Mapping the Future

UAE's Physical Climate Risks – Trends, Impacts and Projections

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Abstract

This white paper provides a scientific assessment of climate change impacts and risks in the UAE, highlighting observed trends, model projections and implications adaptation and resilience.

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Executive Summary

This white paper presents an in-depth assessment of the physical climate risks facing the United Arab Emirates (UAE), contextualised within broader Middle East and global climate trends. It draws on historical observations, regional climate models and forward-looking projections to evaluate key hazards including extreme heat, humidity, precipitation shifts, sea-level rise and dust events.

With a specific focus on risk implications for urban centres like Dubai, this paper outlines:

- The accelerating trends in heat and extended duration contributing to prolonged exposure to heatwaves and rising wet bulb temperatures
- Projected intensification of storms, flooding and fog events
- Sea-level rise with granular insights into coastal exposure
- Sectoral risks for health, infrastructure and financial stability
- Strategic recommendations for resilience-building in the UAE context

1. Introduction

1.1 Background

Climate Change is no longer a distant but a present-day challenge with measurable impacts across the UAE. Over the past four decades, the region has experienced a rapid rise in average air temperatures - approximately 2OC between 1982 and 2022 – nearly double the global average. This warming trend is accompanied by increasing humidity, shifting precipitation patterns and more extreme weather events, poses serious risks to infrastructure, energy systems, public health and financial stability.

The UAE's unique geographic and economic profile, marked by coastal megacities, energy-intensive industries and arid conditions, amplifies its vulnerability. Dubai, in particular faces compounded threats from rising sea level, urban heat island effects and prolonged periods of heat stress, all of which require urgent strategic planning.

1.2 Objectives

The white paper presents a focused analysis of physical climate risks in the UAE and surrounding Gulf region. Using regional climate model projections, historical datasets and sectoral impact assessments, it evaluates changes in air temperature, wind patterns, humidity, precipitation and sea level rise. Based on these findings, it provides adaptation strategies for strengthening resilience and policy recommendations to guide long term planning.

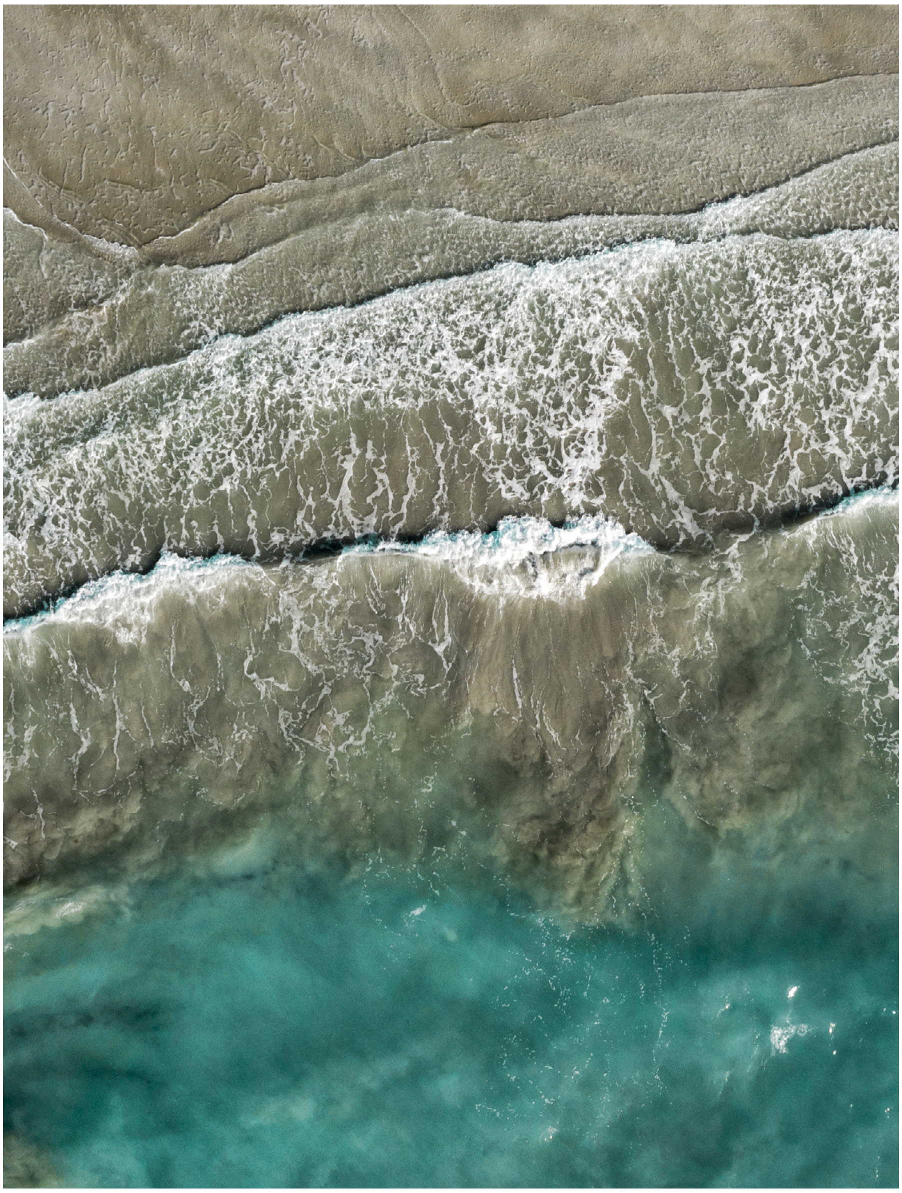
1.3 Significance

This white paper is intended to support national planning, infrastructure resilience and policy development. By delivering a comprehensive, data-driven analysis of climate change impacts specific to the UAE, it provides essential insights for policymakers, planners and financial institutions to design effective adaptation and mitigation strategies.

The findings highlight the potential physical risks including extreme heat, rising wet-bulb temperatures, sea level rise, and increased precipitation variability, that are already influencing major sectors such as energy, water, real estate and public health. These risks have direct implication, on the operational resilience of cities such as Dubai.

By demonstrating how global climate change manifests in specific regional contexts, this research contributes to the broader understanding of climate change impacts and adaptation strategies worldwide. This research integrates multiple of climate parameters and their interconnections, providing a holistic view of climate change impacts, fostering interdisciplinary approaches to climate resilience.

Moreover, this comprehensive analysis identifies key areas for future research, particularly in improving regional climate models and understanding local climate dynamics in arid regions. In conclusion, this research provides a crucial foundation for understanding and addressing the complex challenges posed by climate change in the UAE. Its findings and recommendations have far-reaching implications for policy, economy and society, not only within the UAE but also for other regions facing similar climate challenges.



2. Literature Review

2.1 Air Temperature and Heatwaves

The global average air temperature has increased by approximately 1.10 C since the late 19th century, primarily due to anthropogenic activities such as burning fossil fuels, deforestation, and industrial processes (1). According to the Intergovernmental Panel on Climate Change (1), future projections indicate that global surface air temperatures will likely rise by about 1.0 °C to 2.0 °C by mid-century relative to pre-industrial levels. By 2100, projected warming ranges from approximately 1.4 °C to 2.4 °C under very low and low emissions scenarios, to 2.1 °C to 3.5 °C under intermediate emissions, and could reach 3.3 °C to 5.7 °C under very high emissions scenarios.

In the UAE and the broader Arabian Peninsula, this warming is occurring at an accelerated pace – up to twice the global average (2, 3). This rapid increase in temperature exacerbates the already harsh climatic conditions, leading to extreme weather conditions, more intense heatwaves, and prolonged periods of extreme heat.

One alarming trend is the rise in daily minimum temperatures, which have been increased at double the rate of the daily maximum temperatures during the summer months (1980-2014). This trend exacerbates the night-time head burden, amplifying discomfort and reducing the effectiveness of natural cooling. Combined with rising humidity, this increase frequently exceeds thresholds for human habitability (4).

These climate shifts place immense pressure on the energy sector, increasing the demand for cooling and air conditioning (5). The strong surface heating also promotes a more active thermal low in the warmer months, known as the “Arabian heat low” (AHL; 6) which modulates the occurrence of summertime convection over eastern UAE where cloud seeding activities are regularly conducted (7, 8, 9). The AHL has shown a north-westward shift as the region heats up, with important implications for the weather conditions in the region for precipitation and dust events (4).

