, resulting in reduced labor productivity, as well as morbidity and mortality due to heat stroke — may introduce new challenges and hinder the achievement of desired health outcomes.

### Assessing climate risks to public health

Based on an extensive review of scientific literature on the impacts of climate change on human health, this report identifies the most relevant impacts, which are further assessed upon consideration of local evidence to fit the UAE context. The impacts are translated into risks through the interaction of impacts and likelihood. In this context, the risk is defined as the likelihood of impact occurrence.

MOCCAE conducted an initial assessment of the shortlisted risks through a five-point scale ("very low," "low," "medium," "high," and "very high"). The preliminary results were then shared with stakeholders through interactive workshops, which involved representatives from the public, private, and civil society sectors, and were facilitated by subject matter experts. MOCCAE consolidated the stakeholder inputs and reflected their comments in the final assessment while further verifying the available evidence.

Based on the results above, one major risk ("high") has been identified as priority risk: reduced labor productivity due to heat stress. For the "medium" risk, although it is not as critical as the "high" risk, a thorough investigation would be necessary to implement control measures to minimize and prevent it from escalating into a "high" risk. The "low" risks also require regular monitoring to determine changes in the situation that may affect the risk level.

Risk level	Impact
High	Reduced labor productivity due to heat stress
Medium	Mortality or morbidity due to heat stroke
	Morbidity due to undernutrition
	Damage to health infrastructure due to extreme events
Low	Disruption in providing access to health care services due to natural disasters
	Mortality or morbidity from the aggravation of cardiovascular diseases
	Mortality or morbidity from the aggravation of respiratory diseases
	Mortality or morbidity due to a rise in vector-borne diseases
Very low	Mortality or morbidity due to diseases from food and/or water contamination

## Options for action

Considering the UAE's current climate adaptation efforts, the below list of potential measures is proposed to address the priority risk to public health. To prioritize actions, current efforts may continue or expand, and new initiatives may be introduced. Some measures may require collaboration across authorities due to their inter-sectoral nature.

Type of	Reduced labor productivity due to heat stress		
measures	Examples of potential adaptation measures		
Physical safeguards	<ul> <li>Expand the use of enhanced technologies on heat-protective clothing and personal protective equipment for outdoor workers.</li> <li>Expand accessible hydration and cooling systems.</li> <li>Enhance medical surveillance and early detection of heat stress and heat stroke symptoms.</li> </ul>		
Risk management	•Enhance early warning systems and develop heat alert plans, especially for outdoor laborers during extreme heat events.		
Knowledge	<ul> <li>Develop the capacity of clinics and health stations to recognize and respond to labor concerns on reduced productivity due to climate-related factors.</li> <li>Research the effects of climate change on labor productivity.</li> <li>Strengthen collaboration with the private sector on addressing heat stress as a hazard at the workplace; intensify campaigns, especially during the peak of summer.</li> <li>Strengthen health monitoring of symptoms and illnesses related to heat stroke, specifically when the temperature and humidity are extremely high.</li> </ul>		
Enablers	<ul> <li>Strengthen enforcement of existing initiatives, such as the Safety in Heat and midday break programs; enhance monitoring and evaluation (M&amp;E) to objectively assess results.</li> <li>Revisit existing recommended standards to prevent or reduce the risk of adverse health effects of heat stress on exposed populations.</li> <li>Mainstream climate change adaptation by reorienting existing programs on environmental health and occupational safety to better highlight the adaptation component of such programs.</li> </ul>		

Going forward, sustained efforts are necessary to address the gaps in mainstreaming climate change in health policies and programs. An enhanced understanding of the linkage between climate change and public health through research and knowledge sharing — bringing together health specialists, scientists, and policymakers — will also help in formulating science-based health adaptation policies. Given the evolving public health threats caused by climate change, it should be noted that risk assessment is an iterative process and thus should be updated regularly to keep up with the changing risks over time.



# Introduction

As part of fulfilling its commitments under the Paris Agreement and in line with the UAE Vision 2021 and the UAE Green Agenda 2030, the UAE Government adopted the National Climate Change Plan 2050 (Climate Plan) in June 2017. The Plan aims to consolidate the country's climate action under a single framework that specifies strategic priorities, covering both mitigation and adaptation.

The Climate Plan structures action areas around three pillars: 1) greenhouse gas (GHG) emissions management; 2) climate change adaptation; and 3) private sector-driven innovative economic diversification. Under the adaptation pillar, the following outcomes are proposed:

- **By 2020:** Climate change risk assessments are performed, and immediate measures are put in place.
- By 2025: Adaptation planning is mainstreamed in development policy.
- **By 2030-2050:** Continuous monitoring and evaluation is conducted to ensure evidence-based adaptation measures.

As part of the implementation of the Climate Plan, the Ministry of Climate Change and Environment (MOCCAE) launched the National Climate Change Adaptation Program. The Program aims to carry out a systematic and participatory risk assessment as a basis for planning adaptation measures in four priority sectors: public health, energy, infrastructure, and the environment.

This report focuses on climate risk assessment for the public health sector. A qualitative assessment of climate-related risks to health has been conducted based on which potential options for action on public health adaptation have been identified. Specifically, it aims to establish the linkage between climate change and public health to better understand the impacts of climate change on human health and well-being; assess climate risks to the UAE's public health system, using a risk assessment framework; and provide a list of potential adaptation measures to address the priority risks and explore opportunities to strengthen climate resilience.

The World Health Organization (WHO) defines "health" as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity."<sup>1</sup> Moreover, "public health" refers to "all organized measures to prevent disease, promote health, and prolong life among the population as a whole."<sup>2</sup> Activities to strengthen public health focus on providing a wide range of services to the entire population instead of individual patients or specific diseases.

The scope of this report includes the direct and indirect impacts of climate change on human health as illustrated in Figure 1. Direct impacts occur when the exposure to climatic signals or events are immediate, directly affecting health, such as the case of heat stress and heat stroke. Indirect impacts are characterized by the effects of climate change on key environmental or social parameters (air, water, and food quality; food production; and disease vectors), leading to health impacts, such as diseases and reduced access to health services.

The figure on the next page further shows how climate stressors, such as rising temperature, humidity, and extreme events, directly or indirectly affect human health, which is also influenced by other important non-climate variables, such as economic, environmental, social, and genetic factors. At the community level, for example, a population with higher levels of income and education, good infrastructure, and adequate access to technology and information can effectively cope with the impacts of climate change on people's health. This principle also applies at the individual level, where age, socioeconomic status, and genetics play a crucial role in shaping health quality and outcomes. Where possible, non-climate factors are also considered in the risk assessment by looking at the "readiness" or adaptive capacity to address the impacts of climate change on health.

