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Statistical and Comparative Analysis of Temperature and Rain in Fergana

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Abstract. The article provides a comparative analysis of the calculated results of air temperature and precipitation values and amounts for different climatic periods for 1934-2020, according to the Fergana meteorological station. The linear trends of perennial average air temperature are positive for selected periods, the highest average annual air temperature was observed in the last 5 years, corresponding to winter months, + 0.7°C in the main climatic period, annual temperature +1 in the following period , Increased by 9°C and in summer by + 0.7°C and + 1.4°C, respectively, winter temperature rose more than summer temperature, linear trend of winter, spring and summer precipitation was positive, linear trend of autumn precipitation while it was found to be negative in appearance.
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Keywords: Fergana Valley, temperature, precipitation, statistical analysis, base climate, current climate.

Introduction

It is known that the global warming is faster than expected.. According to the research of the International Climatologists, heat anomalies in Central Asia have worsened over the past 20 years. January this year was the hottest month in the last 140 years.In January, the temperature was +1.14 degrees higher than the average temperature of twentieth century.In the last five years, the four warmest Januaries documented in the climate record have occurred. In the early February of this year, the +20-degree temperature has been recorded for the first time. After several observations, it has been identified that the last seventeen warmest years have been occurring in this century [1,2]. Especially, the temperature change in the previous three years is completely different from other years. In such circumstances, climatic anomalies can cause uncomfortable agroclimatic conditions.

According to the World Meteorological Organization, every year at least one billion people have to adapt to the severe climatic conditions in agriculture, livestock and farming due to the 1°C increase of the average annual air temperature of the World [1,4]. It should be noted that the modern climate period is much different from the previous ones.The current trend of climate change is also especially important because of the fact that the air temperature rises very fast.In recent decades, the development of industry, intensification of agricultural production and the population increase in Central Asian countries has caused many regional environmental problems [7].Accordingly, the study of the climate of individual regions and the assessment of changes in them remains an urgent problem.

Goal and objectives of this work.

The purpose of this studyis to determine the trend of changes in air temperature and precipitation over time.To achieve the objectives of the study, the following tasks were set:

- calculation of the statistical characteristics of the temperature and precipitation;
- analysis and comparison of the data and graphs according to the average monthly, average annual, average summer and winter air temperatures; annual October-March, April-September and winter precipitation rates.

Main part

The Fergana Valley, in particular, the Fergana region, has long been suitable place for living not only in our country, but also in Central Asia in terms of natural and climatic conditions.The northern part of the Fergana region is formed by the Karakalpak and Yazyavan deserts, the hills in the south and the foothills of the Alay and Turkestan ridges, including the spread of rivers flowing from the Alay ridge.Fergana region is a high seismic zone.

The climate is continental. Winters are mild, sometimes very cold.The average air temperature in January is -3.2°C, and in July +28°C. The lowest temperature is 27.9°C. The maximum temperature is +42 ° C.Strong "Kokand wind" blowing in the west of the valley has a negative impact on the climate. The wind speed is sometimes 35-40 meters per second. In the south-east part of the region, the hot summer wind, which is harmful to crops, blows. Annual precipitation ranges from 100 mm in the west (around Kokand) to 170 mm in the east and up to 270 mm on the mountain slopes; The rain falls mainly in the spring.

It is known that in the context of recent global climate change, various levels of geoecological problems are emerging. Such problems require the study of the natural and climatic potential of the regions, the elimination of adverse meteorological processes and their negative consequences, the preservation of a favorable natural environment for the regions. In Uzbekistan, especially in the Fergana region, the researchers have collected tons of scientific and practical experience in the study of such problems in order to provide sufficient recommendations for the national economy.In particular, in the sources described on the basis of Agrometeorological researches under the direction of Ya.N. Babushkin, A.A.Abdullaev, B.A. Kamolov, V.E. Chub, D.A. Ivanova, N.S. Kopovalova, O.N.Reyzvix and Hydrometeorological researches of F.A. Muminov, F.H. Hikmatov directly studied hydroclimatic features of Fergana valley [8].

