International Journal of Multidisciplinary Trends

E-ISSN: 2709-9369
P-ISSN: 2709-9350
www.multisubjectjournal.com
IJMT 2021; 3(1): 191-196
Received: 25-12-2020
Accepted: 28-01-2021

Qurban Aliyar
Department of Forestry and Natural Resources
Faculty of Agriculture
Bamyan University, Afghanistan

Mohammad Ali Eltfs
Department of Civil and Industrial Construction
Faculty of Construction
Kabul Polytechnic University
Kabul, Afghanistan

Corresponding Author:
Qurban Aliyar
Department of Forestry and Natural Resources
Faculty of Agriculture
Bamyan University, Afghanistan

Analysis of Climate indices in Daykundi province, Afghanistan

Qurban Aliyar and Mohammad Ali Eltfs

Abstract
Climate events can have many impacts on various sectors. The studies show notable change in trait of natural disastrous. This study examined maximum, minimum tempratures and precipitation trend of climate indices in Daykundi province of Afghanistan during the 1986 to 2019. This analyzed eight sites and each stations calculate minimum, maximum and DTR temperatures variability and precipitations trend with positive and negative trendies were gotten. The linear regression trend was utilized to find out notable trends. The finding of study showed maximum and minimum temperature were observed upward trend significantly in nationwide of Daykundi. Minimum temperature has been raised greater compared to maximum temperature resulting diurnal temperature range (DTR) has remarkably decreased. Precipitation indices of climate change were detected by high fluctuation during 1986-2019. Positive precipitation trend were happened in all study sites except of Kajarn district. The mean annual precipitation had upward trends with extensive range of scattering. Kajran district were experienced on precipitation reduction -0.48 mm per annum during study period.

Keywords: Climate indices, Temperature, Precipitation, DTR, Trends

1. Introduction
Climate parameters which are used to distinguish the condition of climate system and perception of different climate mechanism have been developed based on climate variability. The spatial-temporal of diverse climate parameters is also defined by climate condition of study site (Baltas, 2007; Deniz *et al*., 2011) [4, 6]. Climate trend analysis find out which mean surface temperature has raised by 0.3°C to 0.6°C globally since last decades of 19th century, and 0.2°C to 0.3°C over last four decades (Easterling *et al*., 2001) [8]. The recent study have indicated that minimum temperature have rarely raised at a higher rate than maximum temperatures, resulting in a decline in diurnal temperature in some parts of the globe. The small positive of precipitation trend have been recorded globally, almost 1% over land during 20th century, with a greater raised, especially in cold season in the high latitude of Northern Hemisphere. The spatial-temporal trend have considerably happened over the last century, and trend of warming, enhanced precipitation, decreased diurnal temperature range (DTR) have not been alike, globally. For instance, in the mid-latitude of Northern Hemisphere continents have been showed warming in winter and spring, whole year cooling in the northwest North Atlantic and mid-latitude over the North Pacific in the last 40 years (Nicholls *et al*., 2001) [17]. The result of studies show that the incidence and severity minimum temperature events have declined dramatically. The maximum temperature trends has increased normally and excessive precipitation trend have happened vast areas especially in the mid and high latitude (IPCC, 2007). There is notable compromise among the finding of regional temperature studies, e.g. North America (Vincent & Mekis, 2006), Africa (Mokssit, 2003), Europe (Tank & Können, 2003) and Asia (Klein Tank *et al*., 2006) [24, 16, 23, 13]. The annual trends lowest and highest daily minimum and maximum temperature have raised in a year in the last five decades of twentieth century in the most part the world. Substantial reduction in the number of frost days and remarkable raise in the minimum temperature have been occurred (Frich *et al*., 2002) [9]. The intense precipitation trends have been showed in positive about 15 percent of sampled global land areas (Alexander *et al*., 2006) [3]. Climate change trend may be critical for arid and semi-arid regions i.e. Afghanistan, and it effect on the flood, drought and heat waves. Afghanistan is landlocked country with semi-arid climate and most vulnerable due to intense of precipitation and natural hazard consisting droughts and floods (Rehana *et al*., 2021) [19]. Overall, the annual precipitation has occurred an increasing in the South, South-west, East and Central zones of Afghanistan. Rainfall has shown in decreasing in and raised temperature in all agro-climate zone of Afghanistan (Saboory & Tomer, 2019) [20].

