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Assessing the status of climate change and consequences: Global and local perspectives

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Abstract
Climate change is among the most challenging and critical issues of our society. This phenomenon concerns all countries all over the world. Climate change and variability may influence ecosystems, food security, the productivity of land, agriculture, tourism, water quantity and quality, human health, economic, socio-political consequences, agriculture structures, planning and designing of hydraulic structures. Thereby, this literature review aims to enhance knowledge of climate change. Also, it focuses on global perspectives on local perspectives in relation to the effects of climate change and its consequences by seeking to examine global, regional, and local climate change perspectives and impacts, especially in Jordan, as this country is characterized by an arid climate with low annual precipitation and is considered to be the second poorest country in water resources worldwide Findings were that change of climate and variability is caused primarily by the effects of unprecedented atmospheric levels of anthropogenic and has a profound impact on the hydrological cycle. Furthermore, the investigation of previous studies in Jordan revealed that a warming trend of mean minimum and maximum temperature records and a negative trend in precipitation southern rest of the country, on the contrary, a positive trend in total precipitation in the northwest of the country. On the other hand, future projections point to a steady increase continuous in temperature, extremely unpredictable precipitation, and an increase in floods and storms. This paper is considered very significant to support the environmental decision-makers in understanding the change of climate to develop strategies that can protect the local environment.

Keywords: Climate change, hydrological cycle, Jordan, hydraulic structures, human health, global

Introduction

Climate change has an impact on all living things on earth, including people's health and well-being, energy and water resources, and food, natural and forest ecosystems, sea level, and air quality; Climate change is inevitable, and it is already evident in many parts of the world (Moseki, 2017; Al-Houri., *et al* 2014; Gurdak *et al*., 2009) [47, 3, 24]. Furthermore, warming has occurred over many decades, causing a variety of landscape and hydrologic shifts, so these changes are anticipated to increase in the 21st century unless greenhouse-gas emissions are reduced and controlled (Abdulla, 2020).

Hence, Regional and global surface temperatures are expected to go up as a result of climate change and change rainfall patterns significantly and is likely to alter hydrological cycle through increasing the surface air temperature and rates of evapotranspiration (Sada *et al*., 2015) [62] (21st Century Climate Change Projections of Precipitation and).

Reviews by the Intergovernmental Panel on Climate Change (IPCC) Global Climate Change Assessment Report have reported that the global mean temperature has already risen by 1 °C overall (relative to 1850 to 1900) (I. P.o.C. Change, 2018) [13]. According to Stocker *et al*., (2013) [70], arid and semi-arid countries, as well as those already water shortages, such as the Middle East and North Africa, will confront massively larger water deficits in the future, not just in terms of quantity but also in terms of quality.

Jordan considered the second poorest countries worldwide in water resources; due to the influx of refugees and arid climate that led to an extremely limited share of water resources (MWI, 2016) [49].

Jordanians have faced water shortages during history as a result of the semi-arid climate and low yearly rainfall. Due to massive population increase, rural-to-urban migration, and massive influx of foreign population in reaction to political and economic crises in the

Middle East, the problem gets significantly in recent decades (Tahboub, 2015) [72]. Furthermore, the country is characterized by a rapidly growing population, that has also contributed to a drastic drop with a per capita water availability, from approximately 2200 m^3/capita/year about less than 100 m^3 of yearly available water resources readily accessible per individual (below the worldwide line for absolute water scarcity of 500 m^3 according to MWI (2017) [50].

However, the most important consequences of climate change are the change in precipitation amount, forms, spatial and temporal variability, and temperature, which is more severe in certain areas of the world and will have an impact on water sustainability. The objective of this paper is to disseminate and illustrate previous work upon those effects of climate change, both past, and future. It also focuses on reviewing perspectives will be undertaken nationally, regionally, and globally in terms of how climate change affects past and future availability, with a spotlight on Jordan being one of the poorest countries, as the country is characterized by an arid climate with low precipitation. However, that will also be required to serve as an introduction to the researchers' study.