During 22 to 26 May 2025, the Middle East experienced an unprecedented heatwave, with temperatures exceeding 51°C in some parts such of the UAE, including Sweihan. Attribution studies analysis shows that climate change and global warming have made this heatwave at least five times more likely to occur (Fig. 1).

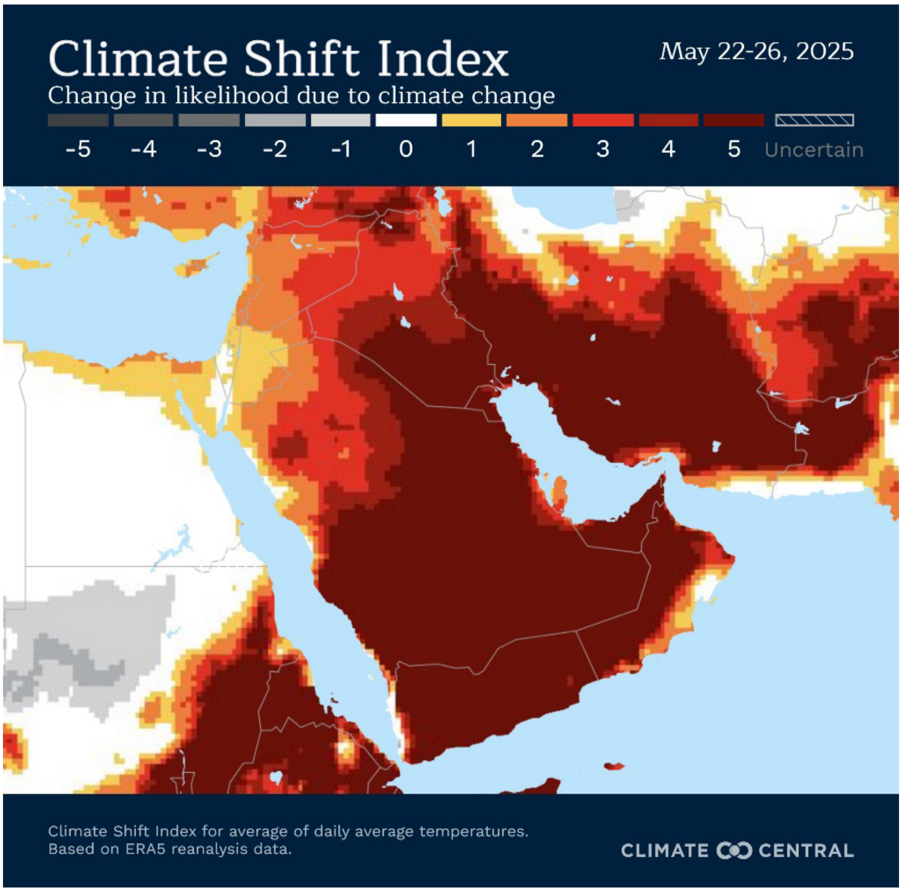


Figure 1

Climate Shift Index for 22-26 May 2025 heatwave over the Middle East and the Arabian Peninsula (Credit: Climate Central).

2.2 Precipitation Patterns

Alterations in global precipitation patterns are a defining feature of climate change. In many regions, climate models project intensified rainfall extremes, while others are more likely to face more prolonged droughts (1). In the Middle East and North Africa (MENA) region, total annual precipitation is expected to decline, exacerbating water scarcity challenges (3).

In the UAE, rainfall variability is increasing, leading to both intense rainfall and extended dry periods (10). Variability in wintertime precipitation is linked to changes in the tropical Pacific (11) and in the North Atlantic and the Mediterranean Sea (12) sea-surface temperatures. The projected poleward shift of the wintertime storm track over southeastern Europe and the Middle East may lead to reduced rainfall in the colder months towards the end of 21st century (4).

Spring rainfall, by contrast is becoming more erratic and intense. Organised convection events have increased in duration and severity during 2000-2020 (13). Recent flooding events on 16 April and 2 May 2024 are illustrative examples (14). These events are often driven by Atmospheric Rivers (ARs), narrow corridors of high moisture content originating in the tropics and subtropics and extending into higher latitudes. Some ARs, such as the one that wreaked havoc in the Middle East in April 2023, have regions of high wind speed and heavy precipitation embedded within their structure that can lead to severe flooding and loss of life (15). ARs are projected to become more frequent in a warming climate (16), leading to higher risks of flash flooding, infrastructure damage and socioeconomic disruption.

2.3 Wind patterns

Wind is a critical component of the Earth's climate system, playing a pivotal role in regulating weather patterns, ocean currents and heat transfer across the globe. Climate change is increasingly altering influencing global wind dynamics, with significant implications for weather systems, ocean currents and energy production.

Jet streams are shifting due to climate change, with the polar jet stream becoming more erratic and exhibiting increased "waviness," leading to more extreme weather events such as cold spells and heatwaves in mid-latitude regions (17, 18, 19). Such variability is projected to become more frequent in a warming climate, with Southeastern Europe and the Arabian Peninsula seeing pronounced changes especially in the winter months (4).

In the UAE, El Niño-Southern Oscillation (ENSO) and alterations in trade winds significantly impact local weather variability (20). Studies (21; 22) reports on the complex temporal variation of the wind speed at different sites in the UAE due to competing influences of different climate modes. The wind speed in the Rub' al Khali desert of the UAE is low, with in-situ measurements at Madinat Zayed indicating an average value of 2.8 m s-1, with wind speeds below 4 m s-1 roughly 76% of the time (23). Higher wind speeds are observed at coastal sites and in eastern UAE, where the wind flow is modulated by the topography-driven circulations (24).

Understanding wind changes is essential due to its role in dust generation. A climatological study (25) reports a double maximum in the concentration of near-surface aerosols in the UAE, with the major peak in the summer months of June to August linked to dust emission by the Shamal winds, and a secondary peak in February, when dust events are associated with the passage of mid-latitude weather systems. Dust events can be highly impactful, as was the case for the May 2022 event that affected the UAE and caused disruption to commercial activities (26).

Wind also modulates fog frequency. The UAE records up to 80 fog days per year, especially inland (27). In coastal cities such as Abu Dhabi there are on average 24 fog days per year (28), with considerable inter-annual variability (29). A comprehensive field campaign targeting fog events has taken place in Barakah in western UAE during 2021-2022 (30; 21, 32) and has revealed the effect of local aerosols on the fog properties in the region. The close relationship between wind, aerosols and dust is evidence of the complex meteorological conditions in this arid region.

2.4 Humidity

Over the past decades, the Gulf region, especially the UAE and broader Middle East, has experienced a clear uptick in atmospheric moisture, driven by warming seas and shifting wind patterns. Summer humidity peaks now range from 70% - 95%, intensifying heat stress and impacting energy demand, especially for cooling systems. Climate models project this trend to intensify under high-emission scenarios: relative humidity along the Arabian Peninsula may rise to approximately 5% in summer by mid-century (3), exacerbating humidity-related thermal stress. By the late 21st century, extreme "wet-bulb" heat events could become frequent along the Persian Gulf coast, occasionally breaching human survivability thresholds—particularly under RCP8.5 conditions. These trends suggest hotter, stickier summers ahead, increasing heat-related health risks and straining energy, water, and outdoor-labour systems across the region.

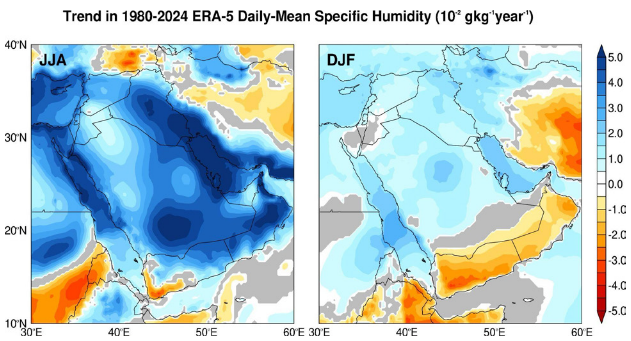


Figure 2

Trends in Specific Humidity for 1980-2024 for the Arabian Peninsula: Trends in daily mean specific humidity (10-2 g kg-1 year-1) from ERA-5 for the period 1980-2024 over the Arabian Peninsula. The left panel gives the trends for the summer season (JJA) season, while the right panel shows the results for the winter season (DJF). Grey shading indicates areas where the trend is not statistically significant at the 95% confidence level.

