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CLIMATE CHANGE IMPACT ON CHITRAL BASIN TEMPERATURE AND PRECIPITATION TRENDS

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Abstract-*Climate change emerging from anthropogenic driven outflows of ozone depleting substances has developed as one of the most significant ecological issues over the most recent two decades. One of the most critical potential outcomes of climate change might be modification in local hydrological cycle and stream systems. Long term Precipitation and temperature varieties are one of the fundamental determinants of climate changeability of one's zone. The point of this investigation is to decide patterns variety in climatic components of temperature and precipitation. In this study, main objective was to observed trends of Precipitation and temperature. The long-term pattern of precipitation furthermore, temperature was assessed by straight relapse and Mann–Kendall test. The magnitude of the trend observed by Sen's Slope. It observed that with the passage of time and change of climate the trends of precipitation are going to decrease and very few trends show significant. In addition, for temperature trends are mix of significant and insignificant but there increase of winter temperature and warming observed and decrease of summer temperature and cooling observed.*

Keywords: *Climate Change, Trends, Trend Analysis, Significance, Insignificance, precipitation, Temperature*

I. INTRODUCTION

Pakistan is one of the most powerless landmasses to climate change and climate fluctuation, a circumstance bothered by the connection of 'numerous burdens' happening at different levels, and low versatile limit [1]. It broadly anticipated that as the planet warms, atmosphere and climate changeability would increment. Changes in the recurrence and seriousness of extraordinary atmosphere occasions and in the inconstancy of climate examples will have huge ramifications for human and characteristic frameworks. Expanding frequencies of warmth stress, dry season and flooding occasions anticipated for the remainder of this century, and these are required to have numerous unfriendly impacts well beyond the effects because of changes in mean factors alone [2]. The Inter-Governmental Panel on Climate Change (IPCC) characterizes environmental change as an adjustment in the condition of the atmosphere that can be recognized (for example utilizing measurable tests) by changes in the mean or potentially the inconstancy of its properties and that perseveres for an all-inclusive period, ordinarily decades or longer [3]. Climate changes in extraordinary and atmosphere condition have significant effects that square measure the first genuine difficulties to society [4]. Temperature and precipitation inconstancy is the significant side affecting on atmosphere fluctuation and limits. The unnatural weather change, brought about by the expanding ozone harming substance outflows, has impelled the environmental change marvel everywhere throughout the world [5]. Temperature and precipitation are the two significant climatic factors, which utilized to analyze the effect of atmosphere change in an area [6]. Getting changes or fluctuation in examples and or on the other hand nearness of patterns in precipitation and temperature arrangement over distinctive spatial skylines have been the fundamental angles in climatological, hydrological and meteorological examinations around the world. The power, recurrence, and term of extraordinary temperatures and precipitation occasions in certain territories have changed. The characteristic biological systems also, human exercises, for example, rural creation, woodland development, urban arranging, water assets the board, and human wellbeing, have been influenced [2]. Along these lines, to contemplate the change principle of outrageous temperature and precipitation was step by step getting to be perhaps the most sweltering theme in climate change inquire about.

II. STUDY AREA

Study area is Chitral basin, which consist of three station of Pakistan Meteorological stations named Dir, Drosh and Chitral. The data obtain for analysis consists of Precipitation, Maximum Temperature and Minimum temperature.