Climate Change	Immediate Effects	Direct Health Impacts	Indirect Health Impacts	
RISING TEMPERATURE AND HUMIDITY	• Air Pollution • Vectors • Food Spoilage	• Heat Stress • Heat Stroke	<ul> <li>Cardio Respiratory diseases</li> <li>Food-Borne diseases</li> <li>Victor-Borne diseases</li> </ul>	S
SEA LEVEL RISE	• Coastal Surge • Coastal Flooding	• Potenial Drowning	<ul> <li>Damage to coastal health facilities</li> <li>Reduced accessto health services</li> </ul>	I TH OUTCOME
EXTREME EVENTS	• Coastal Flooding • Storm Surge • Heavy Rains	• Potenial Drowning	<ul> <li>Damage to coastal health facilities</li> <li>Reduced access to health services</li> <li>Vector-borne diseases</li> </ul>	HEAL
रेष्ट्र रङ्गर DROUGHT	• Limited freshwater for food production		• Undernutrition	
Economic factors	Environmental factors	Social factors	Genetic factors	

Figure 1. Direct and indirect impacts of climate change on public health

The report is divided into three chapters:

- Chapter 1 sets the scene for understanding how climate change affects **public health.** It also describes the observed and projected climate change in the UAE, as well as global practices on climate resilience for public health.
- **Chapter 2 focuses on the results of the risk assessment,** which was conducted based on available evidence, stakeholder consultation, and expert input, using a framework developed from global practices.
- **Chapter 3 presents adaptation measures** to help address the priority risks identified by the risk assessment. The measures include an extension of existing initiatives as well as new actions.

# Climate Change and Public Health 1.1. Climate change in the UAE

The Intergovernmental Panel on Climate Change (IPCC) has reported that the observed changes in the climate system are clear and have been unprecedented since the 1950s: increasing concentrations of carbon dioxide ( $CO_2$ ), warming atmosphere and oceans, melting ice, and rising sea levels.<sup>3</sup> These global trends are projected to continue through this century and beyond, leading to a range of adverse local impacts.

Current trends and future projections of the UAE's climate are presented in Table 1. More information on past climate trends and future projections from various sources is compiled in the Annex. The Abu Dhabi Global Environmental Data Initiative (AGEDI) study projects that the UAE could be warmer in the future, with an expected temperature increase of 2–3°C, alongside increasing humidity. However, these changes will not be the same for all seven emirates as terrain, elevation, and weather patterns vary across the country. It should also be noted that there remain varying levels of uncertainty behind climate projections due to the complex interaction of climate, economic, social, and environmental factors, as well as the relative scarcity of climate modeling research for the region.

#### Table 1. Current trends and future projections of the UAE climate<sup>4</sup>

	Contractor	HUMIDITY	SEA LEVEL RISE	RAINFALL	EXTREME EVENTS
What has been happening?	Temperature in summer months rises to about <b>48°C</b> in coastal cities – even <b>50°C</b> in the desert regions.	Average humidity is <b>50-60%</b> in coastal areas; <b>45%</b> in inland areas. Extreme humidity reaches as high as <b>90%</b> .	Average sea level rise over the past decades in the Arabian Gulf is <b>0.18-0.23 cm</b> per year.	Annual rainfall is around <b>100 mm</b> .	<b>3 super cyclones</b> hit the Arabian Peninsula in a span of 40 years (1977-2018).
What could happen?	2-3°C average increase during the summer months by 2060-2079.	Increase in humidity by about <b>10%</b> over the Arabian Gulf.	Increasing mean high tides in coastal areas	More <b>intense</b> <b>rainfall</b> , particular- ly in Northern Emirates and Dubai.	More frequent and severe extreme events. Growing risk of high-impact storms

In terms of precipitation, the AGEDI study reported that rainfall is projected to increase over much of the UAE. Increases of 50–100% from current amounts are projected for Dubai, Sharjah, and the Northern Emirates. Atmospheric modeling projects a 15–20% increase in rainfall over the Hajar Mountains by 2050. Despite the projected increases in rainfall, however, the number of wet days (with over 1 mm of rainfall) is projected to decrease. This implies that larger amounts of rainfall would occur during comparatively fewer rainfall events than currently observed. And while there might be some positive changes in terms of rainfall in some parts of the UAE, higher rates of evaporation may cancel out the increase in volume.

Sea level is also expected to rise in the UAE, increasing the threats of inundation along the coastline. Conducting climate modeling for sea level rise remains complex due to its broad suite of characteristics. Regarding extreme events, although current models cannot accurately predict their occurrence, current projections imply that they will become more frequent, their intensity more severe, and their trajectories or pathways less predictable.

#### 1.2. Linkages between climate and health

The impacts of climate change on public health occur in varying degrees of scale, complexity, and exposure — either directly or indirectly. The Climate Plan noted that the impacts of climate change will have significant implications on the UAE's growth potential, including health.<sup>5</sup> According to a review of available scientific literature, there is a strong link between climate change and the following health-related issues:

• Heat stroke: Cases of stroke may increase with increasing temperature, where the elderly and isolated individuals are at greatest risk.<sup>6</sup> Physiological adjustments to cold and warm climate involve changes in blood pressure, blood viscosity (thickness), and heart rate, which are important determinants of mortality related to strokes and cardiovascular diseases.<sup>7</sup>

- Heat stress resulting in reduced labor productivity: Heat stress leads to health problems and productivity losses among outdoor workers as they slow down their pace, take longer breaks, and shift their work schedule to cooler hours.<sup>8</sup> Excessive body temperature and/or dehydration causes heat exhaustion, slower work, more mistakes while working, heat stroke, accidental injuries, and even death.<sup>9</sup> Outdoor manual laborers are most exposed to impacts, resulting in diminished work capacity (up to approximately 60% decline in productivity).<sup>10</sup>
- Cardiovascular diseases: Cardiovascular illnesses have been linked to climate change-related variables, such as average daily temperatures.<sup>11 12 13</sup> Studies in Egypt, Kuwait, Lebanon, Syria, and the UAE show a significant association between climate change specifically temperature and humidity increases and cardiovascular disease.<sup>14 15 16 17 18</sup> As the leading cause of death in the UAE, cardiovascular diseases account for 41% of all mortalities, and their treatment is expected to represent 24% of the total health care expenditure in 2025.<sup>19</sup> A UAE environmental health risk study assessed that three additional cardiovascular disease fatalities were attributed to climate change influence in 2008.<sup>20</sup>
- **Respiratory diseases:** Climate change worsens respiratory problems,<sup>21</sup> and respiratory allergies and diseases may become more prevalent.<sup>22</sup> Air pollutants can irritate the respiratory system, decrease lung function,<sup>23</sup> aggravate asthma, and cause chronic bronchitis, irregular heartbeat, and nonfatal heart attacks.<sup>24</sup> Increased human exposure to air pollutants may also be linked to cancer.<sup>25</sup> Air quality studies for the UAE estimated that in 2008, approximately 651 excess deaths were attributable to outdoor air pollution (about 7.3% of the total deaths in the UAE).<sup>26</sup>

