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Worrying about Climate Change

Naser W. Alnaser[1], Roger Flanagan[2], Lawrence Kazmerski[3], Ali A. Sayigh[4], Munir H. Nayfeh[5], Waheeb E. Alnaser[6]

[1]Department of Architecture and Interior Design, College of Engineering, University of Bahrain, Isa Town, Kingdom of Bahrain
[2]School of Construction Management and Engineering, University of Reading, Reading, UK
[3]National Renewable Energy Laboratory (NREL), Renewable and Sustainable Energy Institute (RASEI), University of Colorado Boulder, Boulder, USA
[4]World Renewable Energy Congress & World Renewable Energy Network, Reading, UK
[5]Department of Physics, University of Illinois at Urbana-Champaign, Urbana, USA
[6]Department of Natural Resources and Environment, College of Graduate Studies, Arabian Gulf University, Manama, Kingdom of Bahrain
Email: nalnaser@uob.edu.bh, r.flanagan@reading.ac.uk, Larry.Kazmerski@nrel.gov, asayigh@wrenuk.co.uk, m-nayfeh@illinois.edu, walnaser@agu.edu.bh

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Abstract

It is becoming clear that Climate Change is getting severe. It was reported that the improved ocean heat measurements have a rate of warming upwards from 4 to 5 Hiroshima bombs liberated heat per second or 388,800 per day. It was reported also that our climate has accumulated the equivalent of a total of more than 2.8 billion Hiroshima bombs' worth of heat since 1998. Despite this global concern about the effect of global change on environment, it is believed that the problem is much more severe and with greater impact on all facets of life. The effect of Climate Change, especially with a 1˚C increase in global temperature (from 14˚C to 15˚C) is equivalent to the heat liberated from explosion of about 300 million Hiroshima of atomic bomb. This is why this CoP 26 becomes more serious and had targeted year 2060 as a year of zero CO_2 emission. This paper discusses the impact of climate change on ten sectors; water, water desalination, energy, renewable energy supply, health, society, agriculture, economy, industry, and built environment.

Keywords

Global Warming, Impact of Climate Change, Major Impact of Climate Change, Physics of Climate Change

1. Introduction

It is becoming clear that Climate Change is getting severe as recognized by many scientists and researchers around the world as well as by many governments. Recent data reveal that the world's oceans (especially the upper 2000 m) in 2019 were the warmest in recorded human history [1]. In 2019, the ocean heat anomaly (up to 2 km from sea level) was 228 × 10^{21} J above the average from the years 1981 to 2010 and 25 ZJ above the year 2018. The evolution of Ocean Heat Content (OHC) shows that the upper 2 km in year 2019 was about 225 ZJ above the average from years 1981 to 2010 which is record-setting ocean warmth; the ocean temperature was 0.075˚C above the 1981-2010 average in 2019 as shown in **Figure 1**. The National Oceanic and Atmospheric Administration/National Center for Environmental Information (NOAA/NCEI) data, showed about 217 ZJ in 2019 above the average from the years 1981 to 2010 (21 ZJ above 2018). Taking into consideration that Hiroshima atom-bomb exploded with an energy of about 63 TJ then the amount of heat added to world's oceans in the past 25 years amounts to 3.6 billion Hiroshima atom-bomb explosions which are equivalent to heat liberated from 4 to 5 Hiroshima bombs into the oceans every second [2]. It was reported that the improved ocean heat measurements have a rate of warming upwards from 4 to 5 Hiroshima bomb liberated heat per second or 388,800 bombs per day or about 142 million per year or 1420 million per decade. It was also reported also that the accumulated heat in our climate since 1998 is equivalent to heat liberated from 2.8 billion Hiroshima bombs [3].

The Earth's temperature increased by 0.08˚C per decade since 1880, and the rate of warming over the past 40 years increased by 0.18˚C per decade since 1981 [4].

More panicking news is that year 2020 was the second-warmest year on record while the land areas were the warmest. Year 2020 surface temperature, averaged across land and ocean, was 0.98˚C warmer than the average of period 1900 to 2000 (which is 13.9˚C) and it is 1.19˚C warmer than the average of period 1880 to 1900 (**Figure 2**) [4]. Furthermore, the 10 warmest years on record have occurred since 2005; from 1900 to 1980 a new temperature record was set on average

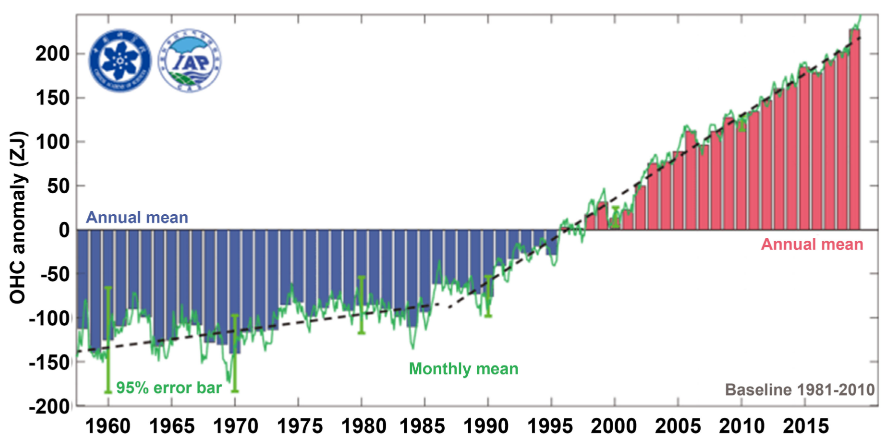

Figure 1. The global ocean heat content (OHC) changes in the upper 2 km. Upper 2000 m OHC from 1958 through 2019. The histogram represents annual anomalies. The positive (blue bars) and negative (red bars) anomalies are relative from 1981 to 2010. The two black dashed lines are the linear trends from 1955 to 1986 and 1987 to 2019, respectively [1].