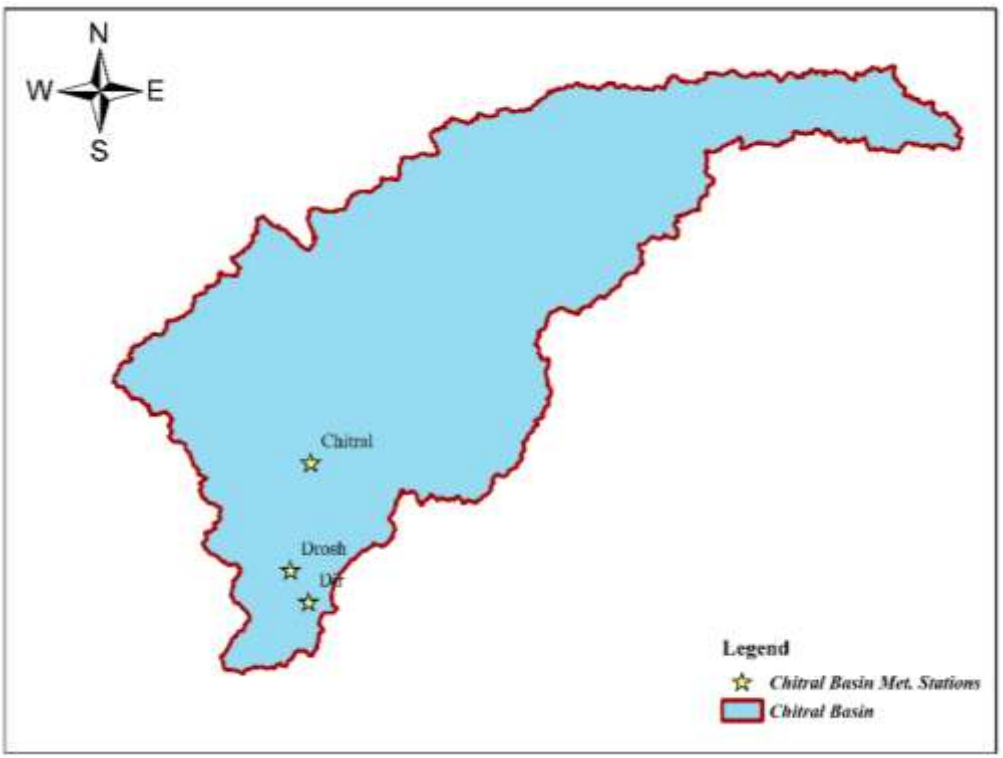

Figure 1. Study Area Plot

III. BACKGROUND

Climate change is pervasive these days as, for example, it has been discovered that Northern side of the equator were exposed to warming air temperatures since most recent 1400 years [1]. Such normal all around warming air temperatures are variable and are not synchronous among various locales [7]. Essentially effects of environmental change contrast extensively, on a neighborhood scale contingent upon presentation, the versatile limit of areas of water, nourishment and vitality security [8]. Additionally, it is the critical need of the day to assess the overall atmosphere state and water accessibility of Upper Indus Basin in light of the fact that the hilly condition is profoundly helpless to environmental change and soften water is chief apparatus for controlling runoff.

It opined that snow spread change has direct connection with summer mean temperatures and consequently results in a high stream. In one of study assessed that neighborhood effects of environmental change contrast impressively relying upon their defenselessness, versatile limit with respect to areas of water, sustenance and vitality security [8]. In perspective on the report conveyed discovered winter warming and summer cooling pattern for a period (1967-2005) [9]. Similarly in another study recommended that mid-year cooling and winter warming patterns are never again pervasive and is evaluated uniquely for Gilgit and Bunji stations for (1980-2009) [10] .Anyway an expansion in precipitation is seen over Chitral, Hindu Kush and Karakoram while a reduction in more prominent Himalayas. A summed up increment in Tmax and Tmin in winter, pre rainstorm by applying diverse measurable apparatuses more than 37 meteorological stations in Pakistan [11]. Additionally in another study contemplated the conceivable effects of climate change on the water assets and Kunhar River Basin, Pakistan. Temperature and precipitation information for a period (2011-2099) were gotten under A2 and B2 situations and examined for future stream stream and decided a general increment of 1.92°C-3.15°C in temperature and 5%-11% in precipitation [12].

Along these lines, there is a need to complete future atmosphere investigation to predict potential perils what's more, at last to create fitting techniques to battle them. As per the fifth appraisal report AR5, "worldwide surface temperature change for the finish of the 21st century is probably going to surpass 1.5ºC in respect to 1850–1900 for all RCP situations with the exception of RCP2.6" [1]. [13] noticed that, over the period 1961–2013, at nearby scale, there is a noteworthy diminishing pattern in precipitation at the station of Soloed (upstream), while an immaterial increment in precipitation is seen in the downstream (Atakpame, Sotouboua, Aklakou and Tabligbo).

