Desertification and the Role of Changing Temperature and Rainfall Trends in Southern Iraq.

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Abstract. Global surface temperature has been increasing mainly due to increase in the greenhouse gas concentration and emissions, which in turn causes climate change and global warming . Iraq has been experiencing the impacts of "climate change" but there are no detailed studies up to date especially at local scale of the country. This study locally discusses the relationship between changes in climate factors (mainly temperature and rainfall) and land degradation on drought and desertification in the southern part of Iraq. We used historical temperature and rainfall data of the region, including satellite imageries of 1988 and 2018 for understanding the extent of land use land cover change and degradation in about 30 years .So as to get an Accurate evaluation for the desertification extent of the study area, we used unsupervised classification for analyzing the two satellite images. We found that the annual average temperature has been consistently increased while the annual average rainfall has showed significant fluctuation in the study. Changes in temperature and rainfall have considerably contributed to drought that in turn led to the expansion of desertification in the southern part of Iraq. Results generally showed that there is a clear relationship between the change in climatic factors and desertification. In addition, there was a significant increase in the area of land covered by sand dunes but barren lands and wetlands have showed a noticeable decrease. We concluded that climate change combined with land degradation have caused increase in the extent of desertification for the study area. Therefore, mitigation measures and strategies to climate change and desertification have been needed for the southern part of Iraq.

Keywords. Climate change, Drought, Desertification, Iraq.

1. Introduction

In conjunction with the increase of CO2 concentration, the global mean temperature is expected to rise. The researchers have expected that the global temperature average for the period of time 2081-2100 will be 2℃ up to 1850-1900 average. According to the "United Nations Convention to Combat Desertification" (UNCCD), desertification is 'land degradation in the arid, semi -arid and dry sub humid areas resulting from various factors, including climatic variation and human activities' [9]. In addition, the Drought resulting from climate change is the main cause of desertification . Drought , Climate change and desertification are therefore Strongly interconnected . Desertification poses

a serious threat to arid and semi-arid regions which covers more than(40%) of the Earth's surface . Extreme situations are expected to continue as temperatures rise all over the world [10]. In other hand, It is possible that current models cannot simulate trends in climate factors   [11]. Moreover, increasing earth temperature will be affective for Variation in the spatial distribution of rainfall   average globally. For example, the precipitation in "arid and semi-arid" areas as As in the subtropics and middle latitudes of the world areas will be decreased [10]. There is projection that "climate change" will lead to a significant and negative impact on natural systems in many regions of the world [2]. Different ecosystems are expected to affect by climate change [12]. Over 200 years, the concentration of atmospheric carbon dioxide (CO2) has been increased by about 120 ppm and thus   Contributed significantly to the emission of greenhouse gases. The use of "fossil fuels" was the main reason for the increase in greenhouse gas Which led to the blocking of infrared rays and preventing them from directing into free space [1]. Although increase in CO2 concentration has been experienced from 1970 to 2010, the CO2 concentration and other greenhouse gases have increased rapidly during the first decade of the twenty-first century [2], which exacerbated the increase in surface temperature. By using simple model, researchers have predicted the change in global temperature with increasing greenhouse gas in the atmosphere [3]. Other natural drivers, sun activity, can also cause increase in global temperature. In order to investigate climate change at different timescales high resolution long-term data should be used [4]. The average temperature of the Earth has increased by about 0.7 degrees Celsius during the 20th century. [5]. Both the Northern and South Hemispheres have experienced increases in surface temperature by 1.12℃ and 0.84℃, respectively for the period from 1901 to 2010 [6]. This indicates that the Northern Hemisphere has experienced higher temperature than Southern Hemisphere. However, The regions that experienced the most significant increase in temperature are the mid to lower latitudes of the Earth's surface. [4]. It is evident that the extent and proportion of earth temperature are different in different regions around the world and few areas have "It increased in its coolness."   [4]. For example, during the period of 1970s the warming of land surface was higher than the sea warming [7]. Surface air temperature can be changed by many factors. In order to accurately determine change in temperature, the noticing of local air temperature should Observations it supplemented with a broader range. [8].
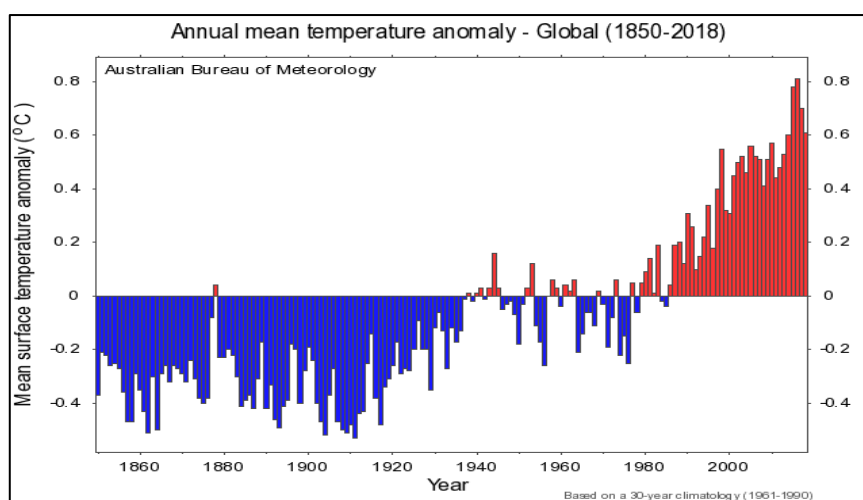