Climate variability and change

The atmosphere, hydrosphere, cryosphere, and biosphere are all intimately connected subsystems of the climate system that develop in response to massive pushing and modifying forces such as solar thermal, Solar system, and gravitational (Lucarini, 2011) [40]. Everyone those subsystems has its particular series of processes that influence the evolution of their observables over periods that are extremely varied (Dekker, 2018) [14]. Weather and climate are considered to be related, but actually they are not exactly similar. Furthermore, the variation in climate and weather is a time measure.

However, Weather is a collection of factors that describes atmospheric changes over a brief period and over a specific area and is what actually happens. Weather conditions involve changes in temperature, clouds, air pressure, hail, humidity, precipitation, snow, and wind. Throughout minutes, hours, days, or weeks, these can change, and weather is different in different parts of the world. Climate normal refers to how the weather changes over time in a specific area or region, which is often measured over a 30-year period. Months, seasons, years, decades, centuries, and even millennia are all part of the climate timescale. As scientists think regarding climate, they often look at averages of precipitation, temperature, sunshine, wind, humidity, and other weather conditions that occur in a particular place over a long period (Dunbar, 2014; J. Shepherd, Shindell, & O'Carroll, 2016) [15, 65].

A long-term change in the statistical distribution of weather conditions is known as climate change which persists for extended periods ranging from decades to millions of years. Also, it might be a fluctuation in the average weather or the distribution of around a certain average (Boisvert-Marsh, Périé, & de Blois, 2019; Sottong *et al*., 2015; Myhre *et al*., 2013; Olaiya & Adeyemo, 2012) [10, 68, 51, 54]. In addition, climatic change has significant consequences for ecological, physical, human-managed systems, food security, the productivity of land, agriculture, water quantity and quality and human health (Giordano, Barron, & Ünver, 2019; Sun *et al*., 2018; Campbell *et al*., 2016; Barrett, Charles, & Temte, 2015; Plan, 2014; Ghanem, 2013;; Lucarini, 2011; Ma, Kang, Zhang, 2008; Walsh *et al*., 2011; Hanjra & Qureshi, 2010; Tong, & Su, 2008) [23, 71, 11, 6, 56, 22, 40, 42, 75, 79].

Causes of climate change

Reviews have documented the evidence extensively through statements by leading research organizations, scientific surveys and released that climate change is caused by humans, according to scientific consensus. (Egan & Mullin, 2017; Vardy, Oppenheimer, Dubash, O'Reilly, & Jamieson, 2017; Hamilton, Hartter, Lemcke-Stampone, Moore, & Safford, 2015; Washington, 2013; Weber & Stern, 2011; Freudenburg & Muselli, 2010) [16, 74, 26, 77, 78, 19].

Since the pre-industrial period, anthropogenic greenhouse gas emissions have steadily increased, owing primarily to economic and population growth, and are now higher than they have ever been, resulting in the highest concentrations of methane, carbon dioxide, and nitrous oxide in the atmosphere in at least 800,000 years. Their effects have been detected throughout the climate system, together with those of other anthropogenic drivers, and are highly likely to be the dominant cause of the observed warming since the mid-20th century (I.C. Change, 2014) [12].

Human activities are considered as the primary reason for the increase of greenhouse gases, leading to climate change in different areas around the world (Gurdak, Hanson, & Green, 2009; Nica, Popescu, & Ibanescu, 2019; Sanikhani, Kisi, Mirabbasi, & Meshram, 2018; Wan, Zhang, & Zwiers, 2019) [24, 52, 63, 76]. Climate fluctuation and change occur on all time scales around the globe as a result of physical processes. The influence of humans on the weather and climate cycle is obvious, and present anthropogenic greenhouse gas emissions are the highest in history.

Global Warming Effect and Greenhouses Gases (GHG)

The concept "global warming" refers to a type of climatic change defined by a dramatic rise in the Average temperature of the earth during the last century, owing mostly to the burning of fossil fuels, which releases greenhouse gases into the atmosphere. As a result, the greenhouse effect is a millions-year-old natural phenomenon. It is vital to the global aspect of the Earth's temperature. (Kweku *et al*., 2017) [35]. In 1827, Joseph Fourier discovered the greenhouse influence, which was later proven experimentally by John Tyndall in 1861 and quantified by Svante Arrhenius in 1896. (Kweku *et al*., 2017; Peterman, 2017) [35, 55].