Today, however, it is very important to determine the consequences of rising air temperatures and draw appropriate practical conclusions from it, which at the same time requires serious hydrometeorological research.

This article used data from the Fergana Meteorological Station for a comparative analysis of air temperature and its fluctuations in the city of Fergana and adjacent areasfor the period from 1934 to 2020. At the same time, long-term data on average monthly air temperature and precipitation were obtained on the basis of materials of meteorological tables TM-1 and TM-8.

Based on the meteorological station data reviewed, the average annual, average monthly, average summer, and winter temperatures were analyzed.According to the data, the linear trends of annual (1934-2020) average air temperature are mainly positive for the selected periods (Figure 1).

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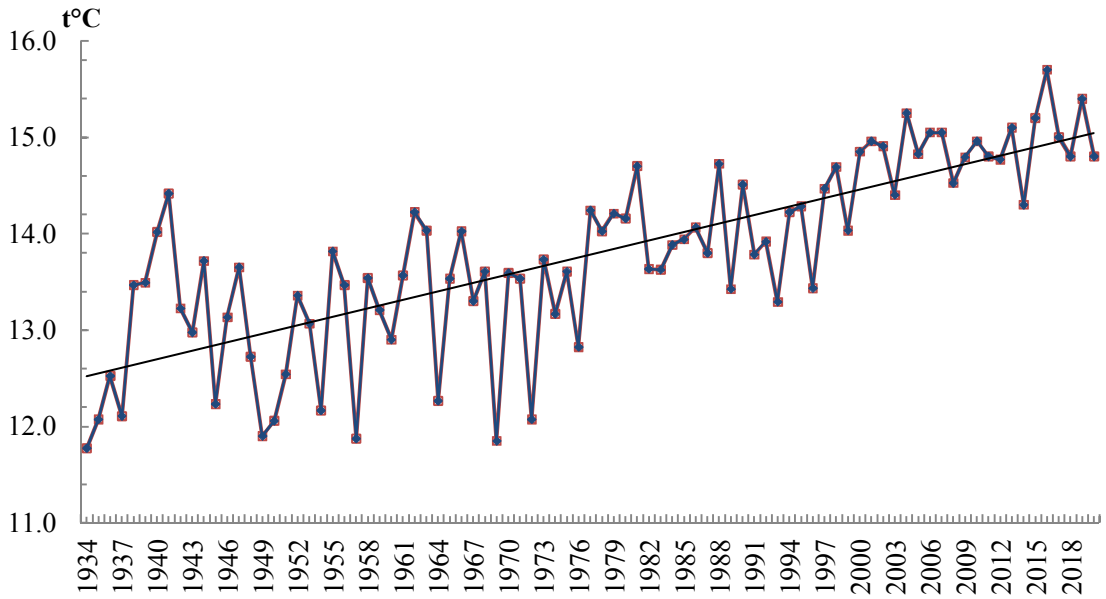

Figure 1. Annual average air temperature change

The lowest average air temperatures were recorded in 1934, 1937, 1945, 1949, 1954, 1969, and 1974. The lowest average annual air temperature was 11.8°C. The highest annual average temperatures were recorded in 2001, 2007, 2010, 2013, 2015, 2016, and 2019. The highest average annual air temperature was 15.7° C, which has been observed in the last 5 years.

All elements of the average monthly temperature norms, the average (Fig. 2), the lowest and highest values, without exception, correspond to July for all considered observation years (Table 1).