Figure 1. Annual mean temperature anomaly-Global (1850- 2018). (Source: Australian Bureau of Meteorology, 2020).

2. Study Area:

Study area is located in the southern part of Iraq within latitude 31.38 north and longitude 45.15 east. It extends over two governorates:

Al – Muthanna and Dhi Qar within the "sedimentary plain" (Figure 2) and the "western desert plateau".
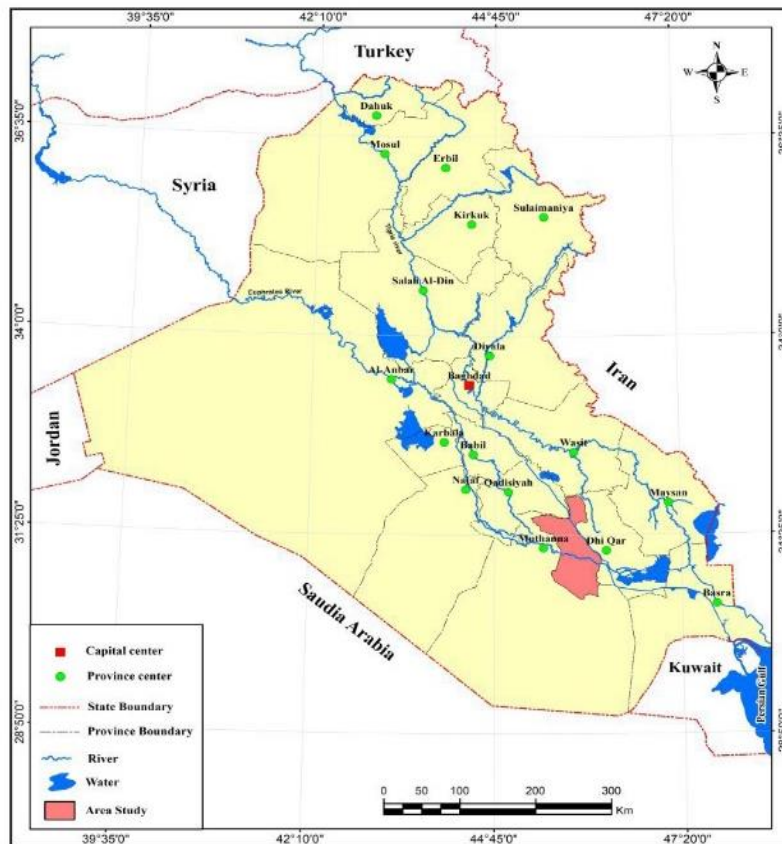

Figure 2. Study area on the map of Iraq.

