TEMPORAL ANALYSIS OF TEMPERATURE AND PRECIPITATION CHANGES IN CHOLISTAN, PUNJAB PAKISTAN

S. S. Wahla[1,3], M. Shahzad[2], M. Asif[3] and M. Z. Faheem[3]
[1]Department of Geography, Govt. Post-graduate College for Women, Bahawalnagar-Pakistan
[2]Department of Geography, University of the Punjab, Lahore-Pakistan
[3]Department of Geography, University of Karachi, Karachi-Pakistan
Corresponding author's E-mail: geosaadiasultan@gmail.com

ABSTRACT: The emission of greenhouse gases due to anthropogenic activities causes extensive global warming. Raise in the temperature also affect almost every ecosystem by shifting the rate of precipitation and other ecological factors. The current study focus to evaluate the temperature and precipitation fluctuation in desert Cholistan. Data was gathered from the nearest three metrological departments of Cholistan such as, Khan Pur, Bahawalpur and Bahawalnagar and were statistically analyzed by using different procedures like linear regression, trend of the time series was analyzed using Mann-Kendal trend test and Sen's slope. Result revealed that there were significant (p=0.0001) increases in the temperatures with trend magnitude of 0.92. Further it was also found that there was non-significant (0.052) increase in the rainfall in overall study period with the trend magnitude of 3.33. Increase in the temperatures result in the high rate of evaporation but unfortunately rate of evaporation is higher as compared to the rate of participation, that result in intense drought condition, which badly affect the flora and fauna of the targeted area of the Pakistan. Based on the current result, it is suggested Cholistan Development Authority and other concerned departments should make an effective strategic plan to decrease the susceptibility of the disaster-prone areas and to overcome the damages caused by meteorological droughts.

Keywords: the Cholistan, rate of participation, temperature, 1980-2020.

INTRODUCTION

Due to the increased level of anthropogenic activities leads to emissions of greenhouse gases (Meinshausen *et al*., 2009), the change in climatic conditions results in global warming. According to the 5th evaluation report of the Intergovernmental Panel on Climate Change (IPCC AR5), worldwide the average temperature augmented more than 0.82 ◦C between1880 and 2014, the earlier thirty years was consecutively warmer as compared to previous years since 1850. The frequency and intensity of rainfall alters due to global warming, thus the hydrological cycle has been influenced, results the chances of pollutants and transportation, with probable calamitous effects on the natural environment (Ye and Grimm, 2013; Jha *et al*., 2015). Identification of the possible impacts of the area of the climatic change on the environmental condition particularly at the basin scale has however engrossed extensive considerations from the government and speculative circles. Fluctuations in the hydro climatic parameters for the extended period such as the temperature and precipitation might signify the regional climatic changes. To know the impact of regional climatic change is consequently related to inspecting the varying effects of hydro climatic variables as the initial phase in the background of directing global warming (Ouarda *et al*., 2014). Presently some reports associated to tendency investigation of hydro climatic variables at water crises scale have been conducted like in East Africa in the Basin of the Lake Victoria (Mbungu *et al*., 2012), three Gorges basin (Chen *et al*., 2014), and the Yellow River Basin (Fu *et al*., 2004). The hydro climatic variables studied usually include the temperature of surface area, streamflow, amount of precipitation, and evapotranspiration (Huntington *et al*., 2014; Bao *et al*., 2012; Xu *et al*., 2010; Yeh *et al*., 2015). The earlier studies of precipitation have mainly focused on variation in monthly or yearly precipitation quantities and they avoid fluctuations in the structure of precipitation including mean intensity of precipitation, precipitation frequency, and amount of precipitation. It should be noted that variation in the amount of precipitation is due to variation of precipitation intensity, precipitation frequency, or combination of both (Brunetti *et al*., 2001; Chou *et al*., 2012) and that the structure of precipitation is the vital factor to understand the hydrological cycle against the climatic change (Zhang *et al*., 2012). Hence, a study of changes in the structure of precipitation can deliver an inclusive viewpoint to understanding the changes in precipitation for the controlling of water resource in the basin. The current study aims to assess

precipitation and temperature changes in desert Cholistan from the last 40 years.