The interaction of the sun's energy in the Earth's atmosphere with greenhouse gases such as nitrous oxide, carbon dioxide, fluorinated gases, water vapor, methane, and nitrous oxide causes the greenhouse effect. (Kweku *et al*., 2017) [35]. Table 2.1 demonstrates the atmosphere's composition all over the earth's surface.

Table 1: Atmosphere's composition all over the earth's surface

Stable Gases			Inconstant Gases		
Gas	Symbol	% (volume)	Gas	Symbol	% (volume)
Nitrogen	N_2	78.08	Water vapor	H_2O	0 to 4
Oxygen	O_2	20.95	Carbon dioxide	CO_2	0.039
Argon	Ar	0.93	Methane	CH_4	0.00017
Neon	Ne	0.0018	Nitrous oxide	N_2O	0.00003
Helium	H_2	0.0005	Ozone	O_3	0.000004

Source: O'Hare *et al*., (2014) [53].

Methane (CH^4), carbon dioxide (CO^2), nitrous oxide (N^2O), and fluorinated gases are the principal greenhouse generating gases. Carbon dioxide accounted for 76 percent of global GHG in 2010, with 16% coming from methane sources, 6% from nitrous nitrate, and 2% from fluorinated gases (Sottong *et al*., 2015) [68]. The main greenhouse gas emissions in 2010 are listed in Table 2.1.

Table 2: The main Greenhouses gases emissions in 2010.

Greenhouse Gases	Symbol	%
Carbon dioxide	CO_2	76%
Nitrous oxide	N_2O	6%
Methane	CH_4	16%
Fluorinated	CFCs	2%

Source: Sottong *et al*., (2015) [68].

The greenhouse effect, on the other hand, is ended up causing by these gases' ability to trap thermal energy near the earth's surface, keeping the average temperature near the surface even warmer. Without the greenhouse effect, the average temperature of earth would have been much extremely cold, and life on Earth that would be impossible (Kweku *et al*., 2017; O'Hare *et al*., 2014) [35, 55]. Three or many atoms are contained in greenhouse gases. As a result, the molecular structure of these gases enables them to store heat in the atmosphere and subsequently transmit it to the heated surface of the Earth (Kweku *et al*., 2017) [35].

The main greenhouse gas forcing gases broken down by economics, North America accounted for 14.5%, OECD Europe 11.0% (Organization for Economic Cooperation and Development) and non-OECD G20 countries (i.e. Argentina, China, Brazil, India, Indonesia, the Russian Federation, Saudia Arabia, and South Africa) 42.5% of GHG emissions in 2010 (Sottong *et al*., 2015) [68]. Table 2.1. Shows the main greenhouses gases emissions by country and economic activity.

Table 2.1: The main Greenhouses gases emissions by country and economic activity (Sottong *et al*., 2015) [68]

Country	Proportion%
North America	14.5%,
OECD Europe	11.0%
non-OECD G20 countries	42.5%

Surface temperature, upper-ocean heat content, sea level, Arctic sea-ice extent, glaciers, Northern Hemisphere snow cover, large-scale precipitation patterns (particularly as reflected in ocean salinity), and high temperature are among the considered signs of global climate change. (Meier *et al*., 2014; T. G. Shepherd, 2014) [44, 66].

However, change of the climate and variability may influence ecosystems, food security, the productivity of land, agriculture, tourism, water quantity and quality, human health, economic, socio-political consequences, agriculture structures, constructing and development of hydraulic constructions (Rosselló - Nadal, 2014; Al-Houri, 2014; Hansen & Stone, 2016; Simon-Lewis, 2018) [61, 3, 28, 67].

The IPCC (2013, 2018) reports that the global mean temperature has already risen by 1 °C overall (relative to 1850 to 1900) (I. P.o.C. Change, 2018; Stocker *et al*., 2013) [13, 70]. According to NASA, During the previous 30 years, the average half-temperature has increased. Moreover, Earth's surface temperature is rising and set to continue increasing into the future (Fauset *et al*., 2018; Rahmstorf, Foster, & Cahill, 2017; Stocker *et al*., 2013) [17, 59, 70]. Furthermore, according to an independent analysis by the National Aeronautics and Space Administration NASA and the National Oceanic and Atmospheric Administration (NOAA) that the earth's global surface temperature in 2018 was the fourth warmest since 1880.