3. Results

3.1. The Mean Temperature and Rainfall

3.1.1. Samawah Meteorological Station
From examining the trend of Annual averages of temperature in the Samawah meteorological station, notice a clear chang in temperature has been occurred for the period from 1973 to 2018 (Table 1). Overall, the mean temperature is generally above the mean value of the period 1973 to 2007 (Table 1). Moreover, annual averages experienced a significant increase in 21st century, especially in the last few years counterpart to the 20th century, where the average of preceding thirty years (1979-2008) was 24.51℃. The average "mean temperature" for the years from 1973 to 2007 was 24.6℃ [13]. Significant change in annual temperature has occurred for the period from 2008 to 2018 (Table 1). The annual average rainfall (97.05 mm)from 2008 to 2018 is "Very closely approximated to" the annual average rainfall of the previous years (1973 to 2007), which is 100.4 mm (Table 1). The average rainfall was from 1973 to 2007 . However, the annual rain values have showed noticeable fluctuation since 1980 (Figure 3).

Table (1) The changes of annual average of Temperature and rainfall in samawah meteorological station.

Year	T, ˚C	Td, ˚C	R, mm	Rd, mm
2008	25.26	0.75	55.92	-44.48

2009	25.4	0.89	54	-46.4
2010	26.6	2.09	46.92	-53.48
2011	26.2	1.69	58.32	-42.08
2012	25.7	1.19	105.2	4.8
2013	25.5	0.99	247.9	147.5
2014	25.8	1.29	111.2	10.8
2015	26.2	1.69	101.1	0.7
2016	26.2	1.69	68.3	-32.1
2017	26.3	1.79	29.7	-70.7
2018	26.62	2.11	189	88.6
average	25.98	1.47	97.05	-3.35

Where T is the mean annual temperature, Td is the deviation from 24.51°C [the average about mean Temperature for the years preceding it (1973 -2007)], R is the mean annual rainfall, and Rd is the deviation from 100.4 mm [the average rainfall for the period from 1973 to 2007].
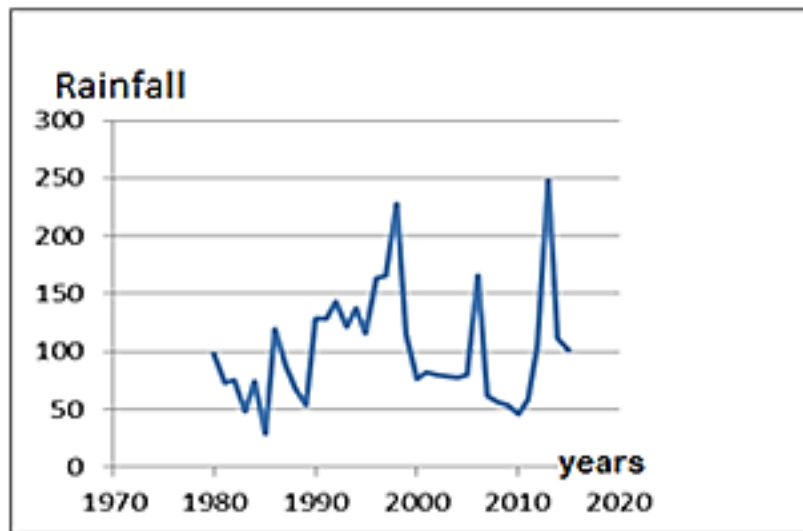

Figure 3 . annual average of rainfall in al-Samawah meteorological station since 1980.

3.1.2. Nasiriya Meteorological Station
The Nasiriya station has also showed similar trends in mean annual temperature change for the period from 2008 to 2018 with respect to mean temperature values of 1978 to 2008. .

Moreover, the average annual significant has been increased in 21th century, especially in the last few years compared to the previous years (1979-2008) that was 25.5°C (Figure 4).

Table(1) The change of Annual mean Temperature and rainfall in Nasiriya meteorological station for the period (2008-2018).