2.5 Extreme Weather Events

Extreme weather events such as hurricanes, heatwaves, floods and sandstorms are becoming more frequent and severe due to climate change (1). In the UAE, heatwaves have intensified, straining health systems and infrastructure (33). Events such as sandstorms and flash floods are increasing in frequency (34; 13; 35), posing substantial risks to both urban and rural areas (36).

While not observed in the recent past, tropical cyclones may form in the Arabian Gulf or reach the region by crossing the Sea of Oman. Tropical cyclones Gonu in June 2007 (37) and Shaheen in October 2021 had a direct impact on the UAE, with their trajectories having been modulated by a strong and eastward displaced AHL (38). Due to the projected increase in surface temperatures, the AHL is likely to play an even more important role in the track of tropical disturbances impacting the Southeastern Arabian Peninsula in a future climate. Model simulations revealed that a direct impact of a tropical cyclone can occur in the future and will be devastating for the UAE (39), with the increasingly warm waters of the Arabian Gulf providing further fuel to such systems.

As noted above, the UAE and surround region face increasing severe weather events, including droughts, heatwaves and hydro-climate extremes, that have become increasingly impactful (40, 3, 4).

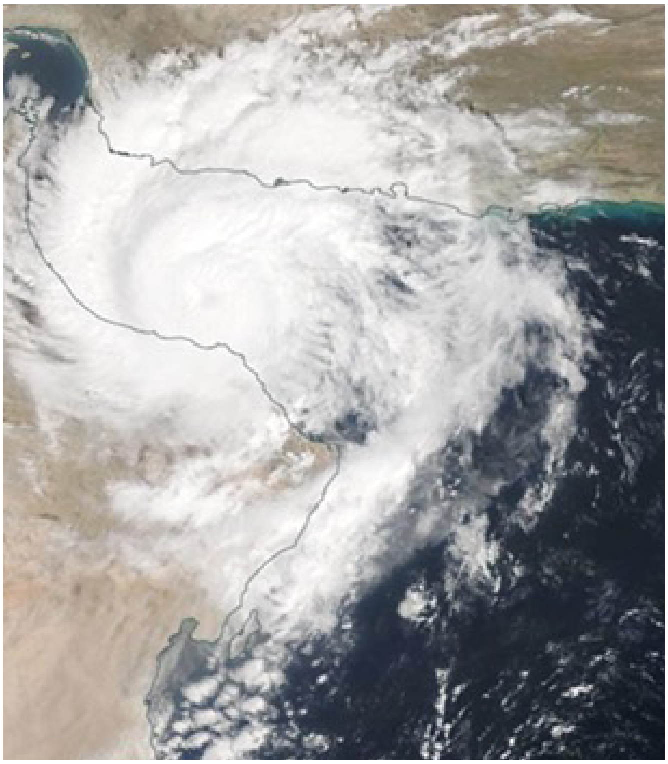


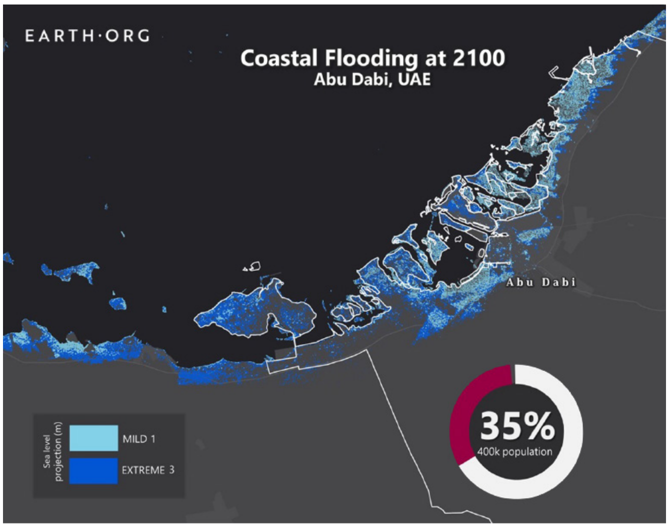
Figure 3

Tropical cyclone Shaheen making landfall over Oman and the eastern coast of UAE in October 2021. Credit: NASA Worldview.

2.6 Sea Level Rise

Sea level in the Arabian Gulf has risen at 2.6-3.1 mm/year since 1993, with recent rates exceeding 4.3mm/year due to thermal expansion and glacial melt (41). Regional climate model projections under IPCC's RCP scenarios estimate sea-level increases of roughly 8cm (RCP2.6), 13cm (RCP4.5), and 68cm (RCP8.5) by mid-century, rising further to about 17cm, 18cm and 39cm, respectively, by 2100.

The UAE's flat, low-lying coastline makes it highly vulnerable: A 1m of sea-level rise could submerge 571km², threatening 85% including mangroves, wetlands, residential zones (42). These projections underscore significant future threats to coastal infrastructure, ecosystems, freshwater resources, and urban planning across the Arabian Gulf.



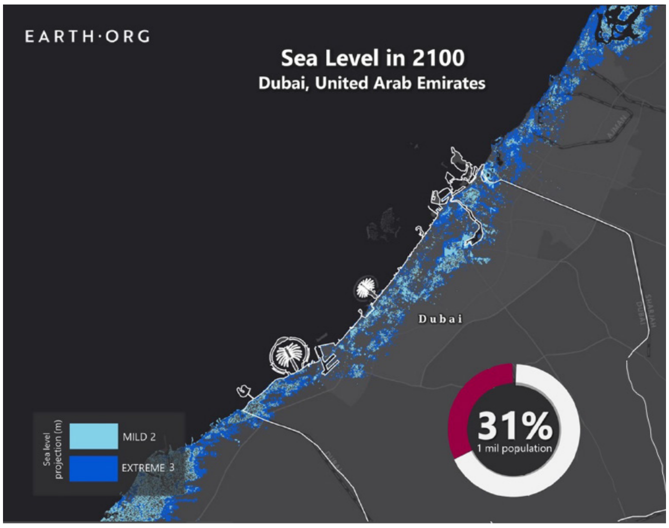


Figure 4

Sea level rise projections by 2100 based on CMIP5 data for Abu Dhabi (top) and Dubai (bottom).

3. Data and Methodology

3.1 Data Sources

A combination of reanalysis, remote sensing and model data is used to perform the analysis presented in this white paper. ERA-5 reanalysis data (43) is considered given its high spatial (0.25°, approximately 27 km) and temporal (1-h) resolution compared to other reanalysis datasets and its good performance in the UAE and surrounding regions when evaluated against in-situ and satellite-derived observations (44).

Daily statistics, including daily mean, maximum and minimum air temperature, daily mean wind speed, sea-level pressure, dewpoint temperature, and daily accumulated precipitation at more than 9,000 weather stations around the world are made freely available at the National Centres for Environmental Information (NCEI) Global Surface Summary of the Day (GSOD; 45, 46) dataset. This dataset is used to explore trends and evaluate model output.

Future climate model projections are extracted from models that integrate the Coupled Model Intercomparison Project's fifth (CMIP5; 47) and sixth (CMIP6; 48) phases. Variables such as temperature, humidity, pressure and wind, both at the surface and throughout the troposphere, are available at a temporal frequency as high as 1-h from 1850 to 2014 for the historical period, and from 2015 to beyond 2100 for different climate change scenarios. The latter are expressed as Shared Socioeconomic Pathways (SSP) defined as SSPX-Y.Y, where X ranges from 1 to 5 (from a mild to a more extreme scenario) and Y.Y gives the expected radiative forcing by 2100 in W m-2 (49; 50). Most of the models that feature in CMIP5 and CMIP6, however, are at a relatively low spatial resolution, typically coarser than 100 km, which prevents a proper representation of the complex topography and land-sea mask of the Middle East. Given this, higher resolution simulations at 0.22° (approximately 25 km) from three global models are also considered. Additionally, higher resolution products available for selected climate change scenarios and variables are also used to gain insight into how the UAE climate is projected to change in a warming world.

3.2 Climate Parameters

The most relevant variables for mitigation and adaptation strategies are the air temperature, 2-m water vapour mixing ratio (a measure of the amount of moisture in the atmosphere just above the surface), 10-m wind speed, and precipitation. These are available from in-situ observations, reanalysis products and model projections, and have a major impact on day-to-day life. While heavy rain events (e.g. 14) can pose a challenge, the combination of heat and humidity in particular in coastal UAE in the summer months can be life-threatening, as it may prevent the human body from naturally cooling through sweat evaporation (51). Another crucial parameter is sea-level height, with the projected sea-level rise driven mostly by the melting of glaciers and the Greenland and Antarctic ice sheets and thermal expansion of the ocean water together with regional- and local-scale factors (52), posing a threat to the livability in coastal cities around the world (53) including to those in the UAE (54).