- Vector-borne diseases: Higher temperature and humidity may trigger outbreaks of vector-borne diseases, such as malaria.<sup>27</sup> Although the UAE is located close to areas where malaria is endemic, there is limited research on how climate change could affect vector-borne disease in the country.<sup>28</sup> The World Health Organization (WHO) declared the UAE malaria-free in 2007, thanks to years of effort by authorities to control the disease.<sup>29</sup> Increased risk from malaria due to climate change, however, might be expected.<sup>30</sup> The WHO noted that the challenge for the UAE is to maintain its malaria-free status and prevent the disease's reintroduction by travelers and foreign workers.<sup>31</sup>
- Disruption in health care provision: Health care infrastructure is also vulnerable to climate change as natural disasters and other events can severely hinder the delivery of health care. The number of patients and the range of diseases could change in some regions as the climate change.<sup>32</sup> The WHO emphasized that "acute shocks, such as natural disasters and disease epidemics, can overload the capacities of health systems in even the most developed nations." The number of disasters reported and people affected have risen in recent decades.<sup>33</sup>
- Water and food contamination: Contraction of water- and food-borne diseases may rise in frequency with climate variation and additional environmental stress, especially with increased tourism and migration. Inland urban flooding and stagnant water pose added risks during and after prolonged precipitation in the UAE; untreated effluent water may also overflow from sewers.<sup>34</sup>
- Malnutrition and/or undernutrition: The impacts of climate change on agriculture may affect the food supply chain as crop yields decline due to rising temperatures and changing rainfall patterns. A study of AGEDI noted that since the UAE heavily depends on food imports, it may be vulnerable to food supply constraints and associated price shocks due to climate impacts in food-exporting countries.<sup>35</sup> Such disruptions in food supply may affect nutritional well-being, leading to undernutrition.

• Injury or death due to extreme events: Extreme weather events can cause disruption of infrastructure, including power, water, transportation, and communication systems, which are essential to maintaining access to health care and emergency response services.<sup>36</sup> In the UAE, extreme weather events include sandstorms, flash floods, heavy rainfalls, and fogs. In 2015, for instance, a sandstorm in the UAE blanketed the country and caused a rise in the number of patients admitted to hospitals.<sup>37</sup> Exposure to sandstorms can trigger acute attacks among sufferers of asthma.<sup>38</sup> A cross-sectional study of 850 schoolchildren in the UAE associated dust storms and humidity with the prevalence of asthma.<sup>39</sup>

The above-mentioned direct and indirect impacts of climate drivers on public health represent the different levels of exposure pathways, leading to positive or negative health outcomes. The interaction of climate drivers, exposure pathways, and health outcomes is influenced by the larger environmental and institutional domains, as well as social and behavioral contexts. Climate drivers also influence the environmental, institutional, social, and behavioral contexts of health. For example, increased morbidity and mortality due to heat waves have prompted several governments to implement a heat wave plan that changes the way people behave during extreme heat events.

### 1.3. Global practices on climate adaptation in the public health sector

The WHO has noted that climate change is the greatest threat to global health in the 21st century.<sup>40</sup> There is growing evidence that climate change will have significant effects on human health and well-being,<sup>41</sup> affecting key social and environmental needs, such as air quality, water supply, food security, and housing.<sup>42</sup> Some of the significant impacts globally are shown in Figure 2.



Figure 2. Global climate change impacts on public health<sup>43</sup>



The United Nations Framework Convention on Climate Change (UNFCCC) has introduced the national adaptation plan (NAP) process to facilitate adaptation planning globally.<sup>44</sup> Similarly, to adopt this framework for the health sector, the WHO has laid out the health national adaptation process (HNAP), the health component of the NAP. One of the steps of the HNAP is the development of a national health adaptation strategy, which identifies priority adaptation options for the health sector to cope with the impacts of climate change.

While many countries have already developed their own national adaptation strategies in various forms, only a handful have developed an adaptation plan specific to public health. Some countries have conducted a national climate risk assessment in various periods and acknowledged public health as one of the critical areas most vulnerable to climate change. There are good examples from Australia, New Zealand, and the United States on risk assessment and public health adaptation (see Table 2), with notable similarities and differences in approaches depending on local needs.



Table 2. Examples of public health resilience initiatives in selected countries

Country	Initiative
Australia	The Framework for a National Strategy on Climate, Health and Well-being for Australia (2017) is a comprehensive roadmap for policymakers to address the causes and impacts of climate change on public health. Notable features are as follows: •Including seven areas of policy actions for all levels of government, research institutions, and the health sector itself, targeting health improvements through a coordinated approach. •Recognizing the systemic nature of climate change and the different determinants of health that lie largely outside the health sector, thus prescribing broader policy directions. •Incorporating health impact assessments in the evaluation of project applications from industry and infrastructure sectors.
New Zealand	<ul> <li>The Human Health Impacts of Climate Change for New Zealand (2017) provides a summary of the major issues on the impacts of climate change on human health as revealed by the following findings:</li> <li>Direct impacts are increased exposure to heat waves and weather events, whereas indirect impacts are related to housing and livelihood stresses and health inequality.</li> <li>Climate change is also expected to have adverse mental health and community health effects.</li> <li>The impacts of climate change will be uneven, exacerbating existing socioeconomic and ethnic health inequalities.</li> <li>More research is needed to better quantify the health impacts of climate change in the short, medium, and long terms.</li> </ul>
United States	Developed by more than 100 experts from various federal agencies, <b>The</b> <b>Impacts of Climate Change on Human Health in the United States: A</b> <b>Scientific Assessment</b> (2016) aims to inform decision-makers of the most pressing climate risks to human health, drawing from a large body of scientific peer-reviewed researches. Notable findings are as follows: •Major climate-induced stresses to public health include degraded air quality; diseases from food, water, and disease vectors; and stresses to mental health and well-being. •In the future, climate change is expected to exacerbate these threats; some people will be exposed to threats not previously experienced in their locations. •Some populations are severely vulnerable, such as low-income households, communities of color, immigrants, indigenous peoples, children and pregnant women or cupational groups and persons with disabilities or medical

conditions.