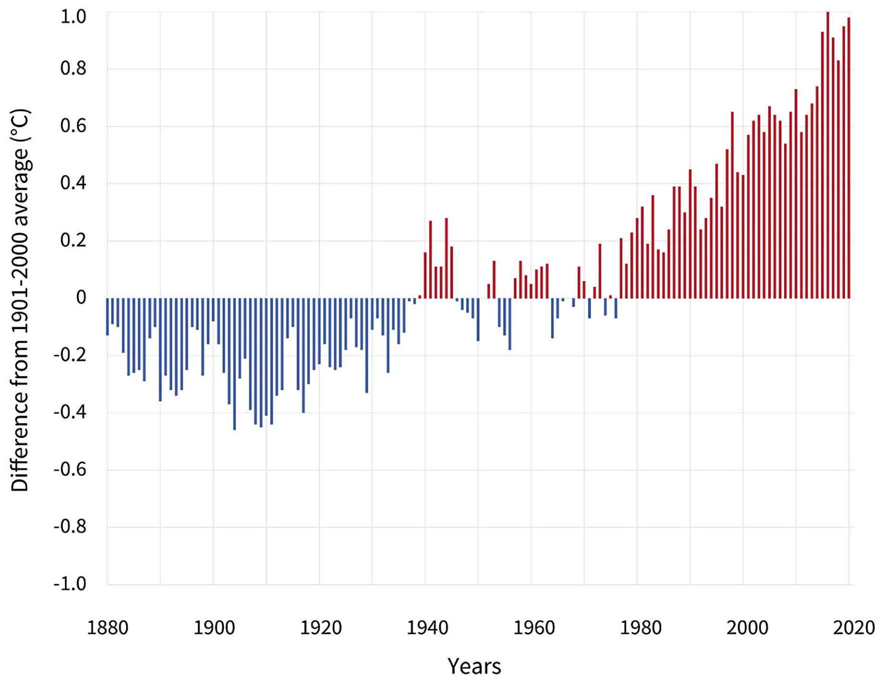

Figure 2. Yearly global surface temperature from 1880-2020. Blue bars indicate cooler than average years; red bars show warmer than average years [4].

every 13.5 years, while from 1981-2019, a new record was set every 3 years. Furthermore, in a recent study [5] across urban worldwide areas, from 2003-2020, 3-day Surface Urban Heat Island (SUHI) extremes are found, on average, more than twice as high as the warm-season median, with local exceedance up to 10 thousand times!

Despite this global concern about the effect of global change on the environment, it is believed that the problem is much more severe and the worry should be many folds larger! For example, the effect of Climate Change, especially with a 1˚C increase in global temperature from 14˚C to 15˚C. This 1˚C increase is equivalent to the heat liberated from an explosion of about 300 million Hiroshima atomic bombs [2]. This is why CoP 26 in Glasgow, UK, was more serious than other meetings, it targeted year 2060 as a year of zero CO_2 emission; the major Greenhouse Gas.

The UK Prime Minister said that the Cop-26 global climate talks were extremely tough and had urged world leaders to take concrete steps to protect the planet. The share of the Middle East, including all the GCC countries (GCCC), to the world's cumulative CO_2 emissions is modest (6.5%) according to the BP Statistical Review of World Energy for 2021. USA alone contributes 13.8% of global CO_2 emissions [6]. Therefore, highest CO_2 emitters have more responsibility than others to clean up their cumulative CO_2 and other GHG emissions. They should provide financial means and technology support to developing nations to reduce emissions growth; unfortunately, the $100 bn/year to support emerging economies from the Climate Finance Delivery Plan is not met [6].

Due to the high concern on Climate Change, the barriers to and facilitators of climate change action (mitigation and adaptation) and the climate change preparedness were very recently surveyed [7]. Barriers to and facilitators of climate change action were found to vary across sectors, with some overlap. However, a limited understanding of preparedness to address climate change action was found across the sectors reviewed. These findings are found worrying because limited understanding of climate change preparedness across these sectors may limit capacity to achieve global goals such as the Paris Agreement which seeks to limit global warming to 1.5˚C. The review revealed that 95 articles were focused on adaptation, 35 on mitigation, and 45 addressed both.

The Regional Organization for the Protection of the Marine Environment (ROPME) Sea Area (RSA) in the northern Indian Ocean (comprising Arabian Gulf, the Gulf of Oman and the northern Arabian Sea) already vulnerable to extreme environmental conditions and is one of the world's warmest seas. Due to climate change is already affecting sea temperature, salinity, dissolved oxygen, pH, and sea level and are expected to vary over time [8].

Due to the concern of Climate Change and the increase of Earth mean Temperature, top physics facilities in Europe and the US, including CERN, the European Space Agency, Fermilab and the Los Alamos National Laboratory -have announced cooperation to tackle the climate crisis [9]. They establish scientific collaboration on carbon-neutral energy and climate change. The reason is that these facilities require large electricity and power supply. For example, CERN particle-physics lab near Geneva, uses 1.3 TWh of electricity annually, which is enough to power 300,000 UK homes for a year. The greenhouse-gas emission emitted by CERN in 2018 was 223,800 tonnes of carbon-dioxide equivalent.

This worry led educators to conduct studies on understanding the relation between psychological distance and connection to nature related to climate change in students where they found that student's connection to nature, their spatial climate awareness, and their geographic location were the most important factors in the perception of students concern about climate change occurring in their countries [10].

The water cycle, the biosphere cycle and the terrestrial cycle are all associated with climate change. Furthermore, our business, social life, energy consumption, tourism, economy, health and even social life may be highly impacted by climate change. Therefore, we should be very concerned with the global warming issue that powers the climate change. The review conducted [11] on the effects of climate change on marine organisms is supporting our concern. Their study showed 1) That in response to climate change, marine species shift their latitudinal range to find suitable conditions leading to the redistribution of species. 2) The growth reduction, sub-optimal behaviors, and reduced immune-competence of marine organisms, are as a result of thermal stress due to climate change. 3) The periodic changes in temperature above or below the optimum have a meditative reproductive effect on marine species, including fish. 4) Several diseases showcase greater virulence in the sense that the marine species become less resistant to these diseases due to stress, increased virulence stimuli, or increased transmission, due to higher sea water temperate.