3.3 Analytical Approaches

Seasonal and annual averages are commonly used approaches to extract a representative state of a selected variable for a given period. The seasons in this report are defined as spring (March to May; MAM), summer (June to August; JJA), autumn (September to November; SON), and winter (December to February; DJF). In addition, trends are computed to assess how a given field has changed over a defined period at a selected location. In addition to the ordinary least square regression (OLS; 55), in which the best linear fit is obtained by minimising the square of the residuals, the Theil-Sen technique (56; 57) is also considered. In this approach, which is more robust and less sensitive to outliers compared to the OLS method, the estimated slope is the median of the slopes obtained with all pairs of points. The statistical significance is assessed with the Mann-Kendall test (58), with a trend regarded as significant if it exceeds the 95% confidence level threshold.

The length of the seasons is computed with a modified version of the methodology proposed in this study (59). This is achieved as follows: For a given year, the daily-mean air temperature is averaged over all grid-points within the UAE, with the 29 February removed for all leap years. The resulting 365-point time-series is then fitted to a third-order polynomial function, and the 25th and 75th percentiles are extracted. Winter is the period for which the air temperature is below the 25th percentile; summer is the period when the air temperature exceeds the 75th percentile; the periods in between correspond to the spring and autumn seasons, with the temperature increasing in the former and decreasing in the latter. The fit to a polynomial function is required to smooth any high-frequency variability and to prevent more than two interactions with each percentile. This technique has the advantage of being insensitive to uniform background warming: if the rise in air temperature is the same for all days of the year, the seasons will have the same length. As in (4), the statistical significance of the projected changes in the duration of the seasons is assessed with the bootstrap technique considering 1000 samples.

4. Results and discussion

4.1 Air Temperature

4.1.1 Historical Temperature Trends in the UAE

Over the last four decades, the daily minimum and maximum air temperatures have increased at a rate of up to 0.1 °C year-1 in the UAE and surrounding region (Fig. 5). A notable finding, also seen in *in-situ* observations (4), is that, and in the summer, the daily minimum air temperature has increased at a steeper rate than the daily maximum air temperature (Fig. 5). This reflects increased humidity levels (Fig. 2) and dust loading, and in the UAE is seen in both the warm and cold seasons, more strongly in the northeastern part of the country. Higher sea-surface temperatures (SSTs) also contribute to the positive air temperature trends. The smaller temperature increases over the Sea of Oman and UAE east coast in summer arise from higher amounts of low-level clouds that develop when the moister air mass from the Arabian Sea moves into the Sea of Oman and rises as it encounters the Al Hajar mountains, leading to condensation and cloud formation. Warmer nighttime air temperatures, in summer when they are coupled to higher humidity levels (Fig. 2), increase the mugginess of the air, which has already crossed established thresholds for human habitability in the UAE in recent years (51).

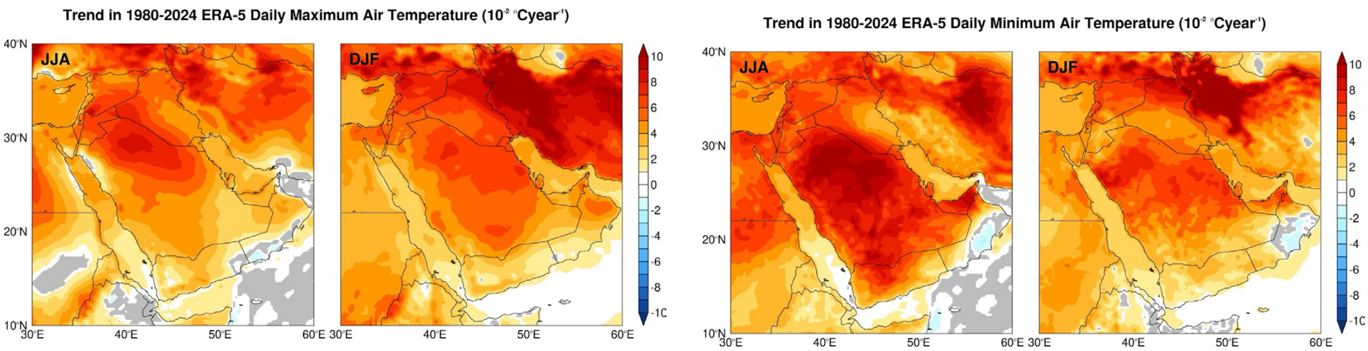


Figure 5

Air temperature trends for 1980-2024 for Arabian Peninsula: Trend in the daily maximum (left) and minimum (right) air temperature (10-2 °C year-1) from ERA-5 for the period 1980-2024 and the Arabian Peninsula. The left panel gives the temperature trends for the summer season (JJA) season, while the right panel shows the results for the winter season (DJF). Grey shading indicates areas where the trend is not statistically significant at the 95% confidence level.

4.1.2 Future Projections

Climate change projections over the UAE for a "business-as-usual" climate change scenario (SSP5-8.5) indicate a warming of up to 6°C by 2070 with respect to 1980-2014. The trend is statistically significant at the 95% confidence level in both the warmer (April - September) and cooler (October - March) months. Its magnitude is about 0.064 °C year-1 in April - September and roughly 0.060 °C year-1 in October - March, largely comparable to that estimated during 1980-2024 (Fig. 5). Hot days, defined as those for which the daily maximum temperature exceeds 35°C and tropical nights, days for which the daily minimum temperature is higher than 20°C, are also projected to become more frequent in the region in a warming world.

4.1.3 Implications for the UAE

High temperatures will increase the demand for cooling systems and therefore for energy while hotter conditions will likely promote the spread of vector-, water-, and food-borne diseases (60). Climate change is projected to have major effects on the UAE population including on (i) health (increase in the prevalence of respiratory, cardiovascular, and vector-borne diseases), (ii) biodiversity loss (major threat to several plant and animal species, including coral reefs owing to warmer SSTs), (iii) food security (substantial impacts on food production systems), and (iv) water supply (increased evaporation losses will affect hydrological resources). These findings highlight the need to implement effective adaptation and mitigation strategies to deal with the projected air temperature increase that will have a wide range of impacts from human activities, fauna and flora to food and water systems.

4.2 Precipitation

4.2.1 Trends in precipitation

No clear trend is found in the UAE precipitation in summer, with a slight decreasing trend in winter (Fig. 6). One of the reasons for this could be its more localised/small-scale nature compared to cold season precipitation events, which coarser resolution products like ERA-5 have difficulty in simulating, as noted by (61). Springtime precipitation in the UAE is driven by organised convection in the form of Mesoscale Convective Systems (MCSs; 62), larger areas of deep convective clouds in which a smaller precipitation region is embedded. The study (14) reported a positive trend in spring rainfall in the UAE. Using high-resolution satellite-derived brightness temperature, a statistically significant increase in the number of convective days in the southeastern Arabian Peninsula during May-October 2000-2024 (approximately 1.42 days year-1) and that the duration of MCS passages in the UAE exhibits a statistically significant increase during 2000-2020 (63).

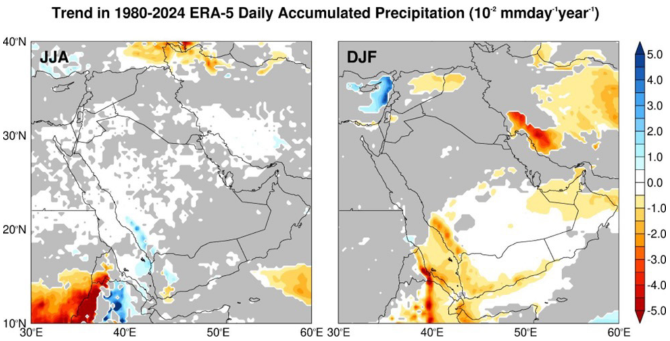


Figure 6

Trends in Daily Accumulated Precipitation for 1980-2024 for the Arabian Peninsula: Trends in daily accumulated precipitation (10-2 mm day-1 year-1) from ERA-5 for the period 1980-2024 over the Arabian Peninsula. The left panel gives the trends for the summer season (JJA) season, while the right panel shows the results for the winter season (DJF). Grey shading indicates areas where the trend is not statistically significant at the 95% confidence level.