Climate indices is poorly documented due to insufficient meteorological data during four war decades. Aich *et al*., (2017) [2] stated based on regional climate model (RCM) of Coordinated Regional Climate Downscaling Experiment (CORDEX)-South Asia that mean temperature raise over global level 1.8ºC during 1950-2010. There is uncertainty regarding analyzed data rainfall on the past change. The precipitation trend from eight different stations in Kabul river basin showed increasing 4.88-30.42 mm/year, also minimum temperature have remarkably raised during 2000 to 2018 (Aawar *et al*., 2019) [1]. In this study will be assessed the precipitation variation, maximum and minimum temperatures trend in Central of Afghanistan, especially Daykundi province based on National Weather Service of Climate Prediction Center (CPC) of global data.

2. Materials and methods

2.1 Study area

Daykundi province is located in central of Afghanistan and the second largest province in the Hazarajat region. The province lies at latitude 33.995 N and longitude 66.321 E and it bordered by Ghor province in the North; Bamyan province in the northwest; Helmand in the West; Urozgan in the South; Ghazni in the East. Daykundi covers about 17,501 km square, and 2.7 percent of total area of Afghanistan which is shown in Fig 1. The land area is covered by 80 percent by mountain. The province is divided in nine administrative government, namely: Nili is capital of Daykindi with elevation 1152 m above sea level, Shahristan, Gizab, Ashtarlay, Khadir, Kiti, Miramor, Sang-e-Takht and Kajran. Climatically, during long winter season the temperatures may drop to 16 degree Celsius, the mean annual precipitation range is 200-250 mm and mostly occurred about 28-35 mm normally during the March and April.

It has a population about 723980 and they rely in agriculture as the main source of income. Around 6 percent is used for agriculture purpose and the main crops grow i.e. wheat, barley, potatoes, almond and beans. This province is the one of least productive province due to barren and inaccessible land with shortage of water, small landholders, poor soil quality and severity of food insecurity.

2.2 Data

The climate indices such as daily temperature and precipitation was extracted from CPC-NOAA (Climate Prediction Center-National Oceanic Atmosphere Administration) website: https://psl.noaa.gov/data/gridded/data.cpc.global temp.html and temporal resolution coverage is a period of 1986 to 2019. The spatial resolution of climate indices is 0.5×0.5 degree. The data was obtained from eight sites of throughout Daykundi province with specified latitudes and longitudes that is shown in Table 1. The center of each districts were selected as study sites.

2.3 Analysis Approach

This study estimated the changes in each of the minimum and maximum temperature trends and precipitation extreme statistics by using linear regression.

2.3.1 Linear Regression

One of the simplest methods to calculate the trend of the data is linear regression. The equation of linear regression line is defined by:

$$Y = a + bX$$

Where, *X* is explanatory variable and Y is the dependent variable, *b* is the slope if the line and *a* is the intercept. The slope of regression describes the trend, with positive as increasing and negative decreasing trend. The observed trend is conducted by considering the precipitation and temperatures as dependent variable and time as explanatory variable.

4. Result & Discussion

4.1 Temperature Trend

Climate change analysis was explored by driving force of prediction and detection long-time change in temperature indices. This study analyzed three indices of temperature i.e. maximum temperature, minimum temperature and diurnal temperature in entire of Daykundi province. The maximum temperature trend have significantly increased all study sites (Fig 2). Khadir, Miramor, Sang-e-Takht and Shahristan with higher raised maximum temperature with 2.1 ºC, 2.02 ºC, 2 ºC and 2.1ºC, respectively during thirty-four years and temperature variations is shown in Fig 2. The mean annual minimum temperature variation has increased significantly, compared to maximum temperatures. The analysis of minimum temperature represent cold season became warmer and these areas are more vulnerable due to climate change impacts. Data in Table 2 were observed Meramoor with highly positive trend (5.8 ºC) and Khadir and Sang-Takht with (3.1ºC) increased minimum temperature. A study of minimum and maximum temperatures was conducted in Thailand that show the temperature extremes raised notably in summer days and decrease cool night (Masud *et al*., 2016) [15]. The mean annual temperature has raised 0.5-1.5 ºC in the south of Canada, and minimum temperature is greater compared to maximum temperature in first five decades of 20th century (Zhang *et al*., 2000) [26]. The finding of study in Arab region during middle of twenty century were on agreement with warming trends that indicate warm days and nights, greater extreme temperature, lower cold days and nights (Donat *et al*., 2014) [7]. The finding a study in Hindu Kush Himalaya over the period of 1961 to 2015 was accord that indicate reduction in number of cold days, cold night and frost days, and trend of minimum temperature water higher than maximum temperature significantly (Sun *et al*., 2017) [22].