This paper will highlight such negative impacts of Climate Change on Earth's habitant that urge us to worry and force us to unite and cooperate to cure our planet Earth from its fever.

2. Physics of Climate Change

The Earth Surface area (A) is 510.1 trillion m^2 (5.1×10^{14} m^2), with Density of Air (ρ) equal 1.225 kg/m^3, thickness of atmosphere (d) equal 480 km (4.8×10^5 m), specific heat capacity of air (c_p) of 1.006 kJ/kg·K. Therefore, the amount of heat (E) casing causing earth warming by 1˚C is:

$$E = \rho A d c \Delta T \quad (1)$$

$E = (1.225 \text{ kg/m}^3) \times (5.1 \times 10^{14} \text{ m}^2) \times (4.8 \times 10^5 \text{ m}) \times (1.006 \times 10^3 \text{ J/kg·K}) \times (1˚\text{C})$;

$E = 3 \times 10^{23}$ J.

Knowing that heat liberated from a Hiroshima bomb is close to 10^{12} J (1 TJ) and (=18,000 tons of TNT), Therefore, the number of Bombs equivalent to raising the Earth's temperature by 1˚C is:

N = (Amount of heat casing causing earth warming)/(Amount of Heat Liberated from a Hiroshima bomb). $N = 3 \times 10^{11}$ bombs = 30 billion Hiroshima bombs, *i.e.* close to what has been calculated earlier [1] [2].

If we assume that the concentration (C) of CO_2 is increasing by 4 times, then the decrease in heat flux escaping to the space (making our atmosphere warmer), after it was 240 W/m^2, will be 8.7 W/m^2. The change in Radiative Forcing is [12]:

$$\Delta F = 6.3 \ln\left(C_1/C_0\right) = 6.3 \ln\left(4\right) = 8.7 \text{ W/m}^2 \quad (2)$$

C_1 is the new concentration of CO_2 and C_0 is original (current) concentration. This mean that the escaped heat flux (EHF) to space is reduced from 240 W/m^2 to 231.3 W/m^2, *i.e.* EHF = 240 W/m^2 − 8.7 W/m^2 = 231.3 W/m^2.

It has to be noted that doubling CO_2, will result in ΔF = 4.4 W/m^2, *i.e.* EHF (E_2) is 231.3 W/m^2 instead of 240 W/m^2 (E_1). This will result in increasing the temperature (ΔT) of the atmosphere to 2.7˚C, assuming the Earth Temperate is 300 K (27˚C) [12]:

$$T_2 = \left[\left(T_1^4 \times E_1\right)/\left(E_2\right)\right]^{1/4};\ T_2 = \left[\left(300^4 \times 240\right)/\left(231.3\right)\right]^{1/4} = 302.7 \text{ K} \quad (3)$$

Therefore, ΔT = 302.7 K − 300 K = 2.7˚C.

Climate sensitivity is the average change in the Earth's surface temperature in response to changes in radiative forcing, which is the difference between incoming and outgoing energy on Earth. The Climate Sensitivity Factor (λ) is very significant to estimate the increase in the Earth's Temperature. It is expressed mathematically as follows [13] [14]:

$$\lambda = \Delta T_s / \Delta F \quad (4)$$

It has units of K/Wm^{-2}, and the most common used value is $\lambda = 0.55$. ΔF is the change in radiative forcing, *i.e.*, the absorbed Heat Energy in the atmosphere and

ΔT_s is the Change in the Earth's Temperature. Therefore, for a change of 8.7 W/m^2 (for CO_2 to be 4 times larger than before), then ΔT_s will be 4.8˚C, while for ΔF = 4.4 W/m^2 (for CO_2 to be 2 times larger than before) ΔT_s = 2.42˚C. The Conference of the Parties (CoP 26) efforts is to not have ΔT_s = 1.5˚C. The question is "Why year 2060 was selected to offset the CO_2 emission effect". The Physics says it is impossible.

3. Impact of Climate Change on Water Desalination

Regional modelling studies projections [15] indicate that by the end of this century, sea surface temperature (SST) could increase by as much as 2.8˚C to 4.3˚C in the Indian Ocean (including Arabian Gulf, Gulf of Oman and northern Arabian Sea), which is a significant increase. The high increase projected for the Indian Ocean is the result of a combination of rapid warming of the shallow water column and the constraint of the Strait of Hormuz, which restricts water exchange with the Indian Ocean. The current warming trend is likely to result in more frequent marine heatwaves [16], locally amplified by up to 8˚C in parts of the southern Indian Ocean due to thermal pollution from power and desalination plants [16] [17] [18]. Regional projections of salinity suggest appearance of changes less pronounced in the Middle east-RSA [19]. By contrast, in the Outer RSA salinity is likely to decrease slightly under the influence of long-term changes in oceanographic conditions and monsoon dynamics [19].

The largest solar water desalination installations, worldwide, are in the Indian-RSA which is drawing water at a rate of more than 120 million m^3 per day [16]. The efficiency and stability of their systems can be limited by increasing water temperature and salinity as well as mass jellyfish and algal blooms [20]. Unfortunately, the desalination sector across the RSA already experiences disruption and damages from mass jellyfish ingress and HABs, which are likely to become more frequent and severe in the future [20]. Toxic HABs near desalination plants have forced cessation of operations for days due to serious human health concerns [21]. The desalination industry has some built-in resilience to be able to cope with current environmental risks to water supply and quality, but future climate change will further challenge the region's water security [22]. Sea-level rise may also result in saltwater intrusions and contamination of ground water reserves in coastal areas, increasing the demand on desalination plants and leading to greater exposure to climate risks for the desalination sector.