Typically, national health adaptation plans set the objectives, specific targets, outcomes, roles and responsibilities of different stakeholders, monitoring of outcome indicators, and human resource and financial costs, if possible. As more countries start to formulate adaptation strategies and plans specific to the public health sector, the WHO has developed an operational framework for building climate-resilient health systems as shown in Figure 3. The framework is composed of 10 components structured around risk management, information, and foundations. The role of risk management in the overall resilience framework is critical to understanding the prevailing risks, this role must be underpinned by reliable information and strong enabling foundations in the form of governance and capacity building.



Figure 3. Key components of climate-resilient health systems<sup>45</sup>

# 2. Assessing Climate Risks to Public Health 2.1. Sectoral risk assessment framework

The UAE Sectoral Climate Risk Assessment Framework (Assessment Framework) consists of a five-step approach as illustrated in Figure 4. The succeeding discussions in this section are based on the application of these steps. The process of risk assessment combines a literature review, stakeholder consultation, and expert input (see the Assessment Framework document for more details).



Figure 4. Sectoral climate risk assessment framework

#### 2.2. UAE public health sector

This section corresponds to Stage 1 of the risk assessment framework, which aims to provide a brief contextualization of the UAE's public health sector and the prevailing challenges and opportunities. The UAE Vision 2021 highlights world-class health care as one of the national priorities. Table 3 shows some of the fundamental health indicators of the UAE, mostly based on the results of the National Health Survey (NHS) spearheaded by the Ministry of Health and Prevention (MOHAP) and approved by WHO.

#### Table 3. Health indicators of the UAE

Indicator	2018	2010	Source
Prevalence of diabetes among adults (over 18 years old)	11.8%	18.9%	NHS
Prevalence of obesity among adults (over 18 years old)	27.8%	37.2%	NHS
Prevalence of obesity among children (5-19 years old)	13.69% (2017)	NA	Vision 2021
Exclusive breastfeeding for babies (0-5 months)	59.7%	34%	NHS
Prevalence of high total cholesterol	43.7%	57.6%	NHS
Prevalence of high blood pressure	28.8%	14.7%	NHS
Prevalence of smoking (over 18 years old)	9.1%	11.1%	NHS
Percentage of the population living below the poverty line	0.1%	-	NHS
Total population using at least basic drinking-water services	99%	-	NHS
Total population using safe sanitation services	99.7%	-	NHS
Deaths from ambient air pollution (2016)	1,432 (2016)	-	WHO
Overall satisfaction in the UAE health care service delivery	96%	NA	NHS

The WHO recognizes the significant progress made by the UAE in improving the quality of its health care system through comprehensive health programs largely supported by the government but with the increasing participation of the private sector. Efforts are underway to accredit public and private hospitals according to national and international quality standards. There is also great emphasis on preventive medicine to address cancer, diabetes, and cardiovascular diseases; smoking reduction; and the broadening of the health care system's capacity to cope with epidemics and other risks. Progress in health care is well reflected in the rapid improvement of key health indicators, such as life expectancy and infant mortality rates, which are already on par with countries in the Organisation for Economic Co-operation and Development (OECD).

According to the 2017 statistics of MOHAP, there were 143 hospitals, 23,107 physicians, and 53,915 nurses in the UAE. Another achievement is the improvement in maternal and child health, where under-5 child mortality has been maintained at as low as one death per 1,000 children over the past decade. Globally, the UAE ranks 27th among 191 countries in national health systems, according to the WHO's World Health Report.<sup>47</sup> In various health parameters, the UAE's health indicators are the best among the Gulf Cooperation Council (GCC) countries.<sup>48</sup>

The UAE's five most common health challenges are obesity, diabetes, cardiovascular diseases, cancer, and mental health.<sup>49</sup>

- Obesity is a major health burden in the UAE, where the prevalence is twice the global average.
- There are 37 million diabetics in the Middle East and North Africa (MENA), and 803,900 are from the UAE. For MENA, the figure is projected to increase to 68 million by 2035.
- Almost nine out of 10 people in the UAE are at risk of cardiovascular disease, and one out of three of them are unaware of it.
- Cancer remains one of the leading causes of death (specifically breast, colorectal, lung, and cervical cancer), with women accounting for 45% of all cancer-related deaths.

• Mental health has been identified as a major health concern in the UAE, but social stigma still exists for people suffering from depression and other psychological illnesses.

Due to the increasing demand for health care services, the health sector has required an influx of medical personnel — particularly nurses, psychiatrists, and other medical specialists, especially those in intensive and critical care medicine, emergency care, neonatology, pediatrics, oncology, orthopedics, rehabilitation, and psychiatry. Furthermore, health care in the UAE is more expensive than elsewhere in the region.<sup>50</sup>

#### Public health policy framework

MOHAP is the lead federal entity in the health sector, with the mandate to enhance community health by providing comprehensive health care services according to international standards and perform its role as a regulator of the sector.<sup>51</sup> In 1972, there were only seven public hospitals in the UAE.<sup>52</sup> Since then, the country has developed a sophisticated health care system involving public and private health care providers. Today, MOHAP focuses its services on the Northern Emirates (Sharjah, Ajman, Umm Al Quwain, Ras Al Khaimah, and Fujairah), while the Department of Health Abu Dhabi and Dubai Health Authority (DHA) cater to Abu Dhabi and Dubai, respectively, as regulatory health care bodies.

Health insurance is a critical component of the UAE's health care policy. Abu Dhabi was the first emirate to make health insurance coverage mandatory in 2006, and Dubai followed suit in 2014; similar plans are in place in the other emirates. The government-owned insurance company, Daman, administers most of the insurance plans, while private health insurance providers fill the gap.

In 2014, Abu Dhabi developed the Healthcare Sector Strategic Plan, which features 58 initiatives covering all seven priority areas: reduction of capacity gaps; quality of health care services; recruitment of qualified health care professionals; emergency preparedness; wellness and prevention; encouragement of private investment in health care; and an e-Health program. Similarly, the Dubai Health Strategy 2016-2021 contains six objectives, 15 programs, and around 100 initiatives on health and lifestyle, excellence in providing service, and smart health care and governance, engaging both

public and private health stakeholders. At the federal level, the National Strategy to Combat Non-Communicable Diseases 2017-2021 aims to reduce cardiovascular diseases, diabetes, cancer, and respiratory illnesses in the UAE.