Diurnal temperature range (DTR) is a parameter independent of interior of climate change. Data shows the mean minimum temperature is not higher than mean maximum temperature and the study is showed the DTR negative trend in all stations of in Daykundi Province. The finding of study in Bangladesh during 1961 to 2008 is agreement that is showed downward trend diurnal temperature trend (DTR) (Shahid *et al*., 2012) [21]. The result of study show the negative trends of DTR are dependent on positive trend of cloud cover (Zhou *et al*., 2009) [27]. The result of study Jaswal (2010) [12] confirmed cloud cover cause reduction of DTR in Bangladesh during pre-monsoon and winter seasons. Reduction in DTR during 50 years is attributed in raised of cloud cover (Braganza *et al*., 2004) [5]. Cloud cover influence on reduction of DTR in northern and southern hemisphere in summer during 1921-2010 (Yong *et al*., 2017) [25]. Also, reduction DTR were occurred in entire of Canada over period of twenty century (Zhang *et al*.,

2000) [26]. The minimum precipitation was with range 15mm in Kejran and 48mm in Meramoor in 2018.

4.2 Precipitation Tend

Mean annual precipitation in center of Daykundi province (Nili) is nearly 214.5 m. Table 3 show the maximum precipitation were occurred in 783 mm in 2019 and minimum precipitation was 20.8mm in 2018. Precipitation trend indicate upward with 5.1mm per year resulting show high fluctuations of precipitation indices during study period (Fig 3). Precipitation oscillation were extremely befallen in Ashtarlay, Shahristan, Sang-Takhat and Khadir districts among Daykundi province. Kejran district with downward trend of precipitation (-0.48 mm per year) were recognized in the study sites. A study was conducted by Longobardi *et al*. (2010) [14] corroborated that decrease precipitation in Italy during last five decades. Finding of study in Pakistan shows notably declining precipitation trends in western parts of Indus River Basin and remarkably raise in precipitation variation in high mountain ranges (Hartmann & Buchanan, 2014). The downward trend of precipitation have been happened in most region of Mediterranean between 1901 to 2009 and scant raised of precipitation in northern Africa, Italy and Peninsula (Philandras *et al*., 2011) [18].

5. Conclusion

The fluctuation of climate indices were occurred significantly during five decades and it affected the nature and living things. Ecosystem and humans can respond alteration in climate parameters rather than they do conversion in average parameters. Although, the analyzed variation of climate parameters is momentous for future prediction, especially agriculture and water sectors. Study examined trendies of climate indices in eight selected sites throughout Daykundi province. The variability of climate indices were observed by linear regression. The mean annual maximum, minimum and diurnal temperatures and mean annual precipitation were analyzed for all stations in the nationwide of Daykundi province the over period of 1986 to 2019.

Results of this study mentioned which climate indices variation numerate momentous climate profile of Afghanistan especially Daykundi province that temperatures trends and precipitation variation have been happened during the past decades. The metereolgocial department have not enough data for analysis of climate parameters due to climate change. Spatial-temporal data from CPC-NOAA (Climate Prediction Center-National Oceanic Atmosphere Administration) is way to analyze the climate indices and shows impact of climate change. According to finding of study, maximum temperature has been increased significantly. T_{max} in Khedir, Meramoor, Sang-e-Takht and Shahristan districts show raised more than 2ºC and these areas is more vulnerable due to climate change. Minimum temperature show positive trend compared maximum temperature whole of Daykundi. Cool days, cool night and frost days were fewer experienced compared to previous centuries. Diurnal temperature range (DTR) has been decreased substantially. Reduction of DTR depend on fewer raised of T_{max} than T_{min} entire of study period and it highlighted ongoing warming is a global phenomenon.

Overall, precipitation shows positive trend with high fluctuation during study period except of Kejran districts. The positive trend of precipitation shows high range of dispersion. Conversely, the western area of Daykundi province were observed negative precipitation trend with record of -0.48mm per year during 1986 to 2019.

Acknowledgments:

The authors were grateful from Kazim Elham that he is senior student of Forestry and natural resources department, due to extracted data by GIS.