Recent studies [23] reported a threating of irrigation in agriculture because of climate change. It is expected that 2.55 billion of the world population might suffer from water scarcity by 2025. Moreover, in countries that have no water resources irrigation management will be more critical. Such countries will survive only if they use non-conventional water resources such as water desalination as part of climate change mitigation measures.

In Kuwait and close to solar desalination plants (Kuwait Bay), the sea water quality index was consistently higher than 75 in the winter season and higher than 100 in the summer season. This was attributed to the discharge of desalination plants brines and other polluted effluents [24]. The worry lies that effluent water from water desalination plants returns back to the sea with much larger salinity, year by year; it will surely affect the absorption of the solar radiation (becoming like a solar pond) and subsequently affect the albedo of the sea water and accordingly is the amount of absorbed solar radiation in Arabian Gulf region as the mainly depends in solar water desalination.

4. Impacts of Climate Change on Water

Figure 3 illustrates the Earth water cycle which clearly gives the impression of how global warming is changing every interaction in the figure. These changes add stress to water supplies for drinking and production of food [25]. Climate change affects agricultural output, sea level rise, wildfires and extreme weather where all ruin the quality of drinking water. Elements in the water cycle like Evaporation, Precipitation, Surface Runoff and Stream Flow, Oceans, Snowpack, Clouds are all associated with solar absorption and emission which is the main issue of the global warming and climate change.

The hydrological cycle is surely affected by climate change. Many meteorological elements are found to be highly affected in river basins in southeastern Brazil such as precipitation and evapotranspiration [26].

Climate change amplifies the risk of drought, flood, water supply shortages and distribution, poor water quality, and disrupted watershed processes. It is reported that climate change will fade many water resources due to less snow, more

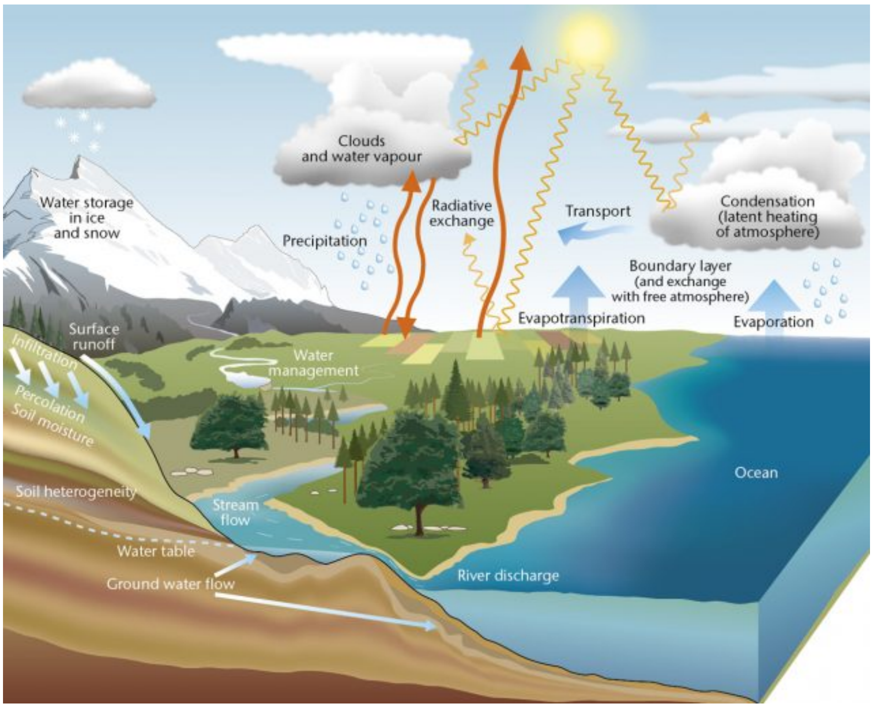

Figure 3. The water cycle diagram; global warming is altering nearly every stage in the diagram [25].

rain, increased winter flooding, less snowpack, earlier snowmelt, lower summer stream flows, increased stream and lake temperature, longer warmer growing seasons, warming surface waters, and intense droughts [27].

5. Impact of Climate Change on Energy

According to a report made by EPA [28], climate change is expected to increase electricity demand for air conditioning in the summer and also decrease electricity, natural gas and wood for heating in the winter. Therefore, new infrastructure investments may be necessary to meet increased energy demand for building more electricity plants or purchasing electricity (energy) from worldwide market, especially during peak demand either during heat waves or severe cold fronts (polar winds). Based on a 3.5˚C to 5˚C temperature increase, climate change could increase the need for additional electric generating capacity by roughly 10% to 20% by 2050 which would require billions of dollars in additional investment [29]. Also, climate change will lead to more need for energy to produce or clean and purify water; water will be needed to produce electricity or extract fuel [28]. In areas where water is already scarce (like Gulf Cooperation Council Countries, GCCC), competition for water between energy production and other uses could increase. On the other hand, sea level rise and the expected extreme weather, due to global warming sickness or symptoms of our planet Earth, frequent intense storms could disrupt energy production and delivery by damaging electricity infrastructure, fuel delivery infrastructure and equipment, power plants, or storage facilities [28].

Furthermore, a warmer climate will reduce the efficiency of power production for many existing fossil fuel and nuclear power plants because of their use of water for cooling; the colder the water, the more efficient the generator and accordingly higher air and water temperatures will reduce the efficiency of such plants [30]. Houses' industry buildings and services places' design as well as construction will change to meet the energy limitation and energy supply and for the optimum use of electricity cars (charged in houses and special stations), green hydrogen, use of solar and wind and circular economy. For example, the current fuel stations and motels will have to be different to meet the life style and energy input from the premises like solar PV roofs, micro wind generators, capturing water during rain, and increasing shadings by planting or sheltering.