Year	T, °C	Td, °C	R, mm	Rd, mm
2008	26.4	0.90	65.5	-34.9
2009	25.9	0.40	56.9	-43.5
2010	25.7	0.20	57.6	-42.8
2011	25.3	-0.20	85	-15.4
2012	26.5	1.00	116.2	15.8
2013	25	-0.50	175.2	74.8
Year	**T, °C**	**Td, °C**	**R, mm**	**Rd, mm**
2014	26.6	1.10	219.7	119.3
2015	27	1.50	93.2	-7.2
2016	26.9	1.40	58.3	-42.1

2017	27.2	1.70	27	-73.4
2018	27.5	2.00	226.5	126.1
average	26.36	0.86	107.37	6.97

Where T is the mean annual temperature, Td is the deviation from 25.5˚C [The average mean Temperature over the years, preceding it (1979-2008)], R is the mean annual rainfall, and Rd is the deviation from 100.4 mm [the average rainfall for the period from 1973 to 2007].

3.2. The Unsupervised Classification for the Satellite Images

Unsupervised classification has been used in this research, which is intended to group the image units (pixels) with similar spectral characteristics into clusters according to the number of classifications to be known or chosen. The Computer is permitted To Table **2**). Four classes were chosen and these are on the maps of classification: water bodies (blue color), wetlands (green color), barren

generate feature vectors without the intervention of the Analyst . "In the basic form of the K-means algorithm, K feature vectors are usually chosen randomly from the data space" . When feature of vectors are to be specified , classification, rules are applying to Assign pixels Assigning the image to one the vectors feature. [14]. The Landsat- 5 satellite images (Figure 1) of the study area for the year 1988 and the Landsat-8 satellite images for the year 2018 were used after mosaic created it (Figure 2) for the purpose of doing an unsupervised classification to determine the extent of desertification (

lands (red color) and sand dunes (yellow color) (Figure 3 and Figure 4).

Table 2. The satellites information used for the study.

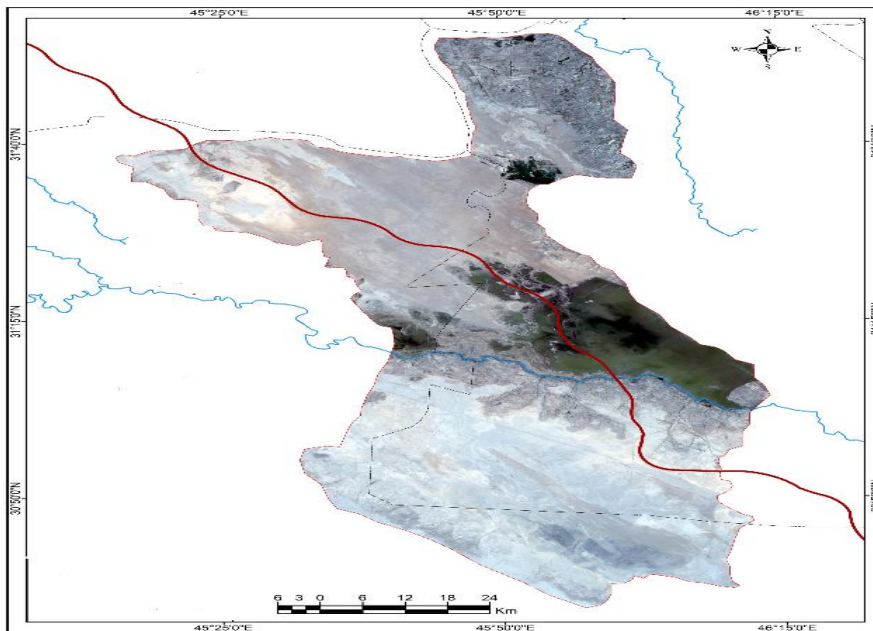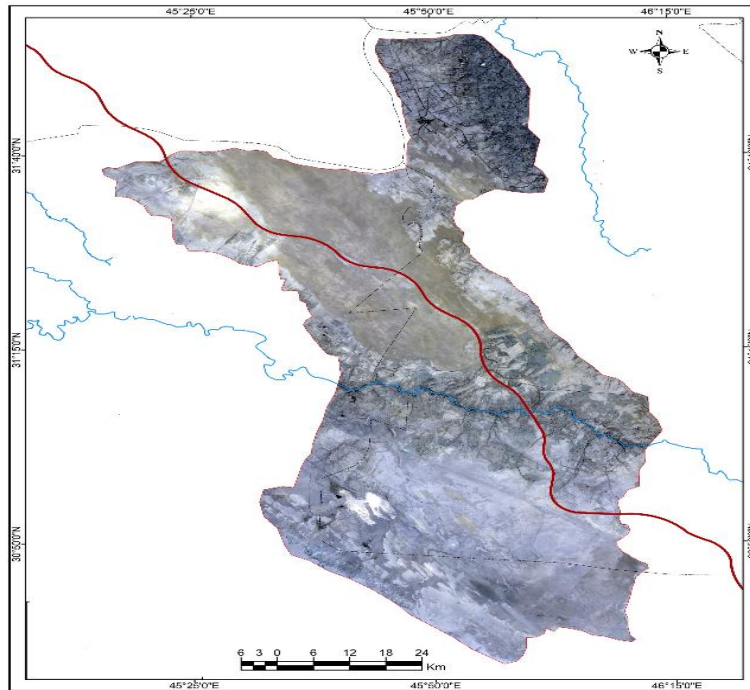| Satellite	Date	Row	Path
Landsat- 5	15-8-1988	38	167
	22-8-1988	39	167
Landsat- 8	2/8/2018	38	167
	8-9-2018	39	167

