

# Climate Change in UAE: Evaluating Mitigation Effectiveness and Social Dimensions in Adaptation Strategies

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**Abstract.** This study discusses climate change challenges in the United Arab Emirates by evaluating both technical implementation and social equity aspects of adaptation strategies through comparative analysis. The research evaluated greenhouse gas emissions while assessing the effectiveness of major mitigation projects operating in the UAE. The study discussed how the UAE produces 0.5 % of global emissions while maintaining the highest per capita emission rate at 22 to 26t CO<sub>2</sub> per person. The Mohammed Bin Rashid Al Maktoum Solar Park reduces annual CO<sub>2</sub> emissions by 6.5 million tons/year, yet this represents only 2.6% of the UAE's total emissions. The study suggested a qualitative conceptual framework for UAE climate vulnerability including (i) extreme heat and humidity, (ii) urban flash flood, (iii) Coastal storm and sea level rise, (iv) socioeconomic vulnerability, and (v) governance and economic capacity. Thus, more additional measures may be needed in future to cope with increasing heat waves during summer.

**Keywords:** climate change in UAE, GHG emissions, renewable energy, social equity, adaptation to climate change, vulnerability assessment.

## 1. Introduction

The United Arab Emirates experienced fast economic growth throughout the last decades, which resulted in substantial environmental sustainability issues. The UAE is situated in a desert area with hot dry weather conditions. This harsh weather creates some environmental challenges such as severe heat waves, minimal water supply, and inadequate land quality. The natural challenges have been exacerbated by some anthropogenic factors, which include industrialization, energy consumption, and population expansion. The UAE faces exceptional climate change difficulties because of its location and its dependence on fossil fuels. There are three major climate threats that intensify in the UAE due to its hot environment, limited rainfall, and rising frequency of severe weather events. This paper presents three contributions that include (1) an evaluation of leading renewable energy projects' actual emissions reduction performance (2) a framework to assess adaptation implementation success across different emirates and population groups and (3) a conceptual framework for qualitative Climate Vulnerability Index that includes socioeconomic vulnerability factors. The aim of this study is to evaluate the UAE's climate response while examining distributional impacts of climate change.

## 2. Methodology

This study uses mixed methods; the quantitative part covers emissions analysis, and the qualitative evaluation covered

aspects of policy implementation. Data have been collected through governmental reports from Ministry of Climate Change and Environment (MOCCA) Environment Agency Abu Dhabi, Dubai Electricity and Water Authority, the UAE and the International Organization Global change data lab.

Authors established a two-dimensional framework to evaluate climate initiatives based on their technical execution and social fairness aspects as well as a qualitative framework to assess the UAE climate vulnerability.

**3. Greenhouse Gas Emissions:** The greenhouse gas emissions per capita in United Arab Emirates (UAE) are considered among highest globally.

According to 2020 statistics it was found that UAE released

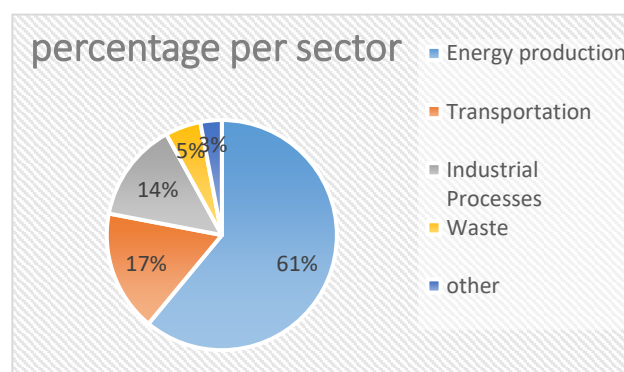


Figure 1: The main sources of emissions by sector (Ritchie et al., 2020a)

238.4 million metric tons of carbon dioxide equivalent (MtCO<sub>2</sub>e) which represents 0.5 % of worldwide emissions. The overall carbon emission for the country is relatively small because of its relatively small area and small population size. The data showed a steady growth in emission levels from 78,602 kt CO<sub>2</sub> equivalent in 1990 until reaching 249,928 kt CO<sub>2</sub> equivalent in 2020 with occasional year-to-year variations recently.