Climate Change Effects

Warming of the climate scheme is apparent, and many of the observable changes since the 1950s have been exceptional throughout decades to millennia. The oceans and atmosphere have warmed, ice and snow levels have decreased, and sea levels have increased (Mudd *et al*., 2014) [48].

The average global integrated land and ocean surface temperature data show a rising of 0.85 ° C from 1880 to 2012, according to a linear trend. Global temperature in 2015 was +1.13 above the 1880-1920 average (Change, 2014; Hansen *et al*., 2016; Hawkins *et al*., 2017) [12, 28, 29].

Moreover, In terms of sea level, it has also been increasing through over a century, and the rate has accelerated in recent decades (Hansen *et al*., 2016) [28]. The rate of sea-level rise has been higher since the mid-nineteenth century than it had been for the previous two millennia (Change, 2014) [12].

Ocean acidification, on the other hand, has been impacted by climate change, with ocean acidification referring to the process of increased acidity in our earth's oceans as a consequence of global carbon dioxide emissions. Because of the fossil fuels and changes in land use since the beginning of the industrial revolution, the concentration of carbon dioxide (CO_2) in the atmosphere has increased. According to models, the pH in open-ocean surface waters has declined by around 0.11 units during the previous two and a half centuries, equating to a 29 percent rise in hydrogen ion (H+) concentration (Blunden *et al*., 2018; Gattuso *et al*., 2015; Gattuso & Hansson, 2011) [9, 20, 21].

Mountain glaciers have been recognized by the Intergovernmental Panel on Climate Change (IPCC) as signs of historical climate change (Rabatel *et al*., 2017) [57]. Additionally, rising global temperatures have resulted in a drop in the extent and mass of glaciers during the previous century. (Bolch *et al*., 2012; Rabatel *et al*., 2012) [7, 58].

Meanwhile, the Jordanian Dead Sea is experiencing the reverse problem: the Dead Sea's water levels have drastically decreased. The Dead Sea has declined drastically a third in the last two decades due to lesser rainfall, greater temperatures leading to increased evaporation, and water stolen from the Jordan River that flows into it. Meanwhile, the Jordanian Dead Sea is experiencing the reverse problem: the Dead Sea's water levels have drastically decreased. The Dead Sea has declined drastically a third in the last two decades due to lesser rainfall, greater temperatures leading to increased evaporation, and water stolen from the Jordan River that flows into it. The Dead Sea will continue to shrink by more than 1.2 m/year, despite Jordan contributing only 0.07% of world GHG emissions (Broom, 2019) [8].

Global and local perspectives

Kweku *et al*., (2017) [35], Egan & Mullin, (2017) [16]; Vardy *et al*., (2017) [74]; Ritchie & Roser, (2017) [60], Stern & Kaufmann, (2014) [69], Sottong *et al*., (2015) [68], Hamilton *et al*., (2015) [26], Munshi, (2015), O'Hare *et al*., (2014) [35], Change, (2014) [12], Washington, (2013) [77], Stocker *et al*., (2013) [70], Weber & Stern, (2011) [78], Kaufmann *et al*., (2011) [31], Freudenburg & Muselli, (2010) [19], and Lacis *et al*., (2010) [36]. They researched the causes of climate change all over the world. They concluded that climate change is caused primarily by the effects of unprecedented atmospheric levels of anthropogenic since pre-industrial greenhouse gas emissions from human activities. However, greenhouse gas emissions affect the energy imbalance in Earth's climate system due to increasing concentrations of heat-trapping gases.