Figure 1. Landsat-5 satellite image in 1988.

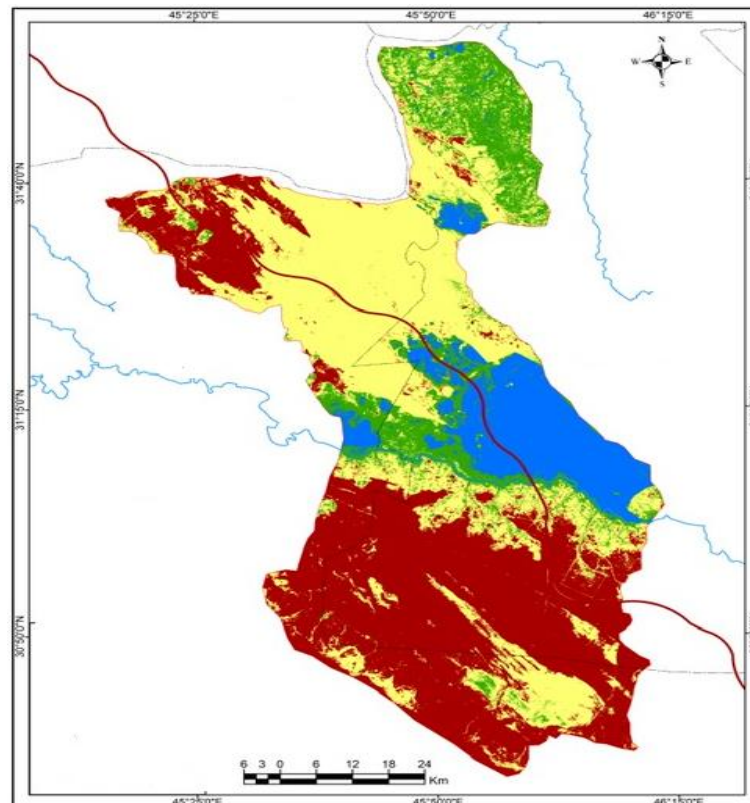**Figure 2.** Landsat-8 satellite image in 2018.