4.2.2 CMIP6 Projections for UAE Precipitation

As opposed to the temperature projections, our analysis shows a substantial spread in the precipitation projections for the UAE. The trends for both seasons are not statistically significant at the 95% confidence level, with a tendency for higher precipitation amounts in the warmer months in the second half of the 21st century. Summertime convective events can be highly impactful, leading to precipitation accumulations of more than 100 mm in a few hours (8). Cold season precipitation projections, on the other hand, range from a decrease to a twice as large increase, a reflection of the changes in the position of the mid-latitude storm track (4). Heavy precipitation days, defined as those with totals more than 20 mm, are generally projected to increase, with a small to negative trend for the maximum length of dry spell, defined as the maximum number of consecutive days with less than 1 mm of precipitation (not shown). This is in line with (64). Fig. 6 highlights an increase in the variability of the precipitation in the UAE in a warming climate in the colder months, stressing the need for high-resolution calibrated model projections for this variable.

4.2.3 Impacts and Challenges

Heavy rainfall events pose a major threat to people's lives and infrastructure in the country, as evidenced by the 16 April 2024 flooding event (14) and July 2022 floods that wreaked havoc in the northeastern part of the UAE (65). On the other hand, prolonged droughts severely deplete groundwater aquifers, which account for approximately 70% of the total water resources in the UAE and hence have major implications for food security (66). Given the widespread impacts of precipitation events (and the lack of it) in the country, it is vital to accurately predict it in the current climate to increase confidence in its climate change projections. Currently there are major challenges in projecting precipitation in the UAE. In the summer, a kilometer-scale resolution product is needed given the scale of summertime convective events (61). In winter, rainfall occurs with the passage of low pressure and frontal systems that are generally well captured by the model. However, a high spatial resolution is also needed to resolve the fine-scale structure of the convection embedded within those large-scale features, as well as to properly represent the topography and land-sea mask. In both seasons, the model-generated precipitation is very sensitive to the selected physics parameterisation schemes for both seasons (67). Dust aerosols also modulate rainfall in the region (68; 69) and coupling with hydrological models may be necessary for a more skillful prediction of the observed precipitation (70). Although considerable progress has been made on this front in the last couple of decades, there is a lot of room for improvement, with Artificial Intelligence (AI) models being increasingly used for this purpose and showing promising results (71).

4.2.4 Conclusions and Future Directions

A correct simulation of precipitation in the hyperarid UAE remains a major challenge due to a combination of deficiencies in the model's physics and dynamics, the need for a high spatial resolution to capture the complex topography, land-sea mask and local-circulations in the region, and the major role played by aerosols (namely dust) in the dynamics of the weather events. It is recommended that additional effort is made to improve the performance of the models, to increase confidence in climate change projections for this variable. AI models have shown promising results in simulating even extreme precipitation events (71). The GraphCast model is capable of accurately simulating the timing, location, and amplitude of 16 April 2024 heavy rainfall in Dubai. As such models are computationally cheaper than the traditional physics-based models, their potential for precipitation simulations should be further explored. The lack of statistically significant trends in precipitation data may be tied to the uncertainties in remote sensing-estimated observations and poor spatial coverage of long-term ground-based measurements. Employing machine learning (ML) methods and incorporating surface variables such as soil moisture that strongly respond to precipitation events may allow for a more robust trend analysis.

4.3 Humidity

4.3.1 Trends

The specific humidity has increased over the Arabian Peninsula during the 1980-2024 period in line with the rise in SSTs (72) and surface and air temperatures (4; 73). Areas over and adjacent to water bodies are major hotspots for the positive humidity trends, with changes in circulation also playing an important role. An elevated moisture content, when combined with higher air temperatures, can lead to a lethal combination of humid-heat, a major health-related risk in the UAE in coastal areas.

4.3.2 Projections

Evapotranspiration is projected to increase in the UAE by 1-5% by 2040-2050 with respect to 2000-2009 (74), a reflection of the projected higher SSTs (75) and precipitation amounts (64). This would lead to higher humidity levels; also, as warmer air is capable of holding higher amounts of moisture (7% capacity increase for each 1 C of warmth). Higher specific humidity values will further exacerbate the oppressive summertime conditions in the UAE, potentially extending the period during which established thresholds for human habitability may be exceeded (76). Additionally, the lack of an index that effectively measures the humid heat risk also hinders the development of targeted projections for this crucial variable.

4.3.3 Conclusions

Little attention has been paid to humidity trends and projections compared to other variables such as temperature and precipitation. This is a drawback, given how important this variable is in the Middle East that often experiences very high moisture levels more than 20 g kg-1 and where the combination of heat and humidity at times poses health-related risks. There is a need for high-resolution climate projections as changes in the dynamics (e.g. position and strength of AHL; Shamal winds) and thermodynamics (e.g. higher SSTs and air and surface temperatures) may lead to opposing trends for this field. Regarding humid-heat episodes, there is a need to develop suitable metrics that can be used to warn the community whenever oppressive conditions are predicted.

4.4 Extreme Weather Events

(Heatwaves, Cyclones, Dust storms, Flooding, Fog)

4.4.1 Heat Waves

While the Arabian Peninsula and in particular the UAE are known for their hot weather, prolonged periods of unusually high temperatures have major effects on the population, leading to a rise in the occurrence of hospitalisations and higher mortality levels (77). Climate change projections indicate that by the end of the 21st century the heat-related mortality risk may increase by up to a factor of 35 relative to 1995-2014, with a more than 20% decline in work performance (78). This stresses the need to better understand the drivers of heatwaves in the region as well as to develop efficient mitigation and adaptation strategies.
Humid-heat conditions are also a major threat to human health, with the combination of high temperatures

and humidity levels having crossed known thresholds of human habitability in the UAE (51). Humid-heat events will likely pose a greater threat to young people under 35 than those above 50 (79), with the larger effect on economically active people having major economic impacts against the background of an aging population. Another challenge is developing an index that provides a reliable indication of the heat risk: it is not sufficient to account for temperature alone, variables such as humidity, wind, and radiation should also be considered, and the currently used metrics can give very different results.

4.4.2 Cyclones

Cyclonic activity in the Southeastern Arabian Peninsula is enhanced during El Nino autumn, winter and spring, when the mid-latitude storm track shifts southwards, and La Nina summers, when the Asian summer monsoon is more active (80). Cold season low pressure systems develop over the Arabian Peninsula typically in association with a southward shift in the position of the subtropical jet (67) and can be intensified through the interaction with the Red Sea Trough (81), a tongue of low pressure extending from the southern Red Sea to the Mediterranean. An example of such an occurrence took place on 16 April 2024 (14), when the low pressure over the southeastern Arabian Peninsula was also reinforced by a wave train emanating from the tropical Indian Ocean in response to deep convection there.

In the warmer months, tropical disturbances that develop in the Arabian Sea can move towards the Arabian Peninsula, as is the case with tropical cyclones Gonu in June 2007 and Shaheen in October 2021 that impacted the east coast of the UAE (38). On average 1.33 tropical cyclones storms form per year in the Arabian Sea, more frequently in June followed by October, November, May, September and December. Early season (May-June) storms tend to follow more sinuous paths, as their trajectories are modulated by the heat lows over the Indian subcontinent and the Arabian Peninsula, while late season (September-December) storms follow straighter tracks (82). While it has not been observed to date, tropical cyclones may form in the Arabian Gulf in a future climate. The exceptionally high SSTs (>34°C) and very stable oceanic state owing to the high salinity levels, when combined with a reduced vertical wind shear, may give rise to potentially destructive tropical cyclones, with wind speeds in excess of 110 m s-1 and storm surges that may surpass 7 m (39).

4.4.3 Dust storms

Dust storms pose a major threat to day-to-day activities and human health. Being adjacent to a dust source region, the UAE has experienced multiple severe dust events in recent years such as in March 2012 (83), March-April 2015 (84), and May 2022 (26). The climatological studies reported that dust events are more frequent in the country in the summer months of June to August (25, 85). The same studies also noted a decreasing trend in dust loading over the UAE from 2006 to 2019, which is attributed to increased precipitation amounts and changes in land use land cover, with recent work also stressing the role of the weakening of the Shamal winds during 1980-2024 (73). Numerical models exhibit considerable biases in the simulation of the dust loading in this region in both the warm and cold seasons (86), even though progress has been achieved in recent years through the calibration of relevant physics schemes (87). This is crucial given the role of dust in modulating convective events and heat lows (68; 69), and that a correct representation of its vertical distribution is critical for remote sensing applications (88) and guidance into transportation activities (89). Climate change projections indicate a tendency for lower dust loadings in the Arabian Peninsula towards the end of the 21st century mostly tied to a rise in precipitation, but with a large uncertainty.