Sun *et al*., (2018) [71], Fauset *et al*., (2018) [17], Rahmstorf *et al*., (2017) [59], Liu *et al*., (2017) [37], Kidd *et al*., (2017) [32], Arnell *et al*., (2016) [4], Hansen *et al*., (2016) [28], Lewandowsky *et al*., (2015) [39], Mooney, (2013) [46], Stocker *et al*., (2013) [70], Karmeshu, (2012) [30], Tapiador *et al*., (2012) [73], Kidd & Huffman, (2011) [33] Michaelides *et al*., (2009) [45], Legates & Willmott, (1990) [38]. They studied, measured, and consequences of climate change through the historical fluctuation of precipitation and temperature. They concluded Earth's surface temperature is rising and set to continue increasing into the future. Moreover, there is change in rainfall amount, forms, and spatial and temporal variability, which is more severe in some parts of the earth and the hydrological cycle will be disrupted, affecting the amount and quality of regional water supplies.

In Jordan, several scientific studies have detected climate change in past years (Sada *et al*., 2015, Matouq *et al*., 2013, Ghanem, 2013, Shakhatreh, 2011, Freiwan & Kadioğlu, 2008, Bani-Domi, 2005, Hamdi *et al*., 2009) [62, 43, 22, 64, 18, 5, 25].

Spatial and temporal Analysis of Climate Change at Northern Jordanian Badia has been conducted by (Sada, Abu-Allaban, & Al-Malabeh, 2015) [62]. They reported an increase in air temperature at an annual rate of 0.02-0.06 C / year and a decrease in annual rainfall at an annual rate of 2.6-0.5 mm/year.

Matouq *et al*., (2013) [43] investigated the impact of climate change on Jordan. They used software MATLAB and GIS for predicting the weather. However, the data used were from 1979-2008. The output data was transformed into geographical maps to forecast for the period (2009–2018). The study concluded that total precipitation in the northern region will increase to 30 mm while total rainfall in the southern region is expected to decline to 50 mm.

Ghanem., (2013) [22] carried out analyzed on fourteen meteorological stations distributed over Jordan for a period of more than 50 years. The result showed fall rainfall increasing tendencies, whereas yearly rainfall showed increasing trends in the northwest and declining trends in the remainder of the region. (Shakhatreh, 2011) [64] carried out a study on trend analysis rainfall and temperature. The study area at three locations in Jordan (Irbid, Amman, and Raba), using linear trend analysis for 30 years to forecast and project precipitation and maximum temperature for 20 years. The result showed that positive trend in mean maximum temperature and a negative trend in total precipitation at three sites in the study area.

Hamdi *et al*., (2009) [25] analyzed the trend analysis of rainfall and temperature in Jordan. According to the findings of the study, there is no visible trend indicating an annual precipitation and maximum temperature. (Freiwan & Kadioğlu, 2008) [18] have been conducted a study on climate variability in Jordan. However, their study indicated that insignificant, declining trend in precipitation.

Bani-Domi., (2005) [5] examined the trend analysis of temperature and precipitation in Jordan, using Lag-one serial correlation and Mann-Kendall rank tests and stochastic climatic trends. The study indicated none of the precipitation series showed significant trends; furthermore, the slope forecasts showed negative changes in the total annual precipitation for most stations and a warming trend of mean minimum and maximum temperature records for several stations in Jordan. Additionally, the study revealed that the overall annual minimum and maximum temperature records in Jordan have been rising during 1964 to 1999.

Conclusion

The cause of climate change is primarily by the effects of unprecedented atmospheric levels of anthropogenic since pre-industrial greenhouse gas emissions from human activities. The impact of climate change on ecological, physical, human-managed systems, food safety, land production, agriculture, water quantity, and human health is significant.

However, the review of previous studies showed around the world on the climate change phenomenon that a significant negative trend in cumulate precipitation and a significant increase in temperature trends. Future estimates, on the other hand, indicate to a continued increase in temperature and mean sea level until the end of the twenty-first century, as well as extremely unstable precipitation and an increase in the frequency of extreme weather events. It's been discovered that the rate of warming varies from one location to the another on the earth's surface, and that precipitation is rising or decreasing at varying rates in different parts of the world.

Furthermore, the investigation of previous studies in Jordan revealed that a warming trend of mean minimum and maximum temperature records and a negative trend in precipitation Southern rest of the country, on the contrary, a positive trend in total precipitation in the northwest of the country.

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