# 2.3. Evaluation and prioritization of climate risks *Climate impacts on public health*

To evaluate and prioritize risks, a list of impacts was first developed based on readily accessible international and local literature, in accordance with Stage 2 of the risk assessment framework. Table 4 identifies and characterizes climate impacts relevant to public health in the UAE.

Table 4. Impacts of climate change on public health per climate signal<sup>53 54</sup>

Climate events/ signals	Direct and indirect impacts <sup>a</sup>
Rising temperature complemented by increasing humidity	<ul> <li>Reduced productivity of outdoor workers due to heat stress</li> <li>Mortality or morbidity from heat stroke</li> <li>Mortality or morbidity from the aggravation of cardiovascular illnesses and/ or diseases</li> <li>Food contamination due to extreme weather or climatic events</li> <li>Mortality or morbidity from the aggravation of respiratory illnesses and/or diseases</li> <li>Rise in vector-borne diseases</li> </ul>
Rising sea level	•Disruption in providing access to necessary health care services due to sea level rise-induced damages to health care infrastructure
Extreme weather and climatic events (storm, flooding sandstorm, and fog)	<ul> <li>Disruption in providing access to necessary health care services due to sea level rise-induced damages to health care infrastructure</li> <li>Damage to health care infrastructure</li> <li>Food contamination</li> <li>Rise in vector-borne diseases</li> </ul>
Extreme drought	<ul> <li>Mortality or morbidity due to undernutrition resulting from diminished supply from food source origins facing extreme droughts</li> </ul>

<sup>(</sup>a) The selection of preliminary risks involved a review of chapters from the most recent IPCC assessment reports. It also used reports from organizations of global authority to verify the evidences and check for consistencies. The risks are then localized through a review of local evidence, such as scientific and policy studies conducted in the country. Through a consultation workshop, stakeholders provided inputs, and the risks were further revised, incorporating their feedback.

Based on the long list above, a final list of nationally relevant direct and indirect impacts was developed as shown in Table 5. Note that while these risks are directly or indirectly linked to climate change, there are other factors (economic, social, technological, and genetic) that determine overall health outcomes. Thus, every individual or population will have different levels of capacity to adapt to climate change based on complex interactions of these factors. For example, individual tolerance to heat stress may vary depending on factors related to acclimation, the presence of pre-existing disease, clothing, age, gender, level of physical activity, and body size.<sup>55 56</sup>

Table 5. Final list of climate impacts on the UAE's public health system

#### Direct impacts

1. Reduced productivity of outdoor workers due to heat stress (mainly due to extreme temperature and humidity)

2. Mortality or morbidity due to heat stroke caused by extreme temperature and humidity

#### Indirect impacts

3. Morbidity due to undernutrition caused by the diminished supply due to extreme events at food sources

 ${\rm 4.}$  Mortality or morbidity due to diseases from food and/or water contamination caused by extreme events

5. Damage to health infrastructure due to extreme events

6. Disruption in providing access to health care services due to sea level riseinduced damage to health care infrastructure

7. Mortality or morbidity from the aggravation of cardiovascular diseases due to extreme temperature and humidity

8. Mortality or morbidity from the aggravation of respiratory diseases due to extreme temperature and humidity

9. Mortality or morbidity due to a rise in vector-borne diseases because of extreme events

#### *Evaluating the magnitude and likelihood of impacts*

Table 6 presents the magnitude and likelihood of the occurrence of the direct and indirect climate change impacts in the above final list. According to Stage 3 of the risk assessment framework, the magnitude of impacts was examined from three dimensions: economic, social, and environmental, whereas the likelihood was assessed based on the estimated chance that the impact may occur in the future. The combined assessment of magnitude and likelihood results in the determination of the risk level of the impacts.

Table 6. Evaluation of magnitude and likelihood of impacts

Import		Magnitude		Likelihood	Risk level	
impact	Econ	Env	Soc	Likeimood	KISK IEVEI	
1. Reduced productivity of outdoor workers due to heat stress	Very large	Small	Very large	Almost certain	High	
2. Mortality or morbidity due to heat stroke	Large	Small	Very large	Very likely	Medium	
3. Morbidity due to undernutrition	Small	Small	Moderate	Likely	Low	
4. Mortality or morbidity due to diseases from food and/or water contamination	Very small	Very small	Very small	Likely	Very low	
5. Damage to health infrastructure	Moderate	Small	Moderate	Unlikely		
6. Disruption in providing access to health care services due to natural disasters	Moderate	Moderate	Moderate	Unlikely		
7. Mortality or morbidity from the aggravation of cardiovascular diseases	Moderate	Small	Small	Likely	Low	
8. Mortality or morbidity from the aggravation of respiratory diseases	Small	Small	Moderate	Likely		
9. Mortality or morbidity due to a rise in vector-borne diseases	Small	Small	Small	Unlikely	Very low	

Moving forward to Stage 4 of the risk assessment framework, which is the final risk assessment and prioritization of the risks, one risk is identified as "high" priority: reduced labor productivity due to heat stress. Also, although not a priority risk, one risk is assessed as "medium" risk: mortality or morbidity due to heat stroke. It is worth noting that these two risks are interrelated, and so the adaptation measures for the former may also apply to the latter.

#### Box 1. Heat stress, heat exhaustion, and heat stroke

- Heat stress is the combination of metabolic heat (heat generated in the body) and environmental heat (heat gained from the environment), minus the heat loss from the body to the environment.<sup>57</sup> Heat stress and dehydration usually occur together, characterized by fatigue, headache, muscle cramps, weakness, dizziness, nausea, vomiting, and hyperventilation.<sup>58</sup> Heat stress can result in heat stroke and heat exhaustion.
- Heat exhaustion is the body's response to an excessive loss of water and salt due to excessive sweating. Some of the symptoms are headache, nausea, dizziness, weakness, irritability, thirst, increased body temperature, and decreased amount of urine. Most vulnerable groups include the elderly, people with hypertension, and workers in a hot environment.<sup>59</sup> Without prompt treatment, heat exhaustion can lead to heat stroke.
- Heat stroke, as the most serious heat-related illness, occurs when the body cannot cool down when the temperature rises rapidly and the sweating mechanism fails. During heat stroke, the body temperature can rise to 106°F (41.11°C) or higher within 10–15 minutes, which can lead to death or cause permanent disability in the absence of emergency treatment. Some of the symptoms are hot, dry skin or profuse sweating; confusion, altered mental status, slurred speech; loss of consciousness; seizures; and very high body temperature.<sup>60</sup>

