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Climate change: The game changer in the Gulf Cooperation Council Region

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ABSTRACT

The GCC experience is the only successful Arab experience at the level of regional cooperation in the Arab region. This success can only be enshrined by the Council's ability to continue. Also, these countries succeeded in promoting a rapprochement between their States and the Arab region and its surroundings. The three wars in the area posed significant challenges to the Gulf Cooperation Council. Arabian Gulf authorities have sensed the need to develop a strategic partnership focus on the defense and the sustainability of the GCC countries, and their well-being.

Climate change has sparked a war; all the wealth and luxury enjoyed by the people of the Gulf States will be affected by climate change. The impact of climate change appears in many forms, including an increase in the average ambient temperature in the region with severe decrease in precipitation. The area climate is rapidly changing because of human activities from year to year and decade to decade. The Arabian Gulf region is interested in climate change on several levels, and there is a growing awareness in the area. The potential for climate change is affecting many sectors and systems, like distilled water processing, food security, renewable energies and public health. This paper will discuss these issues in this paper. The information presented in this article aims to give a review and discussion of the effect of climate change in the GCC to the researchers; decision makers, politicians, and engineers.

1. Introduction

The Arabian Peninsula States are coastal areas on the Arabian Gulf. The Arabian Gulf region is vital due to its natural resources and reserves of oil, and because its geographical location constitutes a pivotal mission connection between the Eastern countries and the West; this represents the cornerstone of the Middle East, because of its importance geopolitically, economically and for security. Also, the strategic Strait of Hormuz acts as a safety valve in the Gulf region.

The dry climate characterizes the Gulf region; it has two seasons, winter and summer. The winter exists in the period between November and March, where the temperature raises up to 26 °C in the morning and 15 °C at night. The scorching summer runs from April until September, and temperatures can rise to 50 °C with low relative humidity. At the same time, some coastal cities tested temperatures higher than 40 °C with high relative humidity up to 90%. Colder climates exist in the mountains at high altitudes. Average temperatures in the winter (during January and February) are between 10 and 14 °C [1].

Rainfall in the area is sparse, and it can be dry for long periods, except for in Oman. The average rainfall for all countries is between 140 and 200 mm per year, while in the regions of Oman, the rain rate is in the area of 350 mm per year. Most of the rain falls during the winter season due to weather depressions from the Indian Ocean meeting those cold northern winds from the Mediterranean region. The rain in the summer is usually small in the coastal areas away from the mountains. In some years, rain does not fall entirely [2]. The Arabian Gulf region is exposed to sharp sand and dust storms, usually because of the Al-Shamal wind and these storms can significantly reduce visibility and cause problems for the air and traffic.

The populations of the area are growing continuously. In 2010, the total population was almost double the population in 2005, and most of the increase in the number of residents appeared between 2005 and 2008. Also, the urban population rate is up to 83% of the total population [3]. The high number of the population is accompanied by a surge in the use of energy, especially for air conditioning in summer with clear squandering in this sector. Ref. [4] indicated that the governmental support for energy had caused this waste, which results in accounting the GCC countries between the highest emitters of CO_2. These energy subsidies ranged from 9.8% in Kingdom of Saudi

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Arabia to 3.9% in Qatar while the highest emitted CO_2 rate was recorded for Qatar with about 36.9 metric tons of CO_2/capita in 2012. Oman was the lowest CO_2 emitter between the GCC countries with 14.7 metric tons of CO_2/capita for the same period [5]. GCC emitting amounted to more than four times the average per capita in the world [6].

All sectors of the Arabian Gulf have been affected by climate change to various degrees. The climate has changed dramatically in the Gulf States, as temperatures rose during the period from 1960 to 2010, as the cold days and nights over this period decreased, and the sector experienced warm nights more than usual. The increased temperatures across the region in summer were due to the impact of human activities on the weather. The climate change impact on the region appeared obviously in the increase in the ambient temperature by about 4 °C more than its averages' in 1960s, accompanied with a severe decrease in precipitation [7].

Ref. [8] analyzed the average temperature for the period from 1960 until 2010 across the Kingdom of Saudi Arabia. The study results showed an increase in average temperatures, as the data showed clear signs referring to high temperatures. Also, the orientation of the more heated air in the summer up to 0.41 °C per decade, and the high temperature at a rate of 0.16 °C per decade in winter [9,10].

Ref. [11] researched the drought areas across Asia (including the Arabian Peninsula) at the end of the 21st century using a multi-model. Rainfall is increasing across much of Asia, and at the end of the drought, may arrive at spaced intervals with low intensity at a few periods. However, for the Arabian Peninsula, the study showed that the decrease in rainfall coincided with an increase in periods of drought. Also, the severity of the drought will increase, especially in the summer months.

Ref. [12] introduced future speculation about the impact of climate change on groundwater sources using a new version of the Water GAP (Water Global Assessment and Prognosis) model. The study gave data related to the number of people that are affected by the change in the groundwater sources due to climate change for the period from 1961 up to 1990. The study is equipped to assess human exposure to declines in available groundwater resources. It has emerged that many of the areas of the Region Gulf countries depend heavily on groundwater sources exposed to high levels of drag. The future estimations of all the Gulf Cooperation Council have shown that it's suffering from a lack of water availability [13].