MATERIALS AND METHODS

Study area description: The geographic location of the desert Cholistan Desert in world is 28.5°N 70°E. In Pakistan it is located in the south of Bahawalpur district and covers most of the area of Thar and Nara desert of Sindh. Further it is above sea level at height of 367ft. common livestock of the desert Cholistan is camel, goat, sheep and donkey. Important flora (medically important) of desert cholistan comprises *Cyperus rotundus, Aerva persica, Cuscuta reflexa, Savadora oleoides, Tamarix aphylla* and *Solanum suranttensa* etc. Among Fauna of the desert Cholistan *Felis caracal, Felis chaus, Herpestes edwardsi, Felis libyca, Sturnus vulgaris, Athene brama, Buteo buteo vulpinus*, and *Circus macrourus* are most common (Chaudhry *et al*., 2004).

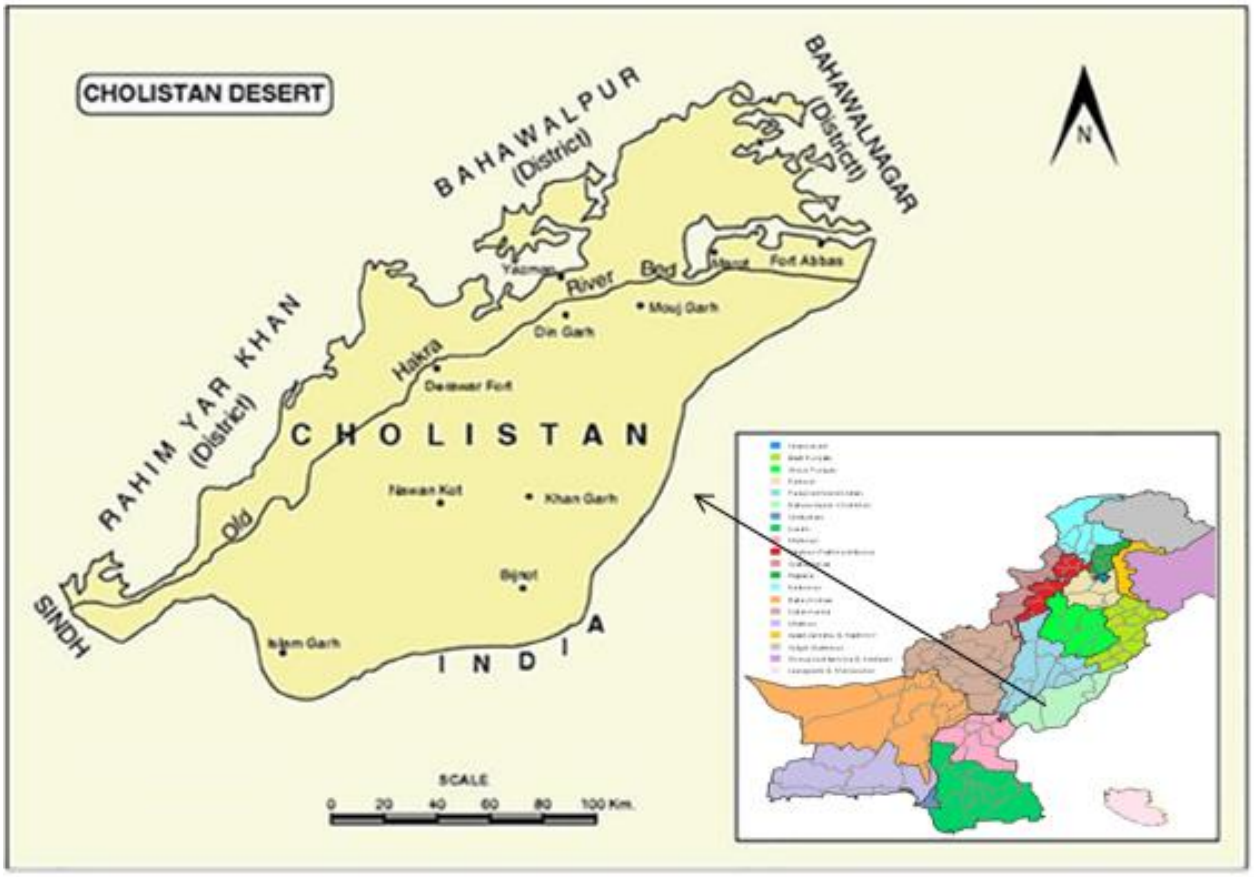

Figure 1: Map of Cholistan desert (modified Zubair *et al*., 2018)