In summary, climate change will affect the energy global market. Therefore, in order to face the growing climate risks, most global energy companies integrate climate risk into their business strategy (72%) [31].

6. Impact of Climate Change on Renewable Energy Supply

Despite COVID-19 pandemic, more than 260 GW of renewable energy capacity added globally in 2020, beating previous record [32]. There is a 10.3% rise in global installed capacity; at the end of 2020, the global renewable generation capacity amounted to 2.8 TW with hydropower still accounting for the largest share (1.2 TW) with new installation of solar (127 GW) and wind (111 GW), catching up fast. Renewable energy resources supply 15% of the global energy with Bioenergy (10%), Hydropower (3%) and other renewables (2%). These are Photovoltaic (PV) and wind energy. By 2040, renewable energies utility may, globally, supply 20% to 30% of primary energy. Studies suggest that by 2050 the world might completely use renewable energy systems. Renewable energy resources are highly dependent on weather conditions (climate), hence they are sensitive to climate change as been confirmed when using strong and reliable mathematical models [32].

Gernaat [33] had made two warming scenarios for eight technologies; these are utility-scale and rooftop PV, CSP (concentrated solar power), wind energy (onshore and offshore), bioenergy (first-generation and lignocellulosic), and hydropower. The only positive, in a baseline warming scenario, is the increased availability of bioenergy which is associated with magnitude of CO_2 fertilization. The impact of climate change on hydropower and wind energy, according to this work, is uncertain; it declines in some regions and increases in others while the impacts on solar power are minimal. The authors [33] also found that there are direct and indirect effects of climate change on renewable energy technologies. For example, higher wind speeds lead to more wind power generation (direct effect). Higher ambient temperatures will lower PV and CSP efficiencies (indirect effect). Another climate change impact on renewable is more complex such relationship between precipitation changes and hydropower potential. The authors found complex optimization lies in Hydropower plant design, hub height in wind turbines, and to a less extent is PV and CSP. Figure 4 presents the Global mean changes in technical potential for each renewable technology.

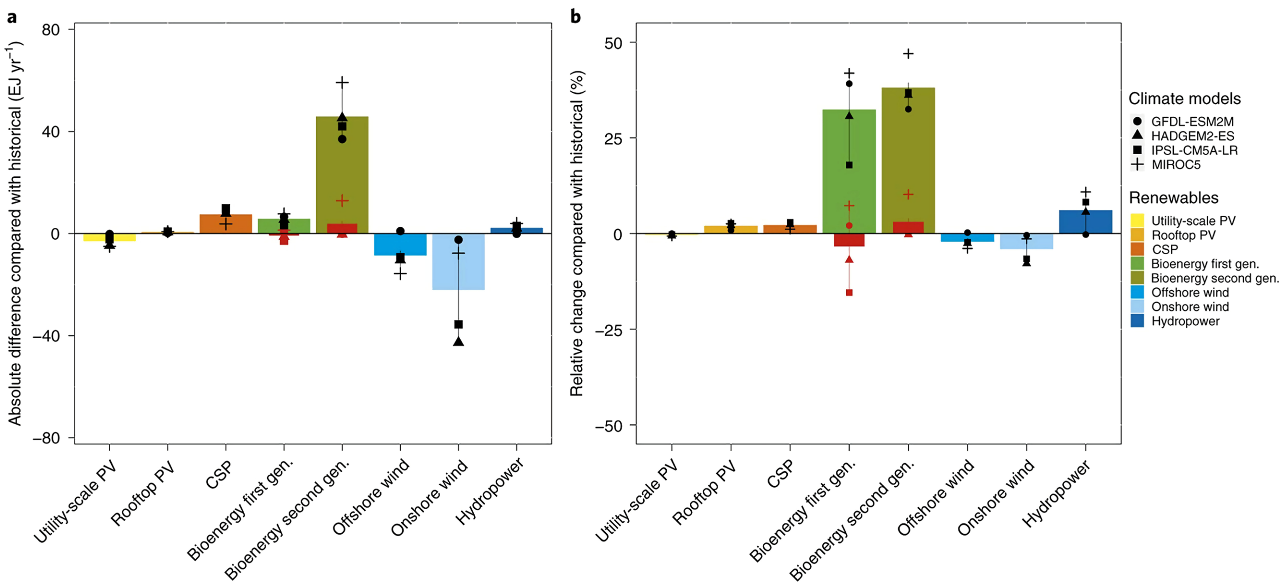

Figure 4. Part (a) the absolute change in technical potential compared with the historical situation (EJ yr^{-1}). Part (b) the relative change in technical potential compared with the historical situation (%). The Green bars are for simulations with CO_2 fertilization; changes in bioenergy potential without CO_2 fertilization are overlaid as red bars [33].

7. Impact of Climate Change Impacts on Health

According to the World Health Organization [34], climate change is the biggest health threat facing humanity, therefore, health professionals work hard to respond and act to combat this threat. The most vulnerable people to this threat is the those who contribute least to its causes and who are unable to protect themselves and their families against it, *i.e.* people with low-income. About 12% of people on Earth (nearly 1 billion) spend 10% of their income on health care; those with very low income have no insurance and are under health stress. It is estimated that every year 100 million are expected to be in poverty due to the impact of climate change and the number is expected to increase with more change in climate [34]. There is a strong connection between climate change, death, and illness due to extreme weather events, such as heatwaves, storms, floods, and shortage in food supply. Livelihoods, equality, and access to health care and social support structures are health consequence issues [34]. The impact of Climate Change on health can be summarized in **Figure 5** [35].

The Eastern Mediterranean Region (EMR), which includes 19 out of the 22 Arab countries, is highly vulnerable to heat exposure after Europe [36]. The Arab region faces direct health effects due to increases in temperature, heat waves, droughts and flooding; not forgetting that the indirect effect will result in deaths and morbidities.