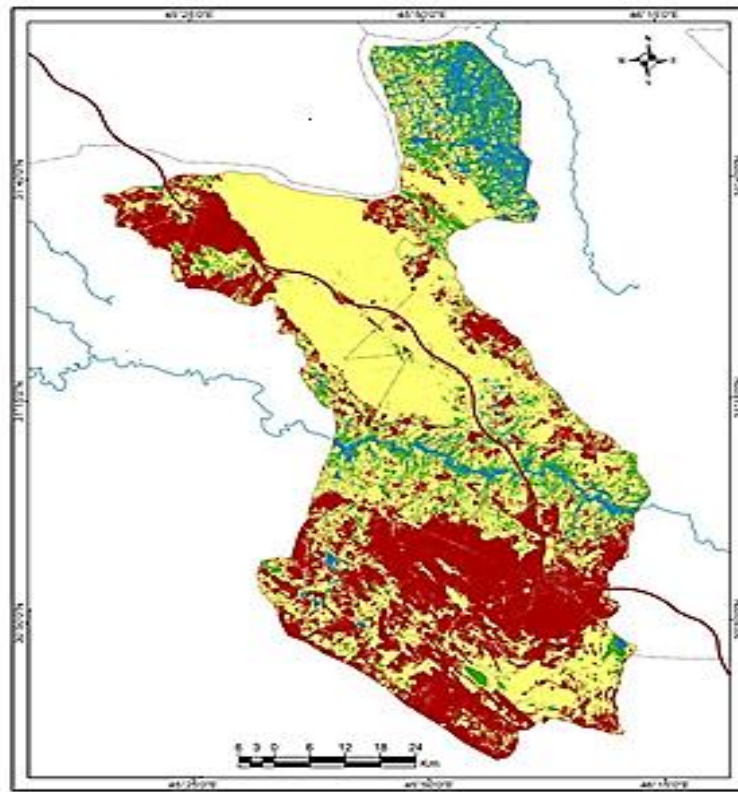**Figure 3.** The map Displays the outcome of unsupervised classification concerning the satellite image in 1988.

Figure 4. The map Displays the outcome of unsupervised classification concerning the satellite image in 2018.

4. Discussion

Increasing temperatures over the surface of the earth are considered a strong signal of the anthropogenic Factors contributing to climate change [13]. However, many different drivers can affect the observed temperature within multiple scales. The variation of Temperatures globally can be created by natural and anthropogenic drivers [5]. Therefore, it is not easy to examining historical climate data at multiple scales in order to make an assessment for the causes of heat trends [13]. In addition, the Temperature of the earth surface and Atmosphere is expected to increase [14] .Although, there are many studies that have tried to determine the changes in the observed rate of warming between the Earth's surface and troposphere [15].

This study analyzed the average changes in mean annual temperature and rainfall for the southern part of Iraq. We found that there were significant changes in temperature, as some years recorded a large increase annual temperature values over the averaged historical values. For example, the year 2018 recorded an increase in temperature of more than 2 degrees Celsius than the average in annual temperature for both Samawah and Nasiriyah stations. Also, the annual rainfall values witnessed significant changes and fluctuations over the period from 1973 to 2018. For example, at Samawah station, an annual rainfall of 247.9 mm was recorded in 2013 while the annual rainfall value in 2017 was 29.7 mm. The Unsupervised Classification for the satellite images of the study area was made, and four classes were chosen for the purpose of determining the extent of desertification. And by following up the results of this classification, we founded that there is a significant increase in the area of land covered by sand dunes and a decrease in the areas of barren lands and wetlands in favor of sand dune lands. The land area of sand dunes increased from 1988 to 2018 (Table3). Overall, climate change and land degradation have attributed increase in drought and desertification for the southern region of Iraq.

Conclusion:

The Climate change has happened all over the world as a result of the high levels of Greenhouse gas concentrations . This study examines the impacts of changing the temperature and rainfall in the extent of desertification phenomenon in southern Iraq as a result of climate changes. The results indicated significant increases in the extent of desertification in the study area. Changes in Annual mean rainfall and Temperature rates were the main cause of increasing desertification. For example, through the result of unsupervised classification of satellite images for the study area, it is seeming clear that the extent of desertification and its aspects are quite different in 2018 from the extent of that phenomenon in 1988. That there is a significant increase in the area of land covered by sand dunes and a decrease in the areas of barren lands and wetlands.