Table 1: Geographical coordination of research studies through-ought Daykundi Province

No.	Districts	Study Sites	Latitudes (º)	Longitudes(º)	Elevations (m)
1	Ashtarlay	Band-e-Mazar	34.067	66.293	2686
2	Kejran	Markaz	33.194	65.625	1244
3	Keti	Bazar	33.513	65.676	1459
4	Khedir	Khadir	33.923	65.933	2461
5	Merammor	Tagab	33.814	66.783	2285
6	Nili	Center	33.722	66.144	2009
7	Sang-e-Takht	Paish-Mazar	34.192	66.041	2730
8	Shahristan	Ulqan	33.702	66.563	2183

Table 2. The variation of maximum, minimum and diurnal temperatures during 1986 to 2019 in Daykundi province

No.	Sites	Change in Tmax	Change in Tmin	Change in DTR
1	Ashtarlay	1.972	2.6826	-0.7106
2	Kejran	1.3906	2.2712	-0.8806
3	Keti	1.3498	2.635	-1.2852
4	Khedir	2.0128	3.1076	-1.0948
5	Merammor	2.0298	5.8718	-3.842
6	Nili	1.8428	2.6758	-0.833
7	Sang-e-Takht	2.0128	3.1076	-1.0948
8	Shahristan	2.159	2.1692	-0.0102

Table 3: Precipitation trend during 1986-2019 entire of Daykundi province

No.	Sites	Mean annual precipitation (mm)	Maximum Precipitation (mm)	Year	Minimum precipitation (mm)	Year	Change in precipitations in year (mm)
1	Ashtarlay	250.9	663	2013	28	2018	8.4807
2	Kejran	146.2	283	1992	15	2018	-0.4864

3	Keti	181	350	2019	20	2018	0.4713
4	Khedir	223.8	449	2019	22	2018	4.3481
5	Merammor	262	644	2016	48	2018	10.226
6	Nili	214.5	783	2019	20.8	2018	5.1468
7	Sang-e-Takht	223.8	449	2019	22.2	2018	4.3481
8	Shahristan	214.6	516.7	2019	25.1	2018	5.5052