An earlier study from Jeddah reported that the risk of Dengue fever is found to increase in November, December and January in Jeddah, KSA; months that have, relatively, high rainfall, high relative humidity and low temperature

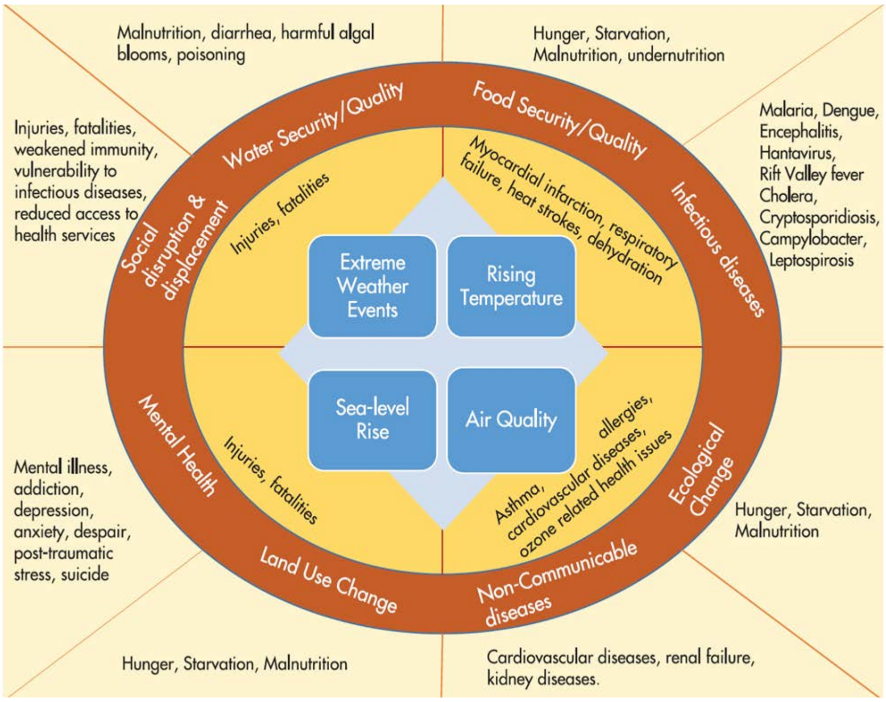

Figure 5. Direct and indirect impacts of climate change on health and related health Consequences [35].

change [37]. In the UAE, 0.2% of cardiovascular disease cases were attributed to the increase in the ambient temperature [38]. High temperatures were also reported to affect the development of ischemic heart disease in Syria [39].

In Bahrain [40], between 2003 and 2016, the rates of annual hospital discharges from ischemic heart disease, circulatory diseases, cardiovascular disease, respiratory diseases and mental illnesses were found to correlate inversely to temperature and correlated positively to humidity.

Tripathi *et al.* [41] concluded that perceptions of the people regarding climate change are more linked to their own experiences with their local weather conditions based on a semi-structured questionnaire filled randomly by 983 households across four districts. The tool covered several sections, *i.e.*, the demographic and socioeconomic related data, views on climate change, awareness of climate sensitive diseases.

8. Impact of Climate Change on Society

Reports show that Climate Change will impact societies in several ways [42] *i.e.* 1) affect certain groups more than others, particularly groups located in vulnerable areas and the poor, young, old, or sick. 2) Cities are uniquely sensitive to many impacts, especially extreme weather impacts. 3) May threaten people's jobs and livelihoods. 4) Impacts on Vulnerability and Equity. 5) Impacts on economic activities and services.

An overview of climate change impacts on the society in China [43] discussed the relationship between society and climate change in China from the aspects of the needs at different socioeconomic developing stages. The authors summarized the relationship of the current spatial pattern and future risks of the climate change impacts on societies. The complexity of social and climatic systems leads to the spatial heterogeneity of climate impacts and risks in China. Greater cross-disciplinary collaboration between climate adaption, poverty alleviation and Nature-based Solutions (Nbs) must be made, which will provide decision makers with more comprehensive train of thoughts for climate policy making. The authors [43] concluded that, in general, public health, livelihood and economy (or prosperity) are all closely relayed to human wellbeing, which are supported by inhabitation, industries and infrastructure; as shown in **Figure 6** [43], these are more or less strained by climate change. Therefore, by enabling the adaption in settlement environment, industries and infrastructure to climate change, the life quality of societies would be maintained and improved.

In a recent article [44], the impact of climate change on the process of creating a pluralistic society was analyzed. The focal point of the article deals with the implementation of the Lifelong Learning concept in contemporary society for the purpose to indicate the public authority of the need for the more effective methods of activating and educating the polish's society to fight against climate change. It was concluded that we need to take up drastic measures to overcome the human loss in fighting the climate change and urged for drastic measures by societies;