References

[1] M. Hertzberg, and H. Schreuder, "Role of atmospheric carbon dioxide in climate change", Energy and Environment, Vol. 27, No. 6, pp. 785-797, 2016.

[2] IPCC, Climate Change: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp 151, 2014.

[3] D. Benjamin, H. Hui por, and D. Budescu, "Climate change versus Global Warming: Who is Susceptible to the Framing of Climate Change?" Environment and Behavior, Vol. 49, No. 7, pp. 745-770, 2017.

[4] P. D .Jones, New, M., Parker, D.E., Martin, S. and Rigor, I.G, "Surface air temperature and its variations over the last 150 years". Reviews of Geophysics, vol. 37, No. 2, pp. 173-199, 1999.

[5] P. J. Lloyd, "An Estimate of the Centennial Variability of Global Temperatures", Energy and Environment Vol. 26, No. 3, pp. 417-424, 2015.

[6] P.D. Jones, D.H. Lister, T.J. Osborn, C. Harpham, M. Salmon, and C.P. Morice, "Hemispheric and large-scale land surface air temperature variations: an extensive revision and an update to 2010", Journal of Geophysical 424, 2012.

[7] Y. Xu, and V. Ramanathan, "Latitudinally asymmetric response of global surface temperature: Implication for regional climate change", Geophysical Reserch Letters, Vol. 39, No. 10, pp. 706-711, 2012.

[8] M. Ogurtsov, and M. Lindholm, "Uncertainties in Assessing Global Warming during the 20th Century: Disagreement Between Key Data Sources", Energy and Environment, Vol. 17, No. 5, pp. 685-706, 2006.

[9] Sivakumar, MVK 2007, 'Interactions between climate and desertification', Agricultural and Forrest Meteorology, vol.142, n.2-4, pp 143-155.

[10] M. Collins, R. Knutti, J. Arblaster, J. Dufresne, T. Fichefet, P. Friedlingstein, X. Gao, W.J. Gutowski, T. Johns, G. Krinner, M. Shongwe, C. Tebaldi, A.J. Weaver, and M. Wehner, Long-term Climate Change: Projections, Commitments and Irreversibility. In: Climate Change 2013: The Physical Science Basis, Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2013.

[11] Ya. K. Kondrayev, "Key Aspects of Global Climate Change", Energy and Environment, Vol. 15, No. 3, pp. 469-503, 2004.

[12] K .J Feeley, J. T. Stroud, and T.M. Perez, "Most global reviews of species responses to climate change are not truly global", Diversity and Distributions, Vol. 23, No. 10, pp. 231-234, 2017.

[13] W. K. Sabri, "Dune in Muthanna Governorate, Applied Geomorphic Study", M.Sc. Thesis, Geography Dept., Univ. of Baghdad, Iraq, 2010.

[14] C. Loehle, Trend Analysis of Satellite Global Temperature Data, Energy and Environment, Vol. 20, No. 7, pp. 1087-1098, 2009.

[15] A. Rosema, S. foppes and J. Van der, Meteosat Deriver Planetary Temperature Trend 1982-2006, Energy and Environment, Vol. 24, No. 3, pp. 381-395, 2013.

[16] D. h. Douglass and J. R. Christy, Reconciling Observations of Global Temperature Change: 2013, Energy and

Environment, Vol. 24, No. 3, pp. 415-419, 2013.

[17] Australian bureau of Meteorology, Available: http://www.bom.gov.au/web01/ncc/www/cli_chg/timeseries/global_t/0112/global/latest.txt

[18] GISTEMP Team: GISS Surface Temperature Analysis (GISTEMP). NASA Goddard Institute for Space Studies, 2018. Dataset accessed 20YY-MM-DD at https://data.giss.nasa.gov/gistemp/.

[19] Australian bureau of Meteorology, Available: http://www.bom.gov.au/web01/ncc/www/cli_chg/timeseries/global_r/0112/global/latest.txt