Data Sampling and analysis: unfortunately, there is no metrological station in the desert Cholistan. There for 40 years' data i.e. from 1977-2017 for rainfall and temperature was collected from the nearest metrological centers. Such as, Khan Pur (28° 39' 0" North, 70° 39' 0" East), Bahawalpur (9° 25' 5.0448" N and 71° 40' 14.4660" E.) and Bahawalnagar (29.999183 N and 73.258844 E) annual mean was calculated after combining the data from the three metrological stations. Several statistical techniques and procedures were used to estimate and detect the trends in different parameters of climate. These several statistical procedures are largely categorized into both parametric and non-parametric methods according to the data distribution (Chattopadhyay and Edwards, 2016). Thus four statistical procedures were used to observe and approximate the temperature trends and precipitation with the help of Excel sheet (MS office 2016). Such as linear regression

$$\Delta y = y(\text{initial point}) - y(\text{terminate point}) \quad (4)$$

method for analysis of behavior. Trend magnitude was analyzed with the help of following formula

Where 'Δy' represent the magnitude of the total trend whereas 'y'_i and 'y'_t show the starting and the termination point of the time series respectively. The positive and negative symbol of 'Δy' represents the increasing and decreasing trend respectively.

In addition, significance of the trend was analyzed with the help of widely used non-parametric test such as Mann-Kendall test. At the same time value of Kendall's tau (τ) and Sens' slope was also analyzed during this test. All of these test was carried out with the help of XLSTAT in excel sheet (MS-Office 2016)

RESULTS AND DISCUSSION

Global warming has a great impact on the biomes of the world. Particularly the precipitation (rain and snow) and temperature both are expected to globally shift. And their individual effect on the world's ecosystem is quite different that directly depends on the current precipitation rate, temperature, several biotic and abiotic factors. Despite, extensive research on this topic still It is not clear enough that whether communities depend on the air or soil moisture, or precipitation. Several kinds of research have been carried out in vitro to understand the basic mechanism of this particular topic such as (Cowles *et al*., 2016). The current study focus to evaluate the last 4 decades' change in temperature and precipitation of the desert Cholistan due to global warming and their possible effect on the Cholistan community.

The trend in temperature: After analysis of the temperature it was found that there was increasing trend of the temperature. Because the value obtained here was positive as shown in the figure 2.

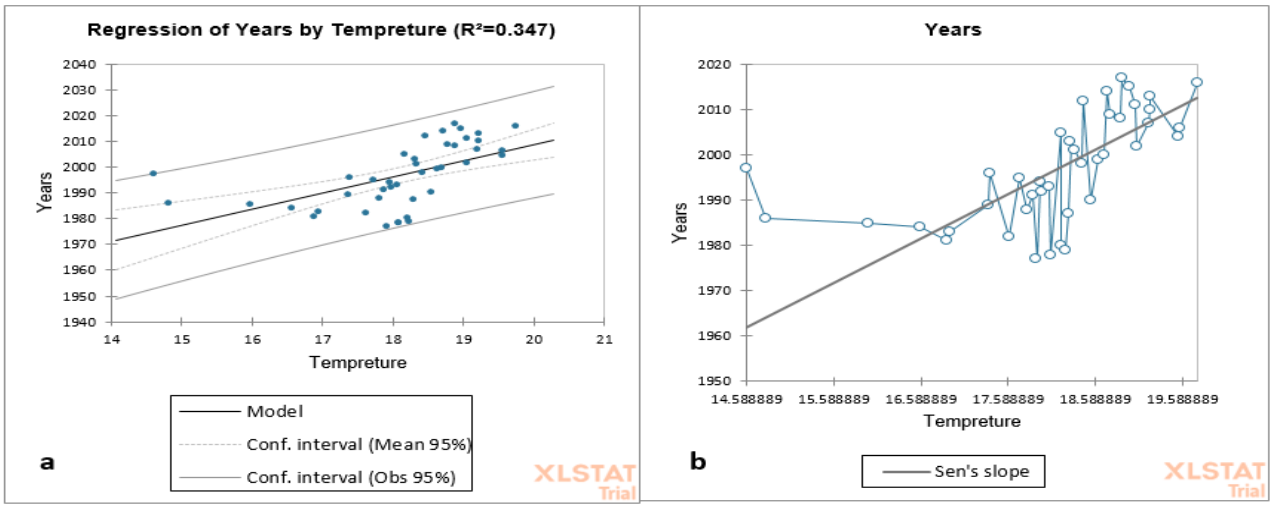

Figure 2: Temperature detail of desert Cholistan a) Liner Regression analysis b) Mann-Kendall test Temperature trend in desert Cholistan along with the Sen's Slope.