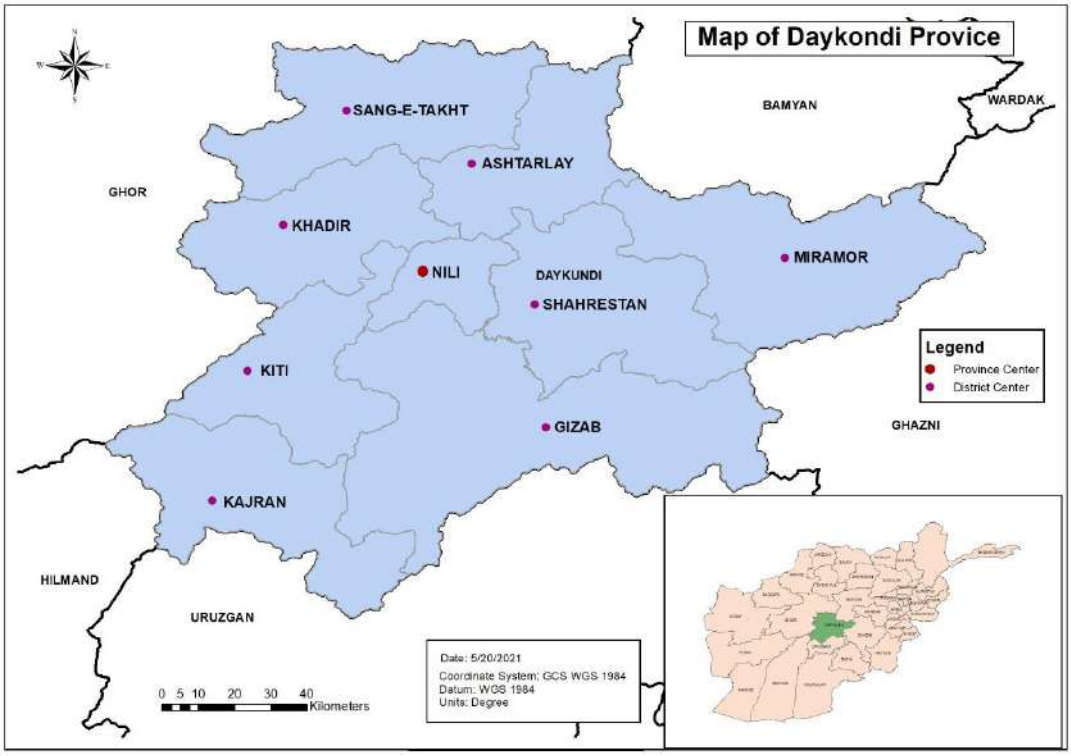

Fig 1: Map the study areas of Daykundi province, Afghanistan

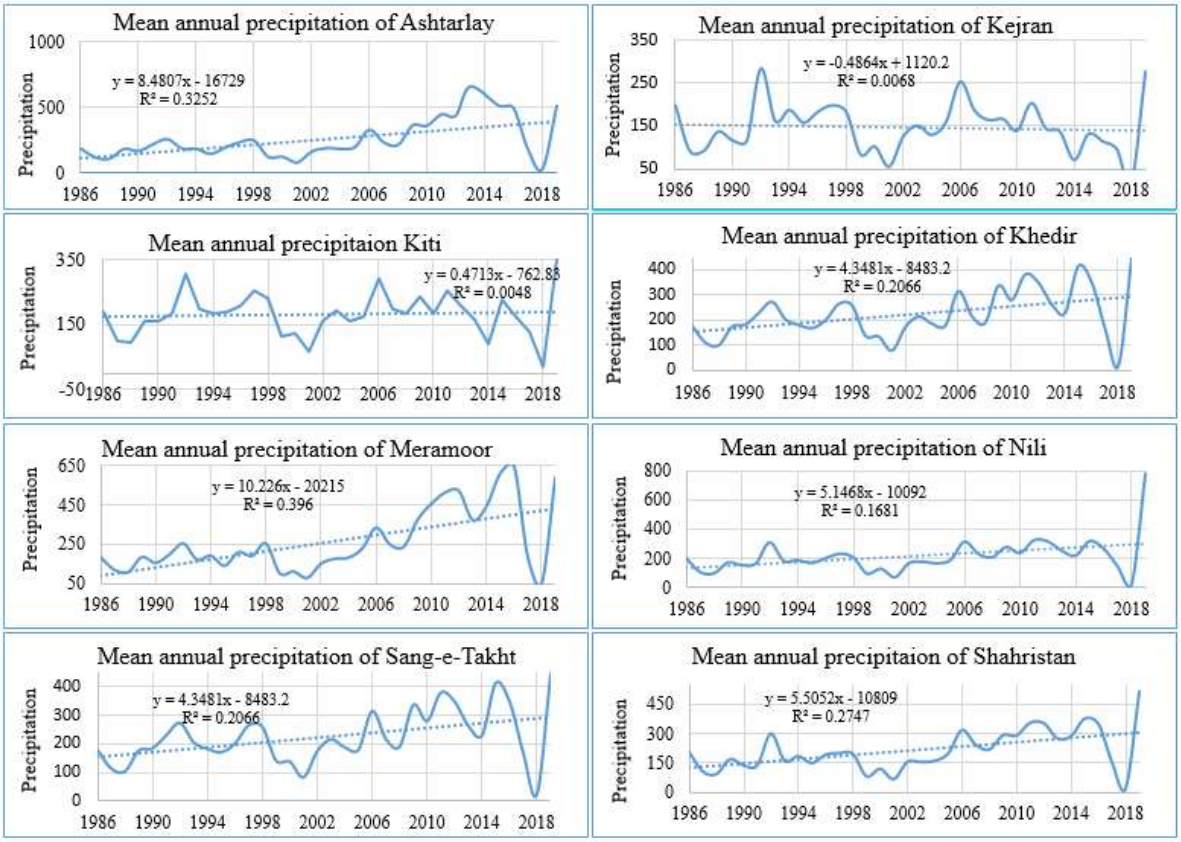

Fig 2: Precipitation trends in Daykundi