**Reduced productivity of outdoor workers due to heat stress.** In terms of the magnitude of economic impacts of this risk, it is rated "very large" due to a large number of outdoor laborers, specifically construction workers affected by extreme heat during summer. For social impacts, this risk is rated "very large" considering the magnitude of the construction and building sector in the UAE, which employs a significant number of outdoor laborers. It is estimated that 14% of the national population are outdoor workers. There were about 1.16 million outdoor workers in the UAE in 2017, and most of them were migrants from developing countries.<sup>61</sup>

A study commissioned by the Department of Health Abu Dhabi investigated the contributing factors to heat stress among workers in the UAE to develop guidelines to prevent and manage heat-related illnesses. The study obtained key measurements from 207 workers from five work sites; these include core body temperature, heart rate, urine specific gravity as well as environmental thermal stress indices - Thermal Work Limit (TWL) and Wet-Bulb Globe Temperature (WBGT).<sup>b</sup> Results revealed that during work shifts, when air temperatures often exceeded 45°C and were accompanied by high relative humidity, there was no sharp increase in core body temperature, no heart rate irregularities, or considerable signs of overfatigue in exposed workers due to their ability to self-pace the work. However, WBGT results revealed significant thermal stress. TWL results showed that well-hydrated workers could perform self-paced work in hot conditions without facing a high risk of heat stress and illness.<sup>62</sup> Another study identified scientific factors that determine climatic heat stress, which are air temperature, humidity, radiant heat, wind speed indicating the environment, metabolic heat generated by physical activities, and "clothing effect" that moderates heat exchange between the body and the environment.63

**Mortality or morbidity due to heat stroke.** This risk is also related to heat stress. In most cases, people experiencing heat stroke do not recognize the symptoms and commonly mistake them as possible high blood pressure or heart attack, making it difficult for illness reporting purposes. Despite the lack of quantification of heat stroke incidences in the UAE, the construction industry remains the most vulnerable to heat stroke effects. While heat stroke is considered the most severe type of heat-related illness, the most common type is heat exhaustion. In Abu Dhabi, for example, heat exhaustion accounted for 67% of all reported cases of heat-related illnesses in 2010.<sup>64</sup> From May to July 2018, 13 workers were treated for heat exhaustion in the Umm Al Quwain hospital.<sup>65</sup> In the absence of a timely and appropriate response, heat exhaustion can lead to heat stroke. In terms of likelihood, the risk of both heat stress and heat stroke stands out as "almost certain" considering the projected temperature increase of 2–3°C in the UAE by 2060– 2079.<sup>66</sup>

<sup>(</sup>b) The WetBulb Globe Temperature (WBGT), as defined by the United States National Weather Service, is "a measure of the heat stress in direct sunlight, which takes into account: temperature, humidity, wind speed, sun angle and cloud cover (solar radiation). This differs from the heat index, which takes into consideration temperature and humidity and is calculated for shady areas."

For the "medium" risk (increased morbidity and mortality due to heat stroke), although it is not as critical as the "high" risk and is relatively acceptable in the short term, a thorough investigation is necessary to implement control measures to minimize the risk, so that the "medium" risk level does not turn into "high." The impacts with "low" risks require regular monitoring to determine changes in the situation which may affect the risk level. Figure 5 provides a visual means to understand and communicate the results of the assessment by plotting all impacts in a 5-by-5 risk matrix.



Figure 5. Risk matrix for the health sector

## 3. Options for Action

#### 3.1. Initiatives on climate adaptation in the public health sector

This chapter applies Stage 5 of the risk assessment framework to elaborate on potential actions to address the priority risks identified in the previous chapter. In providing recommendations, it is important to acknowledge existing initiatives relevant to climate change adaptation in public health. This will help identify the gaps and explore the opportunities to address them.

Measures for climate change adaptation can generally be classified into four types:<sup>c</sup>

- **Physical safeguards** refer to engineered structures, technological systems, and services, as well as ecosystem-based infrastructure, that support adaptation objectives.
- **Risk management** covers the regulations, incentives, and financial mechanisms, as well as early warning systems and emergency plans, that directly address climate risks.
- Knowledge encompasses climate data and research, risk assessment, and awareness campaigns and communication.
- **Enablers** are foundational policies not directly targeting adaptation but providing an enabling condition for improving resilience.

Tables 7 shows examples of climate actions that are relevant to addressing the priority risk identified in the previous chapter according to the four categories. The list is not exhaustive and is only intended to provide illustrative examples.<sup>d</sup> The measures include both options directed to address the risk itself and those that could compensate or offset the risk and help build resilience. MOCCAE developed a proposal of measures based on the results of the risk assessment and existing initiatives.

<sup>(</sup>c) This typology of adaptation measures is consistent with the IPCC categories (structural/physical, social, and institutional adaptation) and the WHO adaptation measure taxonomy (risk management, information, and foundations).

<sup>(</sup>d) Most of the recommendations focus on either continuing current efforts or addressing the challenges through new initiatives in line with international best practices. Some measures may require collaboration across authorities due to the inter-sectoral nature of adaptation initiatives. Note that the associated costs of the proposed measures are not considered as it is beyond the scope of this report and separate analyses are required.

#### Box 2. Initiatives relevant to climate adaptation in the health sector

- Ministerial Order No. 401 of 2015 concerning the determination of afternoon working hours. This policy established by the then Ministry of Labor determines the working hours of laborers working outdoors and under the sun to reduce heat exhaustion, heat stress, heat stroke, and related illnesses. Specifically, it requires that no laborer shall be present at the working site after 12:30 and that no business shall resume before 15:00.<sup>67</sup>
- Safety in Heat program. This initiative by the Department of Health (DoH) aims to reduce and prevent cases of heat-related illness in the workplace, offering free awareness and educational material to assist employers, managers, and supervisors in implementing control measures in workplaces where workers are exposed to heat in summer.<sup>68</sup>
- National Strategy and Action Plan for Environmental Health. This EAD initiative recommends actions to improve the understanding of how climate change will affect human health, including the monitoring of conditions likely caused by climate change; informing health care specialists on climate-related health issues; and identifying priority actions for health protection and disease prevention.<sup>69</sup>
- Weqaya program. "Weqaya" is the Arabic word for prevention. Targeting all UAE nationals under the Thiqa insurance system (18 years old and above), the DoH provides screening of the health status of an individual and a proper follow-up, if necessary, or of individuals who are at risk of developing cardiovascular disease and diabetes or have the risk factors associated with these preventable diseases.<sup>70</sup>
- Malaria control program. This aims to eliminate or minimize the spread of malaria along the border of the UAE and Oman. All UAE cities are free from locally transmitted malaria, except the highlands of the eastern emirates, and 95% of reported cases are brought into the country from overseas.