This temperature raise is not only observed in the desert Cholistan but most of the world places. This rising of the temperature not just only raised but affect many factors like it reduces moisture in soil. Due to this decrease in the soil moisture causes high frequency and intense drought across the world (Weeks *et al*., 2020). A very recent study carried out by the khan *et al*., (2020), conclude that during major part of the year, desert Cholistan remains extremely dry and meteorological droughts occur frequently. This intense drought condition of the area badly effects flora and fauna of the area while leads to hard life of the human. This raising temperature is not only observed in the desert Cholistan, but in different regions of the Pakistan like Samo *et al*., 2017 conclude that there is increase in the monthly minimum temperature of the Shaheed Benazir Abad from the 1986 to 2014. Further according to the Chaudhry, (2017), catastrophic floods, droughts, and cyclones have plagued Pakistan in recent years, that badly affect most flora and fauna of the Pakistan including human. Further it was also concluded from the same author that there will be progressive increase in the upcoming years. Detail of this study can be seen in the figure. These all effect are directly linked to the increased in the temperature.

The trend in the rainfall: Predicting rainfall is one of the most challenging task as compared to the temperatures but this cannot be ignored as it is the most critical factor that overall explain the change of climate (Moulana etal., 2020). Though it is considered as one of the most difficult task still scientists can make confident statements about the future. As we know that warm atmosphere can hold more moisture as compared to the cool atmosphere (Segun *et al*., 2015). Globally moisture in the air is increasing 7% for each one-degree rise of temperatures, though it is difficult to predict future rainfall with this statement but there is increase in the rainfall by 1-2% per degree raise in temperatures (Roderick *et al*., 2019). In current study it was found that there is the slight increase in the precipitation of desert Cholistan. Though this change is not significant. But a

progressive increase in the trend is observed. Detail can be seen in the figure 3 and table 1. This slight increase in rainfall is not sufficient to overcome the water shortage of the study area.