4.4.4 Flooding

Despite the hyper arid conditions, the UAE at times receives extreme precipitation that results in localised to widespread flooding. This is true during both winter/springs, such as the 16 April 2024 floods (14) and summer, such as the July 2022 floods that impacted eastern UAE (82). Factors that can make rainfall extreme in nature include high moisture levels and aerosol loading (14). Flooding can also occur during the passage of an atmospheric river (AR), which occurs more frequently in the Middle East during March-April (90) and is projected to occur more frequently in a warm climate (16). A highly impactful AR that affected the Middle East took place in April 2023, with very high-resolution simulations revealing fine-scale convective structures, termed as “AR Rapids”, not represented in coarser resolution models that account for some of the extreme periods of weather (15). Further research is needed to elucidate the properties and frequency of occurrence of such features.
Numerical models used to investigate heavy rainfall episodes should incorporate a hydrological component. For the 9 March 2016 rainfall event in the UAE, a study (70) found that an atmosphere-hydrology coupled model outperforms the atmosphere-only model in the simulation of precipitation and surface variables. Flooding rains also have a major impact outside the urban areas: e.g., 2-3 months after the April 2024 event there was a fourfold increase in vegetated regions in the UAE (14). These further stresse the need to include a proper representation of the soil and underground aquifers, also because subsequent rainfall events may lead to a substantial rise in the streamflow.

4.4.5 Long-lasting fog events

Fog poses a greater threat to air and ground transportation in the UAE compared to dust events and its prediction is still challenging (91). For nowcasting, ML methods have shown promising results (27; 92). In the UAE fog is generally more common in the colder months of December-March and is typically of a radiative-advective type: the sea-breeze advects in the more moist air marine air inland during the day where it gets trapped at night, with

the strong radiative cooling bringing the air mass to saturation (28). Sea fog may occasionally drift into coastal areas in the warmer months (21). On the east coast, however, fog occurs more frequently from July to September (93), when clouds form as the more moist airflow from the Arabian Sea enters the Sea of Oman and interacts with the Al Hajar mountains. Spatially, an area parallel to the coast located roughly 40-60 km inland has the highest fog frequency in the country with up to 80 fog days per year. Closer to the coast the weaker nighttime radiative cooling hinders the development of fog, while further inland fog formation is hampered by reduced moisture levels (27). In Abu Dhabi, where there are on average 24±10 fog days per year, there is an uptick in fog occurrence during September-October, followed by a relative minimum in November and a second fog season from December to March. The November minimum has been attributed to a reduced aerosol loading (28), stressing the role of aerosols in fog formation in the UAE. Field campaigns conducted in the country have provided in-situ measurements of fog properties (30; 31, 32, 94), with fog in the UAE is generally more opaque than elsewhere (29). The latter study investigates the drivers of multi-day fog occurrences in the UAE, tying them to climate modes of variability. They note that consecutive fog days, which are linked to favorable synoptic patterns, have become more frequent but weaker in strength during the period 1985-2021, tendencies that are driven by both changes in the atmospheric circulation and aerosol loading. In addition to a better understanding of the physics and dynamics of fog events and improving the accuracy of its forecast, it is crucial to explore whether fog is projected to occur more frequently in a warming climate and how its properties may change with climate change.

4.4.6 Economic Impact of Extreme Weather Events

Extreme weather events impose substantial economic costs by disrupting transport and supply chains, damaging public and private assets, straining utilities, and reducing labour productivity. For example, the 16 April 2024 floods caused large scale aviation disruption Dubai's International Airport (over 1,500 flights delayed or cancelled) and insured losses estimated at 2.9-3.4 billion USD, and this was followed by a 15% rise in property insurance rates, illustrating how a single episode can transmit costs across sectors and into risk pricing (14). A dive into extreme periods of weather in the UAE since records began in the 1930s shows that the investment made on infrastructure and rapid emergency response in recent decades has better prepared the country for such occurrences and substantially reduced their effects (95). Fog, a leading cause of one of the major causes of traffic accidents in the region, regularly triggers multi-vehicle collisions and road closures, resulting in asset damage, congestion costs and higher insurance claims e.g., the 14 March 2019 fog event involved a 68-vehicle pileup that paralysed a key corridor (96; 97). Dust Storms reduce visibility, degrade equipment, and force flight diversions, while clean -up and maintenance needs add to municipal and business expenditures; a severe dust storm of July 2018 (7) led to more than 1000 road accidents and wide-ranging service disruption (98). Extreme Heat and humidity affect outdoor and manual-labour productivity, shorten working hours in summer, increase cooling demand and peak electricity loads, elevate occupational health related costs – together raising operating expenses for construction and logistics and services (99), with economic impacts also arising from the shorter working day for those working outdoors. Heatwaves, tropical cyclones, dust storms, and flooding are therefore major drivers of economic and financial losses in the country, stressing the need to better understand and predict such occurrences, analyse their projected changes in a warming climate and implement effective adaptation and mitigation strategies to minimise their effects.

4.4.7 Conclusions and Future Directions

Despite massive improvements in infrastructure and more targeted and timely warnings, the UAE continues to be vulnerable to extreme weather events. As anthropogenic climate change is making at least some more frequent and/or intense, such as the 16 April 2024 floods (14), there is a need to further our understanding of their drivers, improve their predictions and better inform the public about the inclement weather. While good progress has been made on this front in recent decades, much is yet to be accomplished. For example, the role of aerosols, with the Arabian Peninsula being one of the major sources in the world, on rain and fog events is still poorly understood, hindering their skillful prediction. Air quality is another area with room for improvement, with models having substantial biases (86) and accurate forecasts needed to warn those at risk. ML techniques can assist in better predicting and monitoring flooding (100, 71), dust (101) and poor air quality (102) episodes. It is recommended that this approach is explored as well. Future climate projections of flooding, fog, and dust events using calibrated numerical models at high-resolution are needed for the development of adaptation and mitigation strategies.

4.5 Sea-level rise

4.5.1 Trends

Satellite altimetry measurements indicate that the sea-level height around the UAE coastline has risen by around 0.03 to 0.05 m decade-1 during 1993 to 2022 (103). Global drivers include the thermal expansion of the ocean water (104) and the melting of glaciers and Antarctic and Greenland ice sheets, while changes in air pressure, freshwater fluxes and ocean currents also modulating the sea-level rise at a regional/local level (52). The sea-level in the Arabian Gulf exhibits a clear seasonal and inter-annual variability (41). In particular, the highest seasonal mean values occur in the autumn and the lowest in winter. The rise in sea-level poses an increasing threat to coastal areas in the country as the risk of flooding and erosion, soil and groundwater salinisation, and environmental degradation rises. These effects are particularly enhanced during the occurrence of extreme weather episodes (14). Although so far not reported in coastal UAE, “meteorological tsunamis” such as those observed in coastal parts of Iran (106) can aggravate the effects of a rising sea level.

4.5.2 Projections

Climate projections indicate a rise of up to 0.8 m in sea-level in the Arabian Gulf towards the end of 21st century for the more aggressive climate change scenario with coastal UAE potentially experiencing more than a 1 m rise by 2100 (105). Such an increase in sea level would have devastating consequences for coastal and even inland areas of the country: A 1 m sea-level rise would impact an area of approximately 571 km2 in the 500 km coastline that extends from Abu Dhabi to Ras Al Khaimah, displacing roughly 85% of the inhabitants with major economic consequences. In addition, the warmer SSTs, projected to increase by about 2-3°C by 2100, would have a considerable effect on marine life. As roughly 85% of the UAE’s population and 90% of the country’s infrastructure are currently within a few meters of the present-day sea-level, sea-level rise will become an even larger threat in a warming climate.