province over the period of 1986 to 2019

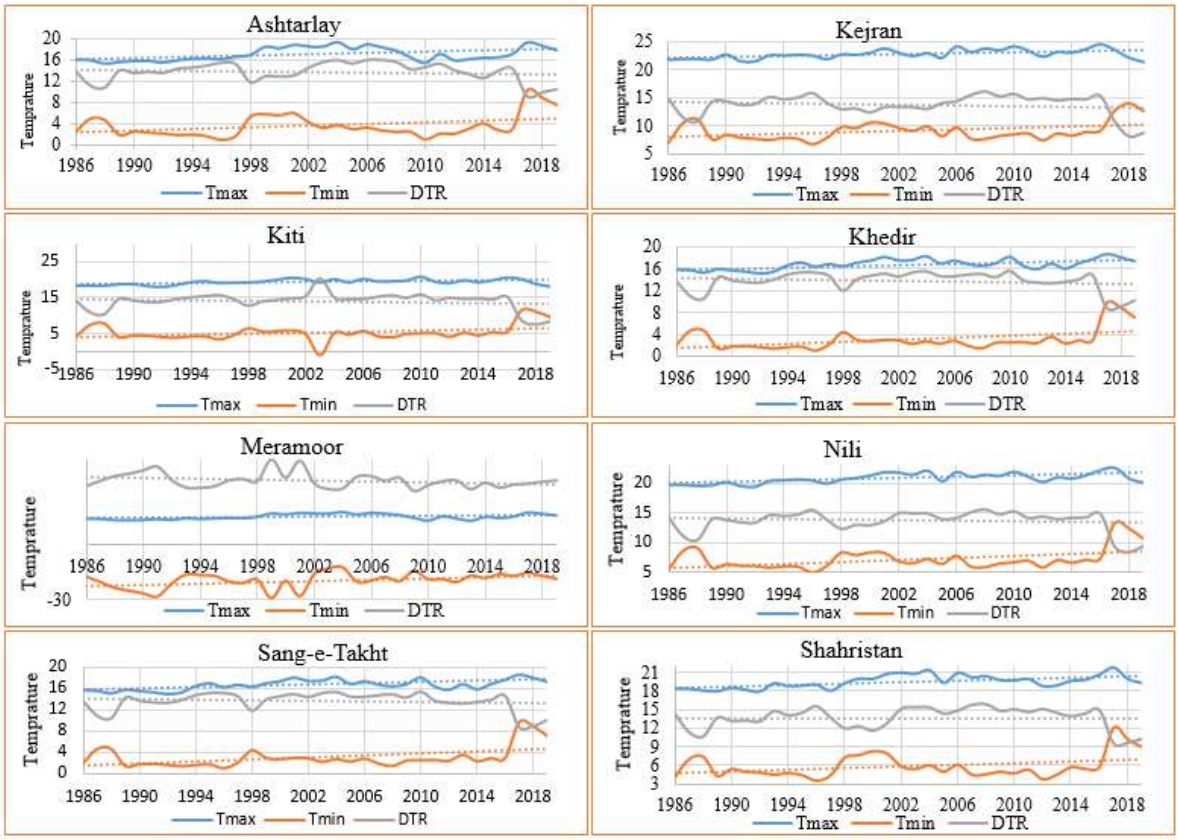

Fig 3. The mean annual of maximum, minimum temperatures and DTR trends in Dayknundi province during 1986-2019