Table 7. Potential adaptation measures for "high" risk

Type of	Reduced labor productivity due to heat stress			
measures	Existing measures	Additional measures		
Physical safeguards	<ul> <li>Rehydration system (e.g., a supplement added to water that replaces minerals and electrolytes lost through sweat)</li> <li>Engineering controls (e.g., increasing cooling/ ventilation, bringing in cooler outside air, reducing the hot temperature of a radiant heat source, shielding the worker, and using air conditioning equipment)</li> <li>Core Body Cooling Vest (CAERvest)</li> <li>First aid measures and emergency medical assistance</li> <li>Expansion of drinking water stations</li> <li>Heat stress monitoring</li> </ul>	<ul> <li>Designate several cooling centers near construction sites</li> <li>Explore the use of enhanced technologies on heat-protective clothing and personal protective equipment (PPE) (e.g., water- cooled garments, air-cooled garments, cooling vests, and wetted overgarments)</li> <li>Explore the use of heat tolerance tests (e.g., acclimatization)</li> </ul>		

Type of	Reduced labor productivity due to heat stress			
measures	Existing measures	Additional measures		
Risk management	<ul> <li>Heat alert initiatives during extreme heat events</li> <li>Health insurance schemes</li> </ul>	•Enhance early warning systems and develop heat alert plans, especially for outdoor laborers during extreme heat events		
Knowledge	<ul> <li>Media and health promotion materials under the Safety in Heat Program" (e.g., posters, leaflets, technical information sheets, training and procedures manual, etc.)</li> <li>Procedures and training manual for supervisors and occupational health and safety professionals on working in the heat</li> <li>Dehydration and heat illness protocols</li> <li>Awareness campaigns and educational programs (e.g., heat stress campaigns in construction sites, Safe and Healthy Summer Campaign, Beat the Heat Campaign, heat stress awareness online class)</li> <li>Capacity-building programs (e.g., Safety in Heat Competition Workshop)</li> <li>Training courses on first aid measures and emergency responses to heat stress</li> <li>Unified guidelines on indoor and outdoor heat stress targeting specific groups</li> <li>Thermal Work Limit (TWL) Heat Stress Index<sup>f</sup></li> </ul>	<ul> <li>Develop the capacity of clinics and health stations to recognize and respond to labor concerns on reduced productivity due to climate-related factors</li> <li>Research effects of climate change on labor productivity</li> <li>Strengthen collaboration with the private sector on addressing heat stress as a hazard at the workplace; intensify campaigns especially during the peak of summer</li> <li>Strengthen health and safety training<sup>g</sup></li> <li>Employers should establish a medical monitoring program to prevent adverse outcomes and for early identification of signs that may be associated with heat- related illnesses<sup>h</sup></li> <li>Enhance the measurement of heat stress by exploring more advanced computers and mathematical models to calculate heat stress indices based on weather station data<sup>i</sup></li> </ul>		
Enablers	<ul> <li>Ministerial Order No. 401 of 2015 concerning the determination of afternoon working hours.</li> <li>Health, safety, and environment (HSE) regulations</li> </ul>	<ul> <li>Strengthen enforcement of existing initiatives, such as the Safety in Heat and midday break programs; enhance monitoring and evaluation (M&amp;E) to objectively assess results</li> </ul>		

(e) According to Joubert et al. (2011), this initiative catered to 465 companies employing 814,996 heat-exposed workers across 6,254 work and labor residence sites. Program participants expressed a high level of support and satisfaction. Results showed a significant decrease in heat-related illness from 2008 to 2009 at two companies, one reported a combined 79.5% decrease in cases (15.3 vs. 1.16 cases per 1,000 workers), while the other experienced a 50% reduction in serious cases (0.08–0.04 cases per 100,000 work hours). For further information, see Joubert, D., Thomsen, J., & Harrison, O. 2011. Safety in the heat: A comprehensive program for prevention of heat illness among workers in Abu Dhabi, United Arab Emirates. *American Journal of Public Health*, 101(3), 395–398.

(g) The United States Criteria for a Recommended Standard Occupational Exposure to Heat and Hot Environments of the National Institute for Occupational Safety and Health (NIOSH) noted that this training should include information on recognizing symptoms of heat-related illness; proper hydration; use of heat-protective clothing and equipment; effects of various factors, such as drugs, alcohol, obesity, etc. on heat tolerance; and importance of acclimatization, reporting symptoms, and first aid.

(h) There are two types of medical evaluations proposed for the medical monitoring program, according to NIOSH: 1) preplacement medical evaluations for candidates of hot jobs; and 2) periodic medical evaluations for those workers who are currently doing hot jobs.

(i) As noted by the United States Criteria for a Recommended Standard Occupational Exposure to Heat and Hot Environments. (f) According to the Department of Health Abu Dhabi, TWL, measured in watts per square meter (W/m2), is "the maximum rate at which heat can be lost to the environment in the conditions. TWL gives a measure of the maximum safe work rate for the environmental conditions present at a worksite. If TWL is too low, then even low rates of work cannot be safely carried out continuously and extra breaks and other precautionary measures are needed to ensure worker safety."

#### 3.2. Opportunities and way forward

The impacts of climate change on public health are already being felt, globally and in the UAE. Given the current projections, such impacts will continue to intensify and affect people's health and well-being, thus making public health adaptation measures urgently necessary. Climate change adaptation involves reducing risks, seeking opportunities, and building capacity at various levels. There are opportunities for scaling up action, such as the following:

 Strengthen the knowledge on the linkage between climate change and public health. Currently, there is limited data that clearly establish the link between climate change impacts and public health in the UAE. Inadequate local research limits the extent stakeholders can act on potential climate change risk factors that could affect public health and well-being in the UAE. Health entities have noted that once a clear association is identified based on scientific information, they can then propose actions to collect the data necessary to further investigate the links.

