In broader perspective climate is the major component of the living biota and is the result of intra and inter changes taking place within the spheres of the earth. The climate of any surface is framed out by the variations in the heat and moisture exchange. Hence climate varies both in spatial and temporal aspects. Climate in a narrow sense is usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period ranging from months to thousands or millions of years. The classical period is 30 years, as defined by the World Meteorological Organization (WMO). These quantities are most often surface variables such as temperature, precipitation, and wind. Climate change is one of the serious problems faced by the present day mankind and the consequences are visible in our daily life. The variations and variabilities which take place in the weather conditions of any specific area for a specific time period and hence tend to change the climate type is known as climate change. Climate change has long since ceased to be a scientific curiosity, and is no longer just one of many environmental and regulatory concerns. The climate of the earth’s surface shows fluctuations and is changing both spatially and temporally, the causes of which are source of considerable speculations and controversies.

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INTRODUCTION
Climate in a wider sense is the state, including a statistical description, of the climate system. The climate system is the system with different attributes contributing to the formation of complex and comparative phenomenon known as climate. “The earth’s climate system is extremely complex and the mechanism of climatic processes are not yet completely understood” (Rampino et al.,). An integrated environment is produced by continuous interchanging of energy and matter among the spheres of earth and one sphere cannot be studied individually without reference to others. Spatial analysis of weather phenomenon is the science of climatology that seeks to describe and explain the nature of climate, it’s spatio-temporal aspect; it’s relation with other elements of natural environment and human activities. Climate plays a dominant role in the sustenance of biosphere. Cyclic movement of nutrients along with ecological balances prevail at various stages in the biosphere are governed by the climate of the place, which is having different range of variations. Climate hence determines the nature of ecology. All related components of the climate including temperature, moisture, sunlight, precipitation affect the various aspects such as occurrence, distribution, productivity and growth of flora and fauna. Besides this range of climatic factors encompass wider centripet al., and centrifugal forces of bio-geo-chemical cycles. Present paper is concerned with the dimensions of climatic change in spatio-temporal context in the Republic of Turkmenistan. The paper focuses on spatio-temporal analysis of climatic change in the Republic and accordingly planners and scientists shall be forecasting their observations for future climate of the country.

Database
As the nature of problem is highly technical and requires a data about temperature and precipitation and it was not possible to have measurement for such complex things individually. Hence the data was collected from various weather stations situated in various regions of the Turkmenistan. This data was supported by satellite data. Most of the data was obtained from different sources like journals, magazines, World Bank reports, statistical digests published by the government of Turkmenistan. The data of various departments associated with the Ministry of Nature Protection of Turkmenistan especially Ministry of Water Management, Institute of Land Management, State Committee of Statistics of Turkmenistan and National Institute of Desert Flora and Fauna was also taken into consideration for the analysis.

Methodology
Data was collected, tabulated and analyzed and results were inferred through relevant statistical and other techniques. The obtained results are highlighted through cartographic techniques. Changes in temperature and precipitation and for assessing their trends, regression and time series analysis method was taken into consideration. For further analysis of temperature and precipitation line of Best Fit Model was applied.

RESULTS AND DISCUSSION
Observed Temperature Changes
Temperature data collected from the twelve weather stations of the Republic of Turkmenistan were analyzed. The stations are located in different Velayats with different latitudinal and
longitudinal extents. The comparison was made between average temperatures for about 30 year’s i.e. from 1980-2010. From this data it was observed that the three decade temperature has shown increasing trend with some fluctuations. The temperature from 1980-2010 has shown an average increase of 1\(^{\circ}\)C.

**Table 1** Temperature trends in Turkmenistan from (1980-2010)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>15.3</td>
<td>15.6</td>
<td>15.8</td>
<td>15.9</td>
<td>16.1</td>
<td>16.2</td>
<td>16.3</td>
</tr>
</tbody>
</table>

**Source:** Calculated and compiled by the Researchers

The temperature regimes also vary from east to west. The eastern parts and the foothills of Turkmenistan has shown increase of 0.3\(^{\circ}\)C while as the western parts has shown the 0.4\(^{\circ}\)C increase in temperature. Temperature above 40\(^{\circ}\)C was observed at some stations which include Ashgabat, Serdr and Takhtabazar. The data also shows that the year 1995 was the hottest in the three decades with a temperature of 16.8\(^{\circ}\)C while as the year 1985 was the year of lowest temperature with the temperature of 14.9\(^{\circ}\)C. Upon the results of the work done it may be concluded that the quantity of days with higher temperatures have increased. Although the increasing trend was uniform but year 1985 has shown an abrupt decrease in temperature while as year 1990 has shown abrupt increase in temperature. The overall temperature regime of the Republic of Turkmenistan is confusing owing to its latitudinal extent. The Siberian anticyclone and the changes in Arabian Sea are responsible for the fluctuation taking place in the temperature. Thus it rejects the idea that the climate of Turkmenistan is more or less constant. The present works has revealed that the temperature is showing increasing trend due to the increase in the carbon content and other green house gases in the atmosphere of Turkmenistan.