## 4. Climate Change Impacts And Vulnerability

The United Arab Emirates has witnessed major climate transformations because temperatures have risen by 0.5-1°C throughout the last hundred years (Connell et al., 2017). The current summer heat in coastal cities reached 48°C, however the desert areas experienced temperatures up to 50°C. The projected summer temperature rise will amount to 2-3°C between 2060-2079 which will surpass the critical heat stress limits for outdoor activities. The current humidity levels across coastal areas reached 50-60% compared to 45% inland regions, extreme levels of

humidity can reach up to 90% during certain periods of the year. The mean sea level could rise around 0.82 meters (Hereher, 2020), the coastal vulnerability to SLR is significant and this may lead to increasing the adaptation strategies by affected companies in approximately of 5% to 10 % of gross domestic product (GDP).

Literature review and previous studies showed that there will be an expected sectoral vulnerability in Agriculture (Mall et al., 2017) and Public Health (Shezi et al., 2019), Infrastructure Resilience (Terry et al., 2023).

### 5. Qualitative Climate-Vulnerability Index for the UAE:

Our evaluation identified some risk domains that are expected to arise during climate change mitigation and adaptation measures. The authors identified the following possible risks as follows: (i) extreme heat and humidity, (ii) urban flash flood, (iii) Coastal storm and sea level rise, (iv) socioeconomic vulnerability, and (v) governance and economic capacity. Table 2 shows our risk ranking considering the hazard, exposure sensitivity and adaptive capacity where the vulnerability index is proportional to the magnitude of hazard, level of exposure, and the level of population sensitivity.

Table 1: Vulnerability ranking adapted from IPCC

Risk	Vulnerability
Extreme heat and humidity	High
Urban flash flood	High
Socioeconomic vulnerability	High
Coastal storm and sea level rise	Moderate
Governance and economic capacity	Low

On the other hand, the vulnerability index is inversely proportional to the adaptive capacity. Our evaluation revealed that extreme heat and humidity, urban flash floods, socioeconomic vulnerability and water scarcity are of the highest priority. The National Center of Meteorology logged 50.8 °C in Al Shawamekh & Sweihan on 27 Aug 2023 (National, 2023). Flash flooding is second vulnerability particularly after the heavy rain that hit UAE on 16 April 2024, it is estimated that Dubai received about 254 mm of rain in less than 24 hours which is considered heaviest rain in 75 years (Hussein et al., 2025). Despite the efforts done by UAE to address the social equity within the context of climate change and adaptation, the harsh weather conditions and extreme heat and humidity conditions make it very challenging to the country where additional innovative solution needs to be considered to address this gap. The consideration of the coastal storm and sea level rise showed moderate vulnerability due to the efforts of the country to protect the coastal line with sea walls as well as planting mangroves tress. During COP 26, UAE declared a plan to plant 100 million mangroves by 2030 where this can improve coastal protection. A study of 500 km using GIS to identify the coastal vulnerability to sea level rise showed that about 13%, 19.2%, 47% and 18% of the UAE coast is at very high, high, moderate and low risk. The majority of the highly vulnerable coastal lines are located in Abu Dhabi. With current activities conducted by UAE to protect the coastal line against sea level rise, the vulnerability index of this aspect can be moderate. With respect to governance and economic capacity, UAE's vulnerability can be classified as low. This classification is based on the ND-Gain country index where UAE ranked 32 internationally with overall score of 60.3, this reflects low vulnerability score, and high readiness score places the UAE in the lower right quadrant of the ND-Gain Matrix

## 6. Conclusion:

The UAE has moved from ambition setting to delivery, yet the window to align with its -40 % BAU 2030 NDC is narrowing. Our analysis shows that leading projects such as the Mohammed bin Rashid Al Maktoum Solar Park already avert 6.5 Mt CO<sub>2</sub> yr<sup>-1</sup>, but meeting the 2030 goal still requires an additional ≈30 Mt CO<sub>2</sub> yr<sup>-1</sup> of abatement. Extending industrial energy-efficiency programmes which currently five times cheaper per tonne than utility-scale solar offers the fastest near-term gain.

On the adaptation side, the qualitative Climate-Vulnerability Index flags *extreme heat, flash floods and social inequity* as the top three risk clusters. Despite a 99.9 % formal-sector compliance with the midday heat break, informal workers and low-income households need more innovative approach to address their possible climate vulnerabilities. Adopting new innovative approach to address these high vulnerabilities will provide solutions not only to UAE, but this can help many other countries having similar harsh environmental conditions in the Gulf region.

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