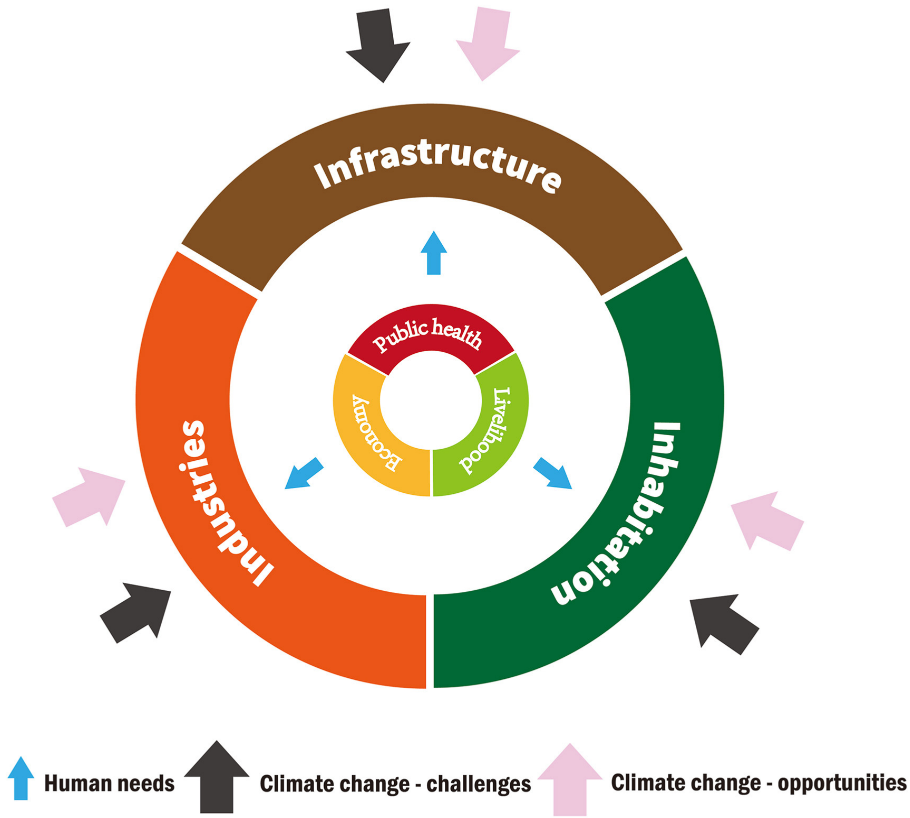

Figure 6. Industries-Inhabitation-Infrastructure and well-being affected by climate change [43].

education seems to be the key to changing that false and social disposition.

9. Impact of Climate Change on Agriculture

In assessing the impacts of climate change on irrigation water requirement (IWR) and crop yields with respect to climate change in mango in three governorates in Egypt (Ismalia, Sharkia, and Bihera) for the 2050s and 2100s [45] it was found that the yield of mango will decrease by 92.53% - 85.73% in the future periods under scenarios A1 and B1, respectively.

The effect of climate change on agricultural land productivity in Europe has been studied [46]. Three Scenarios were made and the result shows that crop suitability and productivity increase in northern Europe (caused by lengthened growing season, decreasing cold effects on growth, and extension of the frost-free period). In southern Europe, the crop productivity decreases (caused by shortening of the growing period, with subsequent negative effects on grain filling), bearing in mind that the simulations considered no restrictions in water availability for irrigation due to changes in policy and not including restrictions in the application of nitrogen fertilizer.

A poll conducted in 2019 in the USA [47] found that only 24% of respondents believed that climate change would have a great deal of impact on their lives; 31% believed it would have a fair amount of impact. There are certain impacts that will probably affect every American's way of life, among these 10 is that food will be more expensive and variety of choice may suffer. In the last 20 years, food prices have risen about 2.6% each year in the USA (and maybe worldwide). It is expected that food prices will continue to rise. Extreme weather affects livestock and crops, and droughts have impacts on the stability and price of food. When temperatures increase and precipitation increases, it is expected more pathogens will thrive and affect plants and accordingly more food will spoil. Food is a global trade, therefore, climate events in one region can raise prices and cause shortages across the globe; a drought in Brazil in 2013 and 2014 caused Arabica coffee prices to double [47].

In the Kingdom of Bahrain, years 2020 and 2021 were very warm (due to global warming) with annual rain level in 2020 of 50.6 mm, annual mean temperature 28.1˚C, annual mean maximum temperature (at noon) of 32.0˚C, and annual minimum temperature (at night) of 24.9˚C while in 2021 it was 13.3 mm, 28.5˚C, 32.5˚C and 25.2˚C, respectively. Farmers had noticed no yellowish leaves of wine trees; they were not able to trim part of its branch. Further strange observation is that in December 2021, farmers noticed that 50% of the date palm trees (12 out 24 tree) flowered, which usually occurs in February every year (**Figure 7**) [48]. This will affect the harvest to be outside its season and market! This is definitely related to climate change and global warming impact; dryness and warm weather.

10. Impact of Climate Change on Economy

Sections from 2 to 8 are related, directly and indirectly, to the economy. If climate change affects the health, it will directly affect the economy as government has to

Figure 7. Noticed flowering (see yellow arrow) of the date palm in the month of December instead of the usual occurrence in February of each year. This was attributed to impact of climate change (warm years) on the date palm harvest in Bahrain [48].

put more budget to provide budget for medicine, hospitals and staff. Similarly, if the energy sector is hit then country has to purchase electricity and fuel from outsource. No different than them, if water and water desalination are hit by climate change the country will have to provide a very costly alternative; this is the main critical issue; Currently, one liter of water bottle is double the price of bottled water. Furthermore, if agriculture sector is hit the economy will suffer.

A recent paper [49] examined the interactions between agriculture and climate in Myanmar using a Ricardian model for assessment of the economic impacts of climate change on crop production in the dry zone. The projected changes in temperature are found to affect the crop productivity. The results also show that the temperature and rainfall are both important. Urban drainage master plans developed in Barcelona city to assess the economic impact of the increase in the rain intensity resulted from climate change (7% - 26% at peak intensity, depending on rainfall duration) and hence [49], the modification of rainfall scenario planning and the typology of mitigation measures result in an important rise in investment budget, infrastructure life cycle, and operation and maintenance budgets for infrastructure (about €1.442 million; nearly double that of the plan developed in 2006).

A dynamic model was established to assess the economic consequences of changes in agricultural production on China (regional and sectoral levels) [44]. The results show that the percentage of the economic damage reaches 1% of (GDP, *i.e.* economic cascade effect amounts to 17.8% of China's GDP). By 2100 it will be 0.1% to 13.6% of GDP (negative values indicate economic gains) without considering CO_2 fertilization effect [50].

11. Industries at Greatest Risk from Climate Change

It is expected that all industries will be affected by the climate change and global warming; some will be minorly affected and some mediumly affected, while others will be badly affected. It is expected that very few industries may not affect. The industries at greatest risk from climate change are:

1) Insurance: Increase in sea level and increase in flooding drives up both premiums and payouts, leading to strain on the insurance industry.