4.5.3 Conclusions

Sea level is an overlooked major consequence of anthropogenic climate change, which has the potential to trigger even more devastating effects than extreme weather events. The lack of in-situ observations and uncertainties inherent to satellite-derived measurements hamper a better understanding of their variability in the region with ML-based algorithms showing great potential to fill in the gaps. Current sea-level rise projections hint at major impacts on the UAE coastline, in the stretch from Abu Dhabi to Ras Al Khaimah. As meteorological factors, currently not fully simulated by numerical models, modulate the sea-level height, it is recommended that effort is placed on improving the performance of the models to generate more accurate sea-level projections. Aggressive adaptation and mitigation strategies must also be developed to address this pressing issue.

4.6 Wet-Bulb Temperature

4.6.1 Trends

The wet-bulb temperature is a measure of the combined effect of air temperature and relative humidity (107). Fig. 7 shows the trends in wet-bulb temperature for the summer and winter seasons for the historical period of 1980-2024. As a result of the increase in air and sea surface temperatures, the wet-bulb temperature in the UAE has risen at a rate at times exceeding 0.05 °C year-1 during 1980-2024. In the summer, the steepest increases are over the Al Hajar mountains and northeastern UAE, with the lowest trends over the Sea of Oman just east of Fujairah. Western parts of the UAE and east of Qatar have experienced the largest rises in summertime sea surface temperatures in recent decades with higher levels of surface evaporation contributing to the faster increase in wet-bulb temperature here. Albeit at a lower magnitude, typically by about a factor of two, the wet-bulb temperature has also been increasing in the colder months in coastal areas that are more exposed to the warmer and more moist marine air mass. Higher temperatures (and hence surface evaporation) have also been observed in winter, suggesting that the increase in mugginess in the UAE has been felt throughout the year, not just in the summer months.

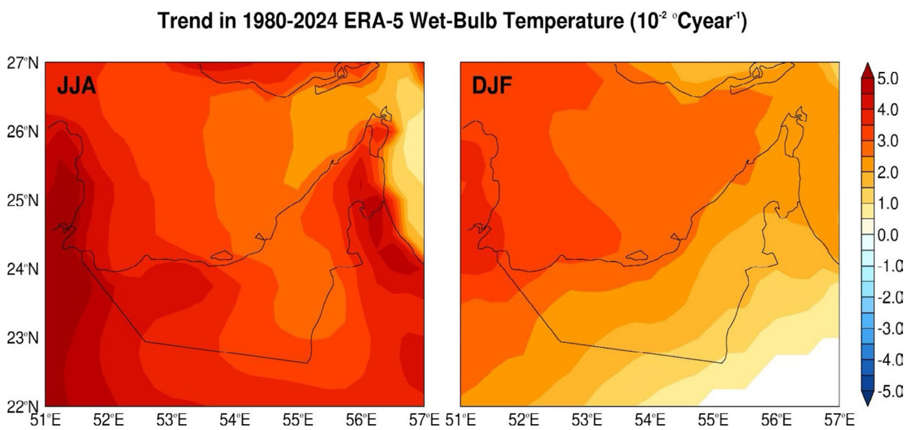


Figure 7

Wet-Bulb Temperature Trends for 1980-2024 for the UAE: Trend in the daily-mean wet-bulb temperature (10-2 °C year-1) for the (left) summer and (right) winter seasons from ERA-5 for 1980-2024. Regions where the trend is not statistically significant at the 95% confidence level are shaded in white.

4.6.2 Projections

The wet-bulb temperature in the UAE, and for a “business-as-usual” climate change scenario, is projected to increase during 2015-2070 in the warmer and colder months, with this field exhibiting a positive trend that is statistically significant at the 95% confidence level in both periods. This can be explained by the projected increase in both air and sea temperatures. The observed wet-bulb temperature in the UAE in the summer has exceeded the 35°C survivability limit on some occasions. The projected increase of 1.5-3.5°C by 2070 would further exacerbate the life-threatening combination of high heat and humidity values and potentially extend the period when established human survivability thresholds are crossed.

4.6.3 Conclusions

The wet-bulb temperature, which is a function of air temperature and relative humidity, is a frequently used metric to diagnose the effects of combined heat and humidity, with 35°C being a commonly used threshold above which humid heat becomes life-threatening. During the reference period of 1980-2024, the wet-bulb temperature increased in the summer, at a rate that in parts of western UAE exceeds 0.05 °C year-1. Climate change projections for a “business-as-usual” scenario indicate further increases that can exceed 3°C by 2070. Should these projections come to fruition, major restrictions on outdoor activities even for those in good health are expected, with targeted warnings required for the community to act whenever extreme conditions are forecasted. It is also imperative to improve the skill of the models used in climate change projections to have more accurate forecasts for the UAE and surrounding areas that are a hot spot for humid-heat conditions in the world.

4.7 Duration of Seasons

4.7.1 Trends

The period 1980-2024 shows no statistically significant change in the length of the summer or winter seasons in the UAE. Unlike in Europe and North America, where summers have lengthened due to early springs and delayed autumns. However, conditions within the summer months, namely air temperature, humidity, and web bulb temperature – have intensified significantly amplifying its impact on human health, energy demand and outdoor work.

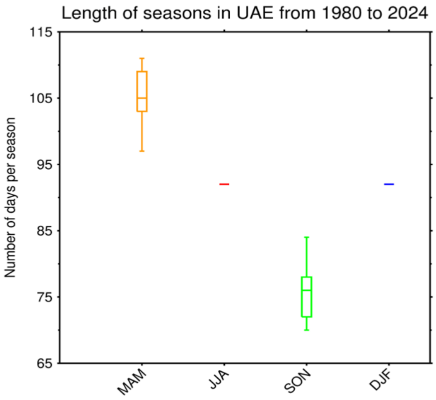


Figure 8

Changes in Season Length during 1980-2024: A box plot showing the variation of the length of each season for 1980-2024 and for the UAE obtained with ERA-5 daily mean air temperature data. The orange, red, green and blue boxes indicate the duration of the spring, summer, autumn and winter seasons, respectively.

4.7.2 Lived Experience and Perceptions

Despite the absence of a clear trend in measured seasonal length, residents consistently report that summers feel longer and winters shorter. This perception reflects several overlapping dynamics:

- Earlier onset of summer-like heat: Rising springtime temperatures make May and early June feel increasingly like mid-summer
- Delayed autumn cooling: High heat and humidity in September and October blue the seasonal transition, creating the sense of a prolonged summer
- Warming winters: Higher average and minimum temperatures during the winter months reduce the seasonal contrast, making winters feel shorter and less distinct
- Greater intensity: increasing wet-bulb temperatures amplify discomfort and risk, reinforcing the perception of an endless summer

4.7.3 Projections

Climate change projections of daily mean air temperature in the UAE obtained with an ensemble of ten CMIP6 models that perform well for the current climate (4) are used to inspect the projected changes in the duration of the seasons. The pie charts in Fig. 9 show the duration of the seasons for 1980-2024, the historical period, and for a “business-as-usual” scenario for 2066-2100, towards the end of 21st century. The projected changes do not exceed two days, with a shorter autumn (by two days) and a longer spring and winter (by one day each), with only the latter statistically significant at the 95% confidence level. This suggests the projected warming is likely to be felt roughly uniformly throughout the year for the Middle East and North Africa regions (4).

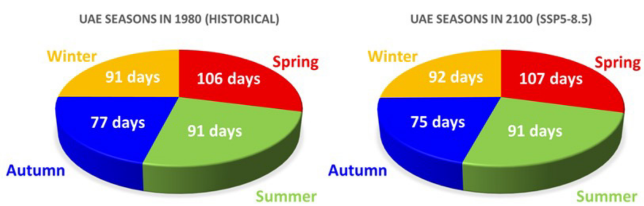


Figure 9

Projected Changes in Duration of Seasons: Duration of the spring (red), summer (green), autumn (blue), and winter (orange) seasons for the UAE in (left) 1980-2024 (historical period) and (right) 2066-2100 (SSP5-8.5 scenario). The results are obtained using the ensemble of ten CMIP6 models considered in Francis and Fonseca (2024).

4.7.4 Conclusions

As global warming is not projected to impact all regions of the world and times of the year equally, the duration of the seasons may change in a warming climate. As a result, it is important to assess the projections for the UAE and whether any statistically significant change has already occurred in the recent past. Our analysis for the period 1980-2024 revealed no statistically significant change in the duration of the seasons. An ensemble of climate models also indicates that no statistically significant change in the length of the seasons is projected towards the end of 21st century for a "business-as-usual" climate change scenario, suggesting that for the UAE global warming is projected to impact all seasons equally.