Precipitation and temperature are two of the most significant factors in the field of atmosphere sciences and hydrology oftentimes used to follow degree and extent of environmental change and fluctuation [1]. The long haul climatic change identified with changes in precipitation designs, precipitation changeability, and temperature is well on the way to

expand the recurrence of dry spells and floods in Ethiopia. The nation's overwhelming ependence on downpour bolstered and subsistence horticulture expands its powerlessness to the unfavorable impacts of these changes [14]. An examination by [15] called attention to that, however there were intra-yearly and intra-territorial contrasts in sum and inconstancy of precipitation in Amhara district (where the degree of fluctuation is higher in the eastern piece of the locale, geological zone where our examination territory is discovered), no methodical example of progress over the area with respect to patterns in yearly and occasional precipitation was gotten. [16],after dissecting information for longer timeframe in Wollo and Tigray, had closed nonappearance of proof for a long haul pattern or change in the yearly precipitation with the exception of a slight increment in belg precipitation (from 1980s up to 1996) and exceptionally slight decline in kiremt precipitation up to the mid of 1980s at Kombolcha. Another examination in the upper Blue Nile stream bowl by [17] uncovered unimportant diminishing patterns in yearly precipitation at the vast majority of the stations. An investigation by [18] in Northern Ethiopia, which was joined by the view of nearby networks, have stated that little blustery season (belg) has been lost and the principle summer downpours have abbreviated in term.

Different investigations have led to look at the patterns in precipitation and temperature records. Creators in [19] have discovered negative DTR slants in the south Asia. Creators in [20] investigated precipitation variability crosswise over 15 areas of Swat River bowl, Pakistan, over a 51-year study period (1961–2011) and demonstrated a blend of positive (expanding) and negative (diminishing) examples of month to month, regularly, and every year precipitation. In Iran, inclines in outrageous precipitation for the period 1951–2007 have been explored by creators in [21] who discovered a solid upward pattern. Different examinations everywhere throughout the world presumed that the recurrence and force of extraordinary atmosphere occasions are rising. Anyway, the reasons for such peculiarities are most certainly not obviously known at this point yet the effects of various components like El- Nino/La-Nina [22] diverse environmental motions [23], anthropogenic exercises and intergalactic gravitational powers have been broke down. The with respect to temperature, the long-term conduct of precipitation is portrayed by bigger spatial fluctuation, exhibiting a proportionately higher reliance on nearby and territorial factors. For this situation, generally small-scale examination may be basic in useful. The aim of this study to detect trends of temperature and precipitation.

IV. METHODOLOGY

For detecting trends of Precipitation, maximum and minimum temperature statistical trend analysis performed. For this purpose, non-parametric technique is use. The significance ever arrangement of present examination evaluated by utilizing the Mann-Kendall test. It is a nonparametric test, which broadly utilized in hydrological and climatological time arrangement. The World Meteorological Association (WMO) has recommended the Mann-Kendall test for surveying the transient patterns in the time arrangement of ecological information [24].This technique utilized to distinguish the factually critical patterns of long haul information. There are two theories to be tried in the Mann-Kendall test .One theory is the invalid speculation H0 that implies that there is no pattern in concerned time arrangement while the other one is the elective speculation Ha. This elective theory expect that there is noteworthy pattern in the time arrangement.

V. RESULTS

The results obtained by performing trend analysis by using non-parametric Mann-Kendall test. The details of results for Precipitation, maximum temperature and Minimum temperature given below in tables. The results are evaluate on the bases of probability of error, which is ***"p".*** For magnitude slope is use, which known as Sen's Slope, this give the rate of change of precipitation and temperature with respect to time. The trend detected by observing the value of "p" which is less than 0.1. Its mean trend is significant within 10% for all parameters.

5.1 Trends of Precipitation

Performing analysis on data of precipitation for Chitral Basin for more than 20 years observed data. It observed that very few trends are significance and are increasing trends. The trends of precipitation are increasing insignificantly during month of May, June. While it observed that trends are insignificantly decreasing during March and February as shown in table 1.

5.2 Trends of Maximum Temperature

Trends of maximum temperature show insignificance for most of month of the year. Only month of November has significant increasing trend of maximum temperature. For Chitral and Dir there are cooling observed in warming months of the year. Only for Drosh met station April, May and June showed significantly increasing trends of temperature as given in table 2.