#### Box 3. Notable research gaps in health sector adaptation in the UAE

- Research on the relationship between the changing climate and asthma incidence in the UAE is inconclusive, and there is a need for proper guidance on the kind of data to collect to establish an association. This also applies to the link between sandstorms, for example, and the incidence of cardiovascular and respiratory diseases.
- There is also a lack of systematic and multidisciplinary research in the region. There are wide data gaps in interventions for non-communicable diseases and risk factors, including climate risks.<sup>71</sup> A regional-scale research agenda can help provide a better understanding of the climate impacts on and trends in public health.<sup>72 73</sup>
- Improve knowledge sharing and training on public health adaptation. The stakeholder consultation revealed that staff exposure to climate change issues is on the lower end. This is because most training programs and workshops are not conducted under the overarching topic of climate change, but rather under environmental and preventive health and

occupational safety. Involving locally-based research institutes and academic units in the climate change dialogues and initiatives is also recommended.

- Put in place a dedicated unit/department and in-house experts on adaptation. Health authorities have noted that issues regarding funding support and the need for in-house technical experts on climate change are key challenges. Creating a department dedicated to climate change within the authorities still has some way to go. It is necessary that environmental health departments are established in health authorities and empowered with environmental health as well as public health specialists who can lead on the issue of climate change impact on health and take preventive actions.
- Give stronger emphasis on adaptation in climate change awareness and education. Among health entities, awareness and understanding of climate change are associated with environmental health, which includes heat stress awareness campaigns and implementation of midday breaks. This is because climate change is commonly under the umbrella of environmental health and occupational safety among health entities. This necessitates a more explicit reorientation or integration of climate adaptation in activities related to this area.
- Explore other areas of public health adaptation research. Knowledge creation and information sharing on public health adaptation should be a continuous engagement. Some of the areas to explore are the following: conducting deeper economic analysis to analyze the costs, trade-offs, and "value for money" of climate change adaptation in the health sector; communicating the long-term outcomes of adaptation and developing indicators as part of a robust monitoring and evaluation system for adaptation initiatives; and investigating how to leverage the potential of emerging technologies, such as artificial intelligence (AI), in predicting the accuracy of weather forecasts and climate projections to better inform the science and policy of risk assessment and climate change adaptation.

• Mainstream adaptation in development policies. At the federal and emirate levels, climate change issues are not yet fully integrated into public health systems via institutional mandates, strategic goals, key performance indicators, annual work plans, and budgets. While the Climate Plan contains provisions to "mainstream adaptation into current and future policies," this needs to be laid out in great detail to identify specific entry points for mainstreaming. In the health sector, a national health adaptation vision that will address the long-term health impacts of climate change is highly recommended to highlight a more proactive approach to climate-proofing the health sector and emphasizing preventive adaptation measures. Given that the determinants of health also lie in other sectors, enhancing intersectoral collaboration on risk assessment and adaptation by working with other sectors beyond the health system is critical.

Moving forward, it should be noted that risk assessment is an iterative process as risks change over time and new information become available. Changes in temperature, humidity, rainfall, sea level rise, extreme weather events, and other climate signals will affect the magnitude of impacts and likelihood of risks. Other non-climatic factors such as population growth and changes in income levels should also be considered in updating the risk assessment.



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## **Annex:** Summary of Climate Change Projections

	Global	Regional (Arabian Gulf)	National (UAE)
Temperature	2046-2065 [A] • RCP 2.6: 0.4-1.6°C • RCP 4.5: 0.9-2.0°C • RCP 6.0: 0.8-1.8°C • RCP 8.5: 1.4-2.6°C 2081-2100 [A] • RCP 2.6: 0.3-1.7°C • RCP 4.5: 1.1-2.6°C • RCP 6.0: 1.4-3.1°C • RCP 8.5: 2.6-4.8°C	<b>By the late 21st century:</b> 3-4°C [B] <b>RCP 4.5</b> [C] 2050: 1.2-1.9°C 2100: 1.5-2.3°C <b>RCP 8.5</b> [C] 2050: 1.7-2.6 °C 2100: 3.2-4.8 °C	2060–2079: 2–3°C [D] 2050: 2.1–2.8°C 2100: 4.1–5.3°C [E]
Humidity	By 2100, the combination of high temperature and humidity is expected to compromise human activities, including growing food and working out- doors (high confidence). [F]	Heat waves due to high humid- ity in the Gulf could increase, leading to higher exposure to heat-related diseases. [G]	Humidity changes are greater in the summer months, about 10% greater over the Arabian Gulf, with higher humidity across most of the UAE. [D]
Sea level rise	<b>2046–2065</b> [A] • RCP 2.6: 0.17–0.32 m • RCP 4.5: 0.19–0.33 m • RCP 6.0: 0.18–0.32 m • RCP 8.5: 0.22–0.38 m <b>2081–2100</b> [A] • RCP 2.6: 0.26–0.55 m • RCP 4.5: 0.32–0.63 m • RCP 6.0: 0.33–0.63 m • RCP 8.5: 0.45–0.82 m	Predicted sea level rise scenar- ios for the Southern Arabian Gulf by 2099: • Low scenario: 0.21 m [H] • Medium scenario: 0.59 m [A] • High scenario: 0.81 m [I] • Extreme scenario: 2.0 m [J]	According to different sources, all coastal cities in the UAE will ex- perience progressively increasing inundation: • Sea levels increasing by 20–30 cm in the coastal shallows of the UAE. [K] • Sea level rise may advance land- ward flooding at a rate of 23–58 m per year and result in flooding 2.26–3.81 km from the shoreline by 2100. [L] • In the worst-case sea level rise scenario, inundation may extend to 25–30 km in Abu Dhabi by 2100. [M]
Rainfall	Changes in precipitation will not be uniform. [F] It is likely that the frequency or propor- tion of heavy rainfalls in total precipitation will increase. [N]	By the end of the 21st century, there is a reduction of the average monthly precipitation reaching 8–10 mm in the coastal areas of the Arab Domain. Some areas, however, show increasing precipitation trends. [C]	Rainfall in the UAE will likely increase, especially in the summer (50–100% in the Northern Emirates and Dubai, and 25% in surrounding regions). [D]
Extreme events	Models project substantial warming in temperature extremes by the end of the 21st century. It is likely that the fre- quency or proportion of heavy rainfalls in total precipitation will increase. [K]	Being in the domain of the monsoon system, the southern part of the Arabian Peninsula is expected to receive more precip- itation in the form of extreme events, such as when Cyclone Gonu hit Oman in 2007. [N]	An increasing risk for "grey swan" (high-impact) cyclones to hit the UAE is predicted. Albeit a low likelihood, this will have a high impact. [O]

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