References

1. Aawar T, Khare D & Singh L. Identification of the trend in precipitation and temperature over the Kabul river sub-basin: a case study of Afghanistan. Modeling Earth Systems and Environment 2019;5(4):1377-1394.
2. Aich V, Akhundzadah NA, Knuerr A, Khoshbeen AJ, Hattermann F, Paeth H & Paton EN. Climate change in Afghanistan deduced from reanalysis and coordinated regional climate downscaling experiment (CORDEX)—South Asia simulations. Climate 2017;5(2):38.
3. Alexander LV, Zhang X, Peterson TC, Caesar J, Gleason B, Klein Tank AMG & Vazquez-Aguirre JL. Global observed changes in daily climate extremes of temperature and precipitation. Journal of Geophysical Research: Atmospheres 2006, 111(D5).
4. Baltas E. Spatial distribution of climatic indices in northern Greece. Meteorological Applications: A journal of forecasting, practical applications, training techniques and modelling 2007;14(1),69-78.
5. Braganza K, Karoly DJ & Arblaster JM. Diurnal temperature range as an index of global climate change during the twentieth century. Geophysical research letters 2004, 31(13).
6. Deniz A, Toros H & Incecik S. Spatial variations of climate indices in Turkey. International Journal of climatology 2011;31(3):394-403.
7. Donat MG, Peterson TC, Brunet M, King AD, Almazroui M, Kolli RK & Al Shekaili MN. Changes in extreme temperature and precipitation in the Arab region: long-term trends and variability related to ENSO and NAO. International Journal of Climatology 2014;34(3):581-592.
8. Easterling DR, Horton B, Jones PD, Peterson TC, Karl TR, Parker DE & Wang SW. Observed climate variability and change 2001.
9. Frich P, Alexander LV, Della-Marta PM, Gleason B, Haylock M, Tank AK & Peterson T. Observed coherent changes in climatic extremes during the second half of the twentieth century. Climate research 2002;19(3): 193-212.
10. Hartmann H & Buchanan H. Trends in extreme precipitation events in the Indus River Basin and flooding in Pakistan. Atmosphere-Ocean 2014;52(1): 77-91.
11. IPCC. Climate Change- the scientific basis. Intergovernmental Panel on Climate Change. Cambridge University Press: Cambridge 2007.
12. Jaswal AK. Changes in total cloud cover over India based upon 1961–2007 surface observations. Mausam, 2010;61(4):455-468.
13. Klein Tank, Albert MG TC, Peterson DA, Quadir S, Dorji X, Zou H, Tang K, Santhosh *et al*. "Changes in daily temperature and precipitation extremes in central and south Asia." Journal of Geophysical Research: Atmospheres 111, no. D16 (2006). 2010
14. Longobardi A & Villani P. Trend analysis of annual and seasonal rainfall time series in the Mediterranean area. International journal of Climatology 2010;30(10):1538-1546.
15. Masud MB, Soni P, Shrestha S & Tripathi NK. Changes in climate extremes over North Thailand, 1960–2099. Journal of Climatology 2016.
16. Mokssit A. Development of priority climate indices for Africa: A CCI/CLIVAR workshop of the World Meteorological Organization. In Mediterranean

Climate (pp. 115-123). Springer, Berlin, Heidelberg 2003.
17. Nicholls N, GV Gruza J Jouzel, TR Karl, LA Ogallo And DE Parker. Observed Climate Variability And Change. In: Climate Change. The Science Of Climate Change. Houghton, J.T.; L.G. Meira Filho, B.A. Callander, N. Harris, A. Kattenberg And K. Maskell (Eds). Cambridge University Press, Cambridge, UK 1995, 132–192.
18. Philandras CM, PT Nastos, J Kapsomenakis KC Douvis, G Tselioudis and CS Zerefos. "Long term precipitation trends and variability within the Mediterranean region." Natural Hazards and Earth System Sciences 11, no. 2011:12:3235-3250.
19. Rehana S, Reddy PK, Reddy NS, B Daud AR, Saboory S, Khaksari S & Sowjanya U. Observed Spatio-Temporal Trends of Precipitation and Temperature Over Afghanistan. Climate Change Impacts on Water Resources: Hydraulics, Water Resources and Coastal Engineering 2021, 377-392.
20. Saboory SK, Tomer SK. Regional scale spatiotemporal trends of precipitation and temperatures over Afghanistan 2019.
21. Shahid S, Harun SB & Katimon A. Changes in diurnal temperature range in Bangladesh during the time period 1961–2008. Atmospheric Research 2012;118:260-270.
22. Sun XB, Ren GY, Shrestha AB, Ren YY, You QL, Zhan YJ & Rajbhandari R. Changes in extreme temperature events over the Hindu Kush Himalaya during 1961–2015. Advances in Climate Change Research 2017;8(3):157-165.
23. Tank AK, Können GP. Trends in indices of daily temperature and precipitation extremes in Europe, 1946–99. Journal of climate 2003;16(22):3665-3680.
24. Vincent LA, Mekis E. Changes in daily and extreme temperature and precipitation indices for Canada over the twentieth century. Atmosphere-Ocean 2006;44(2): 177-193.
25. Yong WANG, Zablon SW. Variability of diurnal temperature range in east Africa during 1921-2010. Journal of Tropical Meteorology 2017;23(4): 345-356.
26. Zhang X, Vincent LA, Hogg WD, Niitsoo A. Temperature and precipitation trends in Canada during the 20th century. Atmosphere-ocean 2000;38(3):395-429.
27. Zhou L, Dai A, Dai Y, Vose RS, Zou CZ, Tian Y & Chen H. Spatial dependence of diurnal temperature range trends on precipitation from 1950 to 2004. Climate Dynamics 2009;32(2):429-440.