2) Agriculture: When temperature rises, many agricultural regions (high production) will feel a squeeze which will directly affect 30% of the world's population working in agriculture [47].

3) Energy: Regulations on fossil fuels are likely to increase, threatening the lucrative oil, gas and coal industries.

4) Beverage industry: Increased water shortages are the biggest threat to the worldwide soft drink and bottled-water market, valued at $247 billion [51].

5) Commercial fishing: Salmon and trout, thrive in cold, free-flowing water. Habitat loss for both could be as high as 17% by 2030 and 34% by 2060 [51].

6) Sport "Skiing": Because more precipitation is falling with the rising temperatures.

12. The Built Environment in a Changing Climate

Planning for climate change adaptation is among the most complex challenges cities are facing today [52]. Urban overheating, worldwide, has been unprecedented recently recorded as it hosts more than 60% of the world population. Cities become major receptors and drivers for climate change impacting both the natural and the socio-economic environment. Global and local dimensions of a changing climate are especially worrisome in cities because the rate of change in the patterns of human settlement, energy consumption, transportation, and industry are accelerating much faster than elsewhere. Furthermore, cities are fertile ground for the interaction between heat and pollution hot spots to the point that where an urban heat island (UHI) exists, likely an urban pollution island (UPI) co-exists [52], causing compound effects on human health. Climatic alterations put a strain on 1) energy needs for cooling/heating and release of anthropogenic heat, 2) mortality and morbidity due to air pollution and air turbidity, 3) productivity and wellbeing, and 4) accessibility to public spaces and social prosperity [47]. Therefore, the future of the urban realm in a changing climate must be well studied. The role of a growing population with expanding patterns of urbanization and consumption must be set and identified. It is important to provide adequate housing and outdoor spaces to the vulnerable population. Houses and buildings in cities must be made to be cooled naturally since urban overheating causes the cooling energy consumption of buildings to double. Criteria and methods to develop meteorological datasets including climate changes must be a priority; planning, designing and constructing must be based in meteorological elements, especially, such as temperature, humidity, wind speed, rain level and evaporation. Innovative monitoring systems must be established to combat the impacts of climate change on the built environment. The criteria and targets for urban- and building-integrated design in a warmer world must be designed.

13. Conclusions

The impact of climate change is variant and vast. It may well substantial. It will affect every single activity and practice such as sport, tourism, business, income, leisure, lifestyle, dress even education. Many immediate activities must be reformed to alleviate global warming due to greenhouse gases (GHG). Reaching zero emissions by 2060 in every single state, especially countries that had a large share in accumulating a lot of GHG since 1980s will be a major challenge. These countries must offer great technical, financial, and innovative solutions to low-income countries with a high population. Unfortunately, Solar PV may not be the solution to minimize global warming. Research published had clearly shown that Solar PV is a contributor to what so called Heat Island (PVHI) [53]. The researchers examined, the PVHI, empirically and experimentally, by simultaneously monitoring three locations (a natural desert ecosystem, a parking lot surrounded by commercial buildings, and a PV power plant) for one full year. They found that temperatures over the PV plant are higher by 3˚C to 4˚C than the natural desert ecosystem (wildland) at night. Their observation contradicts other studies suggesting that PV systems are expected to decrease the ambient temperatures.

To overcome the PVHI it may be a sensible idea is that PV cells to be white color to have higher albedo. Also, the supports of PV systems must be made of wood or any new materials that have low specific heat capacity to reduce their emission and absorption.

There are many innovate ideas and proposals suggested in order to minimize the impact of climate change. Digital Natural Gas (DNG) and Methane Performance Certificates (MPCs) [54] are among them. It enables producers to differentiate low-methane production. Xpansiv company recently launched MPCs-tradable contracts that enable natural-gas producers to differentiate and markets to incentivize responsible production that controls methane emissions. The rationale is that methane emissions trap more than 80 times as much heat as carbon dioxide during the first 20 years in the atmosphere and account for about 15% of greenhouse gas emissions. The mission of MPCs is to help markets accelerate the transition to a low-carbon economy and emission across multiple sectors.

GCC countries are engaged in Energy Transition, *i.e.* Transformation of the global energy sector from fossil-based to zero-carbon [55], aiming to reduce energy-related CO_2 emission to limit climate change.

Among innovative ideas is the Carbon Capture and storage, electric cars with PV roof with high technology of batteries to store power and using electrolyzers to extract hydrogen from water, known as power-to-X as a way of storing energy in different forms.

Nanoparticles and nanostructures have been found to enhance the absorption of light, increase the conversion of light to energy, improved thermal storage and transport and enable to convert the incident UV radiation, which is the enemy of PV, to a radiation in the visible range that can produce more PV electricity. Chowdhury [56] reported a 23% increase in efficiency of using Si, InN and Au nanoparticles. Their nano-treated cells show an average improvement of about 25% in short circuit current and reduce the reflection by 2.7% compared to reference cells at a wavelength from 300 to 800 nm, which indicates light is getting scattered by these nanoparticles. Other research [57] reported that nanoparticles and nanostructures enhance the absorption of light, increase the cell efficiency (by conversion of light to energy), and have improved thermal storage and transport.

The UN Environment Program [58] shows that 2021 was the year in which climate impacts hit developed and developing countries brutally. The IPCC warned to have a 50% maximum chance of limiting global warming to a 1.5˚C temperature rise this century. The Organization for Economic Co-operation and Development stated that the top 10 donors funded about 2600 projects focusing on adaptation from 2010 to 2019. The report [58] also pointed that since 2020 about 80% of world countries have adopted at least one national level adaptation planning instrument; an increase of 7%.

Built environment can alleviate the climate crisis through successful policies by 1) Intersection of form and performance; 2) Reducing energy consumption; 3) Changing policy at the local and state level; 4) Creating intelligent buildings; 5) Addressing embodied carbon in building and construction [59] [60].

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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