Dust plays a significant role in the earth's climate system, although the effects of quantity and the radiation at the high atmosphere are still uncertain [14]. Most of the atmospheric dust is generated from the deserts and semi-deserts and affects local and global levels. Dust storms transport millions of tons of dust into the atmosphere. This vast quantity of dust causes severe dust pollution in the air, reducing visibility, shutting down airports, and increasing the risk of air and traffic accidents [15]. The effect of dust storms also reduces soil fertility and exposes the crops to damage, reduces solar radiation on the earth's surface, and as a result creates less efficient solar devices. They also destroy communications and mechanical systems and increase incidences of lung disease and other effects on human health [16,17]. However, the dust deposition in the oceans provides nutrients in the surface waters of the ocean and the seabed [18].

The radiation effects of direct and indirect dust have implications for climate change, which is one of the important variables in climate models. The Asian and African deserts - called the dust belt - are the primary source of dust in the world [17,18]. The dust belt includes the Sahara, the dry and arid and semi-arid regions of the Arab world and Asia, Turkmenistan and the Gobi Desert in East Asia. During severe dust storms, dust from East Asia can reach far beyond the continent transient Pacific, and reach North America's west coasts [19]. Similarly, Saharan dust crosses the Atlantic Ocean to the Americas [20].

The Sahara is the world's largest dust source [21]. Saharan dust specifications have been studied practically since 1990 [22]. In the Arabian Peninsula, dust storms and blowing dust are recurring events throughout the year. The most significant sources of dust in the Arabian Peninsula are the Tigris and Euphrates basin and valleys, the alluvial plains of Iraq and Kuwait, and low plains in the east of the Arabian Peninsula along the Gulf Coast and the Arabian Dana, and the Al-Rube Al-Khali deserts [23,24]. Ref. [25] discussed the causes of dust storms in this region. The researcher declared that eastern Syria, western Iraq, and northern Jordan are the sources of fine dust (less than 50 μm in diameter). This dust moves away inside the Arabian Peninsula, losing part of its load because of precipitation in parts of the Arabian Shield, and even in the Asir plateau. Sand storms that contain larger particles (150–300 μm in diameter) pass through the Arabian Peninsula, usually at low altitudes not exceeding 15 m. Most of the grains of sand are soil that is moving due to disintegration and ground creep; they rarely hang in the wind storm [26].

Dust storms repeat in larger numbers in the south of the Arabian Peninsula in the summer. In the north of the Arabian Peninsula, the larger repeat dust storms occur in the spring. The effect of dust storms during daytime is greater on solar radiation intensity that heats up the land and generates turbulence and gradients in temperatures [27,28]. The peak dust storms occur during the period from May to August across the Arabian Peninsula [29,30]. The United Arab Emirates studied dust storms and their characteristics for the period from August to September 2004 in a project called (UAE2). This study focused on dust storms in the desert and coastal areas. The study was conducted to evaluate the dust particle specifications reaching the UAE from a large number of sources, and the effect of this dust on solar radiation [31]. Ref. [32] investigated the impact of dust particles on compact systems where the dust particles increase the radioactive heat of these devices. Ref. [33] carried out a simulation for the winter dust incident that occurred in January 2009 across the Arabian Peninsula and the Red Sea, and studied the dust phenomenon. Ref. [34] examined temporal and spatial characteristics of dust storms in Kingdom of Saudi Arabia using path analysis. The study showed that the highest optical depth of the dust particles occurs during dust storms originating in the deserts of the Al-Rube Alkali and Iraq [35,36].

About 88% of the most important human activities that caused the change in the Gulf region climate are linked to persistent energy production and consumption. Many valuable studies showed that CO_2 dominates the other emissions by up to 79% by CO_2-equivalent. The pollutants resulting from hydro-fluorocarbons (HFCs) can be ignored, as the production of these gasses is not in the region. By CO_2-equivalent basis, the CO_2 pollutants in the area rose up to 80% during the period 2000–2010, at a rate of 8% per year [37].

Greenhouse gasses (GHG) associated with human activities to produce energy and its consumption in 2005 rose to 88% of pollutants emitted in the region. These greenhouse gasses caused by the burning of fossil fuels for energy production and emissions also resulted from the activities of oil and gas exploration. The pollutants are associated with fuel combustion using a range of products of petroleum and natural gas. Oil and natural gas are mainly utilized for the production of power and heat in the productive processes. A large portion of the diesel and gasoline is devoured in transportation and industry, with generally little sums expended in electricity generation [38]. Liquefied petroleum gas (LPG) is utilized for cooking in establishments, business, and residential areas.

The energy consumption in activities such as industry (cement, iron and steel industry, the production of aluminum) and construction caused 34% of the total energy-related pollution. Energy production significantly based on the use of natural gas, with less of crude oil, residual oil, and the remaining quantities of diesel. This percentage is almost 32% of the total pollutants for all production and consumption energy in the UAE. These levels are higher than for the year 2000, at 33%. This is equivalent to the growth of up to 8% per annum in line with the rate of economic growth in the countries of the region during