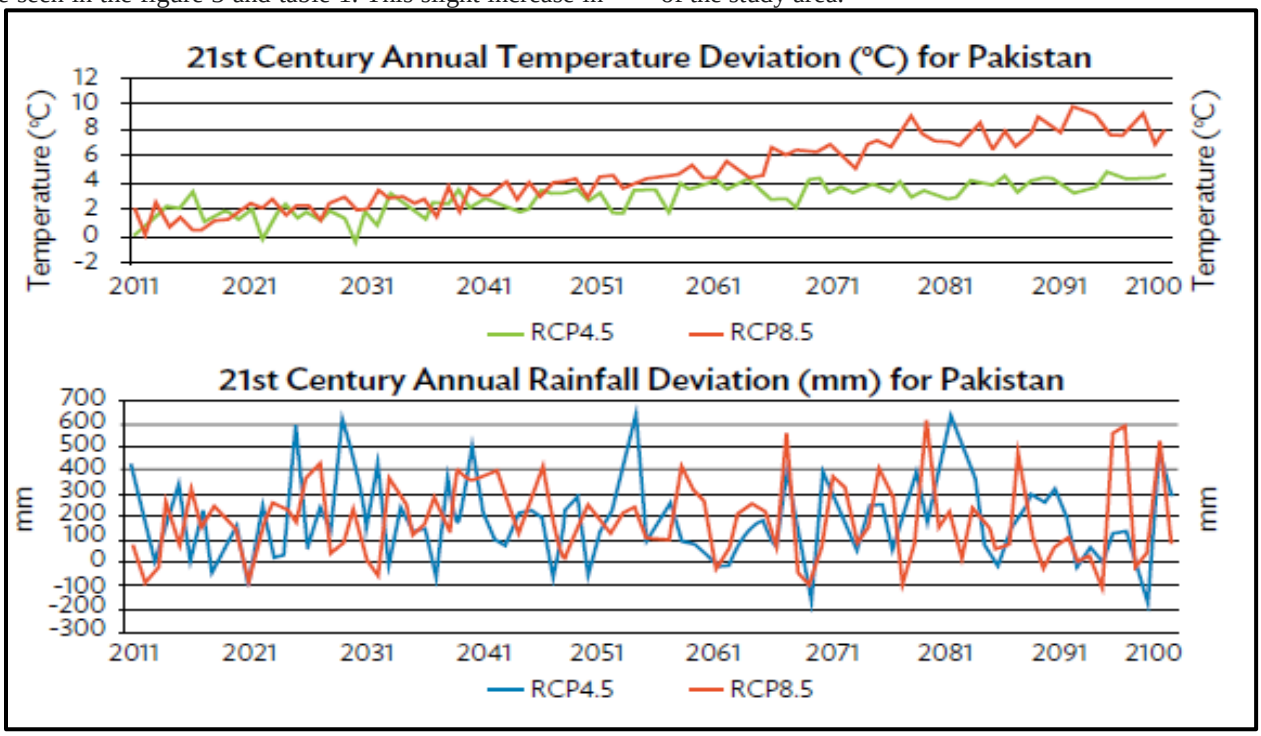

Figure 3: Pakistan temperature and rain fall status and future projection (adapted from Chaudhry, (2017).

Table 1: Rainfall and temperature statistics by Mann-Kendall Test.

Parameters	Mann-Kendall Statistic(S)	Kendall's Tau	P-value	Alpha	Sen's Slope	Trend magnitude
Temperature (Max)	0.524	0.524	<0.0001	0.05	9.801	0.92
Rainfall	0.212	0.212	0.052	0.05	0.561	3.33

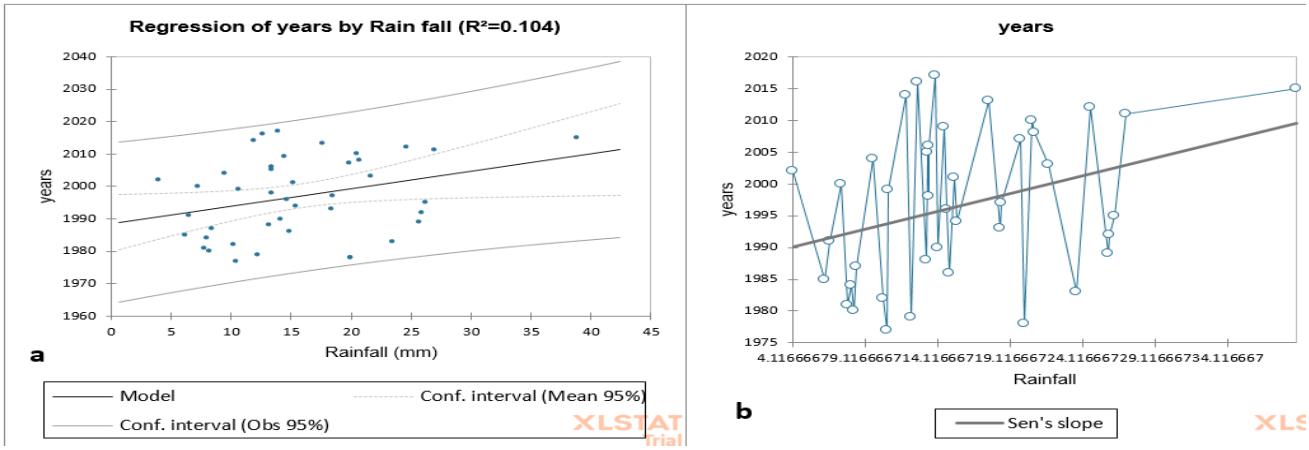

Figure 3: Mean year rainfall of Cholistan desert

By this result it can be suggested that annual rain fall is very less as compared to the rate of evaporation. Which leads to continuous drought condition in this area. Reduced rainfall leads to reduced surface runoff, flow of steam and moisture of the soil, these all factors greatly and badly influence all life form that exist in that particular area. Because plants and animals both needs sufficient water to survive, low rainfall and dried periods that continue whole month or

years turn into the intense drought condition (Marengo *et al*., 2021).

Conclusion: From the current study, it was found that the Cholistan is a hot arid area that is located in the sub-tropical region, with extreme arid and average summer temperature may rise above 50 degrees while the rate of evaporation normally exceeds the rate of precipitation, which leads to extreme drought condition in the desert Cholistan. Statistical analysis, field observation and from the recorded data it was indicated that prolonged droughts and high temperature badly affect the flora and fauna of the area and even human life. But in recent years, very minute increase in the rainfall observed but no significant. However, all these problems can be overcome if, water is made available through a canal system. Based on the current result, it is suggested Cholistan Development Authority and other concerned departments should make an effective strategic plan to decrease the susceptibility of the disaster-prone areas and to overcome the damages caused by meteorological droughts.

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