Table 1. Trends of Precipitation

Station	M-K Trend Test	Janu	Febr	Marc	Apri	May	June	July	Augu	Sept	Octo	Nove	Dece
Chitral	p-value (Two-tailed)	0.151	0.749	0.462	0.52	0.67	0.132	0.264	0.62	0.229	0.74	**0.085**	0.869
	Sen's slope	0.593	-0.16	-0.538	-0.4	-0.14	0.271	-0.1	-0.029	0.143	-0.039	0.637	-0.05
Dir	p-value (Two-tailed)	0.627	0.723	0.919	0.418	0.68	0.169	0.206	0.312	0.163	0.571	0.116	0.84
	Sen's slope	0.375	0.4	-0.19	-0.663	-0.264	0.432	1.391	-1.037	-0.677	-0.171	0.771	-0.164
Drosh	p-value (Two-tailed)	0.326	0.133	0.921	0.636	0.265	0.602	**0.046**	0.376	0.388	0.842	**0.08**	**0.080**
	Sen's slope	0.218	0.333	-0.027	0.145	0.23	0.04	0.240	0.058	0.055	-0.022	0.359	0.206

Table 2. Trends of Maximum Temperature

Station	M-K Trend Test	Janu	Febr	Marc	Apri	May	June	July	Augu	Sept	Octo	Nove	Dece
Chitral	p-value (Two-tailed)	0.851	0.262	0.721	0.414	0.269	0.24	0.435	0.242	0.871	0.685	**0.048**	0.33
	Sen's slope	0	0.036	0.012	0.036	0.05	-0.029	-0.014	-0.023	0.004	-0.02	0.064	0.033
Dir	p-value (Two-tailed)	0.32	0.339	0.182	0.548	0.177	0.693	0.866	0.792	0.652	0.749	**0.085**	1
	Sen's slope	0.039	0.05	-0.045	-0.031	0.084	0.01	-0.005	0	0.009	0.009	0.051	0
Drosh	p-value (Two-tailed)	0.557	0.947	0.629	**0.053**	**0.074**	**0.055**	0.201	0.399	0.845	0.152	**0.050**	0.609
	Sen's slope	0.01	0	-0.01	0.05	0.063	0.024	0.022	0.014	-0.003	-0.033	0.058	-0.013

5.3 Trends of Minimum Temperature

Minimum temperature trends are significant for most of the months of the year. Only month of May, July, August and February showed insignificant trends, which are decreasing as well. Overall, minimum temperature trends are decreasing significantly. For met station, Drosh only month of November showed significant increasing trends given in table 3.

Table 3. Trends of Minimum Temperature

Station	M-K Trend Test	Jana	Febr	Marc	Apri	May	June	July	Augu	Sept	Octo	Nove	Dece
Chitral	p-value (Two-tailed)	0.986	0.617	0.315	0.268	0.307	**0.055**	0.455	0.178	**0.071**	**0.002**	**0.027**	**0.069**
	Sen's slope	0	0.015	-0.032	-0.026	-0.03	-0.105	-0.029	-0.041	-0.045	-0.063	-0.038	0.045
Dir	p-value (Two-tailed)	**0.066**	0.215	**0.084**	**0.059**	0.153	**0.058**	0.154	0.252	0.144	**0.080**	**0.08**	**0.093**
	Sen's slope	-0.082	-0.035	-0.064	-0.1	-0.049	-0.091	-0.062	-0.064	-0.055	-0.10	-0.051	-0.083
Drosh	p-value (Two-tailed)	0.543	0.499	0.137	0.411	0.71	0.969	0.822	0.642	0.167	0.166	**0.032**	0.733
	Sen's slope	0.008	-0.012	-0.02	0.017	0.007	0	0.003	-0.008	-0.023	-0.024	0.029	-0.009

VI. DISCUSSION

On the bases of analysis perform for Chitral basin Precipitation and temperature trends it observed that there are only few trends are significant for Precipitation and Maximum Temperature. In contrast, Minimum temperature trends are significant for most of month of the year. It is also observed that precipitation is going to reduce and increase observed insignificantly for month of June and July. For temperature trends, it observed that during warming months of the year it is going to decrease and cooling is observed for Maximum Temperature. For Minimum temperature, trends are increasing insignificantly during months of winter. Therefore, it is conclude that winter temperature is going to increase and summer temperature is going to decrease.

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