5. Adaptation strategies

The UAE has taken major steps towards mitigating the effects of climate change and raise awareness of the risk of climate-related disasters with a strong focus on energy, water, infrastructure, and community resilience.

Energy Transition: The launch of the Mohammed bin Rashid Al Maktoum Solar Park in Dubai (the largest single site solar park in the world, targeting 5 GW capacity by 2030) and Barakah Nuclear Power Plant, which is expected to provide up to 25% of the UAE's electricity, are central to reducing dependence on fossil fuels.

Water Security: The UAE has scaled up energy efficient desalination plants such as the Taweelah reverse osmosis facility in Abu Dhabi, along with cloud seeding operations that enhance rainfall in arid conditions.

Urban resilience: Dubai's Green Building Regulations and Specifications and Abu Dhabi's Estidama Pearl Rating System have been embedded into building codes to enhance energy efficiency, reduce water consumption, and lower urban heat stress. Retrofitting initiatives, including the Etihad ESCO program, are upgrading older buildings to meet higher sustainability standards.

Infrastructure protection: Large-scale investments have been made in stormwater drainage systems (e.g., Dubai's deep tunnel drainage project to protect against flash floods) and coastal defense projects to safeguard infrastructure against sea-level rise.

Climate-smart agriculture and food security: Programs like the National Food Security Strategy 2051, and projects such as Pure Harvest Smart Farms and Emirates Bio Farm, are advancing vertical farming, hydroponics, and drought-resilient food systems to strengthen resilience against water scarcity and extreme heat.

Early warning and disaster risk reduction: The UAE has enhanced its National Emergency Crisis and Disaster Management Authority (NCEMA) systems, integrating advanced weather monitoring with early warning alerts. During the April 2024 flood event, rapid deployment of response units reflected improvements in disaster preparedness and coordination.

6. Conclusions

This white paper presents a comprehensive scientific assessment of the UAE's exposure to climate change, integrating observed trends and model projections across key climate variables. The evidence demonstrates that the UAE is already experiencing significant climate stresses, with risks projected to intensify across the coming decades.

Key Findings

- Accelerated Warming: The UAE is warming at nearly twice the global average. Under a "business-as-usual" pathway (SSP5-8.5), temperatures could rise by up to 6°C by 2070, with hot nights and tropical nights becoming more common. Heat-related mortality is projected to increase substantially, while outdoor productivity outdoor may fall by more than 20%
- Heat and Humidity: Humidity is rising in line with higher sea surface temperatures. The UAE has already recorded wet-bulb temperatures above the 35°C survivability threshold, and projections suggest an additional 1.5–3.5°C rise by 2070, making parts of the country periodically uninhabitable without artificial cooling
- Precipitation Extremes and Water Security: Rainfall trends remain highly variable, but extreme rainfall events are intensifying, leading to urban flooding and infrastructure disruption. At the same time, prolonged droughts continue to stress groundwater aquifers, which supply around 70% of the UAE's freshwater—highlighting the dual challenge of flood and drought risk
- Dust Storms and Air Quality: Severe dust events (2012, 2015, 2022) remain a major hazard, disrupting health, transport, and infrastructure. While future dust loadings may decrease due to increased precipitation, the role of Shamal winds and land-use change introduces large uncertainty
- Flooding and Fog: Urban flooding is projected to worsen due to atmospheric rivers and high-intensity convective storms. Fog remains a persistent hazard, with up to 80 fog days annually in some areas, causing aviation and transport disruption. Both phenomena are expected to intensify with warming and aerosol interactions
- Sea-Level Rise: Arabian Gulf Sea levels have risen at 2.6–3.1 mm per year since 1993. Projections suggest up to 1 m rise by 2100, potentially inundating approximately 571 km² of coastline, displacing communities, and threatening critical infrastructure concentrated along low-lying coastal zones
- Seasonal Shifts: While overall season lengths remain relatively stable, modelling indicates subtle shifts—such as shorter transitional seasons and slightly longer winters. More importantly, all seasons are projected to warm, extending climatic stress across the year

An Integrated View of the UAE's climate Risk Profile

The UAE's climate challenge lies in the compounding and converging nature of risks:

- Extreme heat and humidity combine

- to create lethal wet-bulb events
- Rising seas magnify the impact of cyclones and storm surges
- Drought and dust intensify water scarcity and degrade air quality
- Urbanisation amplifies flooding, fog and heat island effects

These overlapping hazards threaten public health, critical infrastructure, energy and water security, biodiversity and long-term economic resilience.

Strategic outlook

To address these escalating risks, the UAE must accelerate action in five domains:

1. Build Climate- Resilient Cities and Infrastructure: The UAE's rapid urbanisation and coastal concentration make it highly vulnerable to heat, floods, and sea level rise. Cities must adopt climate -resilient urban design – including reflective materials, shaded walkways, heat resistant building codes, green infrastructure, and advanced stormwater management. Coastal protection systems, from engineers' sea walls to nature-based solutions such as mangrove restoration, should be prioritised to shield communities and critical assets from storm surges and rising seas.
2. Water and Energy Security: With groundwater resources under pressure and cooling demand rising, integrated strategies are essential. Scaling up sustainable desalination powered by renewables, investing in water storage, and expanding reuse and recycling will strengthen resilience. On energy, accelerating the transition to low-carbon power and advancing district colling networks can reduce the cooling trap of higher electricity demand during hotter periods, ensuring sustainability and security.
3. Public Health Preparedness: Rising heat and humidity are already pushing the limits of human survivability. Public health systems must adapt by expanding heat stress monitoring, emergency cooling centres and occupational safety standards for outdoor workers. Climate change will shift disease patterns, requiring stronger surveillance and healthcare capacity to manage new risks.
4. Predictive Modelling and Data Systems: The UAE should leverage its position as a hub for technology and innovation to build world class forecasting and modelling capabilities. AL satellite data, and advanced climate models can provide impact-based forecast for floods, dust, storms, fogs, and cyclones. This will strengthen climate risk disclosure framework, and climate linked insurance mechanisms will ensure that businesses and financial systems are prepared for escalating risks.
5. Global Climate Leadership: The UAE has positioned itself as a convenor of climate diplomacy through COP28 and beyond. It has the opportunity to lead by example in pioneering adaptation strategies, sharing best practices. By investing in research partnerships, the UAE can set the global benchmark for thriving in extreme climates while reinforcing its roles as a trusted sustainability leader.

Final Call to Action

The UAE's climate reality is no longer a projection but an observable fact. Rising temperatures, more frequent extreme heat events and intensifying pressures on water, food and health systems place the nation on the frontline of global climate risk. Scientific evidence confirms that these challenges will accelerate without urgent and coordinated intervention. At the same time, the evidence also demonstrates that a window of opportunity remains to act decisively, reduce risks, and build long-term resilience.

The UAE has already taken important steps to strengthen adaptation. The National Climate Change Adaptation Programme is guiding sectoral resilience planning in health, energy, and infrastructure. The country's Water Security Strategy 2036 and large-scale investments in desalination and reuse technologies are designed to address increasing water stress. The National Food Security Strategy 2051 seeks to diversify and secure sustainable food supply chains. Urban resilience is also being advanced through initiatives such as Dubai's Clean Energy Strategy 2050 and the nationwide drive towards green building codes and climate-smart infrastructure. Collectively, these measures form a critical foundation on which to build a comprehensive, long-term adaptation agenda.

Decisive action now requires scaling up these efforts, accelerating emissions reduction, embedding climate risk into financial and urban planning, and mobilising investments in clean technologies and nature-based solutions. Preparing cities, securing water and food resources, and modernising infrastructure will not only reduce exposure to climate risks but also safeguard economic growth and social stability. Equally, inaction or delay will amplify vulnerabilities, constrain future options, and significantly increase the cost of response.

The coming decades will be decisive. The UAE can either remain highly vulnerable to escalating climate threats or establish itself as a global leader in adaptation and resilience. Through targeted investments, science-based policymaking, and strong governance, the nation has the opportunity to transform vulnerabilities into strengths. Positioned in one of the world's most hyper-arid and high-risk environments, the UAE can serve as a global testbed for adaptation strategies, setting benchmarks for other nations confronting similar challenges.

The science is clear, the risks are immediate, and the imperative for action is unequivocal. By acting with urgency and ambition, while building on the adaptation measures already underway; the UAE can not only safeguard its future but also demonstrate international leadership in addressing the defining challenge of this century.

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