**Trend Analysis of the temperature data in Turkmenistan**

<table>
<thead>
<tr>
<th>Year (x)</th>
<th>Temperature (y)</th>
<th>X = (x - 1995)</th>
<th>X²</th>
<th>XY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>15.3</td>
<td>-15</td>
<td>225</td>
<td>-229.5</td>
</tr>
<tr>
<td>1985</td>
<td>15.6</td>
<td>-10</td>
<td>100</td>
<td>-156</td>
</tr>
<tr>
<td>1990</td>
<td>15.8</td>
<td>-5</td>
<td>25</td>
<td>-79</td>
</tr>
<tr>
<td>1995</td>
<td>15.9</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>16.1</td>
<td>15</td>
<td>225</td>
<td>337.5</td>
</tr>
<tr>
<td>2005</td>
<td>16.2</td>
<td>20</td>
<td>400</td>
<td>324</td>
</tr>
<tr>
<td>2010</td>
<td>16.3</td>
<td>25</td>
<td>625</td>
<td>412.5</td>
</tr>
</tbody>
</table>

Total \(\sum x = 111.2\) \(\sum y = 0\) \(\sum xy = 700\) \(\sum x^2 = 225\)

Let the linear trend equation be

\[Y_t = a + bx\]

Subjected to the given normal equation

\[\sum Y = N a + b \sum X\]
\[\sum XY = a \sum X + b \sum X^2\]

Sub. All the above calculated value in

111.2 = 7a + 0.0b ... (2)
22.5 = 0.0a + 700 b ... (3)

From eq. (2), we get

111.2 = 7a
A = 111.2
A = 15.8
From eq. (3),
22.5 = 700b
b = 22.5
700
b = 0.03

Sub. The value of a and b in eq. (1), we get

\[Y_t = 15.8 + 0.03X\]

Now, Computation of trend value of

\[Y_{2050} = 15.8 + 0.03X\]

<table>
<thead>
<tr>
<th>Year</th>
<th>X</th>
<th>(Y_t = 15.8 + 0.03X)</th>
<th>(Y_t) (Trend values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>-15</td>
<td>15.8 + 0.03(-15)</td>
<td>15.35</td>
</tr>
<tr>
<td>1985</td>
<td>-10</td>
<td>15.8 + 0.03(-10)</td>
<td>15.5</td>
</tr>
<tr>
<td>1990</td>
<td>-5</td>
<td>15.8 + 0.03(-5)</td>
<td>15.65</td>
</tr>
<tr>
<td>1995</td>
<td>0</td>
<td>15.8 + 0.03(0)</td>
<td>15.8</td>
</tr>
<tr>
<td>2000</td>
<td>+5</td>
<td>15.8+0.03(5)</td>
<td>15.95</td>
</tr>
<tr>
<td>2005</td>
<td>+10</td>
<td>15.8+0.03(10)</td>
<td>16.1</td>
</tr>
<tr>
<td>2010</td>
<td>+15</td>
<td>15.8+0.03(15)</td>
<td>16.25</td>
</tr>
</tbody>
</table>

From the graph, we notice that the temperature for the year 2050 could be (38.2)\(^{\circ}\)C. Also from the trend lines

\[Y_{2050} = 15.8 + 0.03 (220)\]
\[Y_{2050} = 15.8 + 22.4\]
\[Y_{2050} = 38.2 \, {^\circ}C\]

**Observed Precipitation Changes**

The precipitation data was collected from the twelve stations of Turkmenistan was analyzed and the mean precipitation trends were calculated for a period of 30 years i.e. from 1980-2010. Year wise data of precipitation was computed and average mean of five years was also calculated. The analyzed and computed data reveals that the fluctuations have occurred in the precipitation scenario. During the thirty years period there has been increase in winter precipitation in the northern parts of the country including foothill areas of Kopetdag Mountains.

**Table 2** Precipitation Trends In Turkmenistan (1980-2010)

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Precipitation (mm)</td>
<td>170</td>
<td>140</td>
<td>145</td>
<td>110</td>
<td>104</td>
<td>114</td>
<td>120</td>
</tr>
</tbody>
</table>

**Source:** Computed and compiled by the researchers

Decrease in precipitation during summer months was observed in whole territory of Turkmenistan increase in precipitation was observed by many stations in the northern and western parts while as other stations have shown decreasing trend. From the table 2 showing precipitation trends in the Republic of Turkmenistan for the period of 30 years (1980-2010) it should be pointed out that the precipitation has shown fluctuations but on an average the decreasing trend in precipitation regime has occurred due to which some areas of the country has been hit by severe droughts which has put its impact on the crop production and on other ecological balance especially biodiversity. The average lowest precipitation (104mm) was observed in the year 2000. While as highest average precipitation (170mm) was recorded in 1980. This show how there has been decrease in precipitation in these two decades.
CONCLUSION

Dimensions of climate change in Turkmenistan has been carried out in a comparative methodological framework and following observations has been deduced. Observed temperature changes have almost recorded an increasing trend with some minor fluctuations while as precipitation has shown a decreasing trend. Line of best fit model reveals that increasing temperature and decreasing precipitation is a matter of concern for the territory. So need of the hour is that there must be curb on carbon emission and other Green house gases(GHG) so that the territory of Turkmenistan can be saved from ill effects of climate change.

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