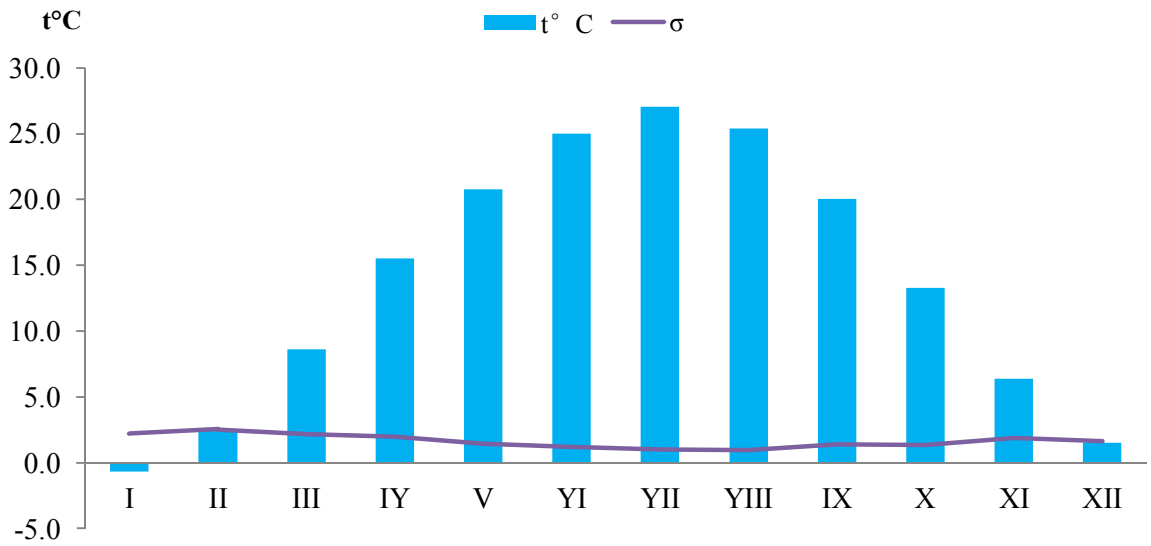

Figure 2. Year-round distribution of average monthly temperature

Table 1
Statistical characteristics of air temperature
(Data of Fergana meteorological station, 1934-2020 years)

Months	Min	Average	Max	σ
January	-7,4	-0,7	7,1	2,2
February	-8,9	2,4	15,6	2,5
March	1,8	8,6	21,1	2,2
April	-0,9	15,5	26,6	1,98
May	15,6	20,8	25,3	1,43
June	19,9	25,0	28,3	1,21
July	24,9	27,1	29,7	0,99
August	22,3	25,4	28,6	0,95
September	13,4	20,1	25,8	1,42
October	9,0	13,3	21,5	1,35
November	-1,6	6,4	13,1	1,90
December	-5,4	1,5	7,3	1,65
Annual (average)	11,8	13,8	15,7	0,77
Summer	23,7	25,8	28,0	0,76
Winter	-3,8	1,1	4,9	1,41

Note: σis the average quadratic deviation

It is known that years from 1961 to 1990 is the basic climatic period defined by the World Meteorological Organization[4,5]. Therefore, the temperature indices for the base climate period were compared with the indices for the period from the beginning of the observation period to 1960 and from 1991 to the end of the observation period (current climate period).The results of the calculations are given in Table 2. The table shows that the average annual temperature in the base climate period was + 0,8°C higher than in the pre-1960 period, and + 1.8°C higher in the 1990-2020 period. The average annual air temperature in the current climatic period is 1°C higher than in the base climatic period.

Table 2. **Basic indicators of average annual air temperature for different climatic periods**

Period	Year	Winter	Summer
1934-1960	12,9	0,2	25,1
1961-1990	13,7	0,9	25,8
1990-2020	14,7	2,1	26,5

For the winter months, the air temperature in the main climate period increased by + 0,7°C, for the following period the annual air temperature increased by + 1,9°C, and in the summer by + 0,7°C and + 1,4°C, respectively.It should be noted that winter temperatures have risen more than summer temperatures. This is also indicated in the studies of B.K. Tsarev[1,5]. He noted that winter temperatures rise three times faster than summer temperatures.

The results of precipitation observations of the Fergana meteorological station for 1934-2020 have been also analyzed. A chronological graph of the average annual rainfall has been plotted (Figure 3).The trend line indicator on the chart is 0,16 mm / year, which represents an increase of 16 mm per 100 years. The highest annual precipitation values in the observed period were recorded in 1949, 1950, 1969, 1987, 1993 and 2003. The highest average annual rainfallwas 405,0 mm (1969).

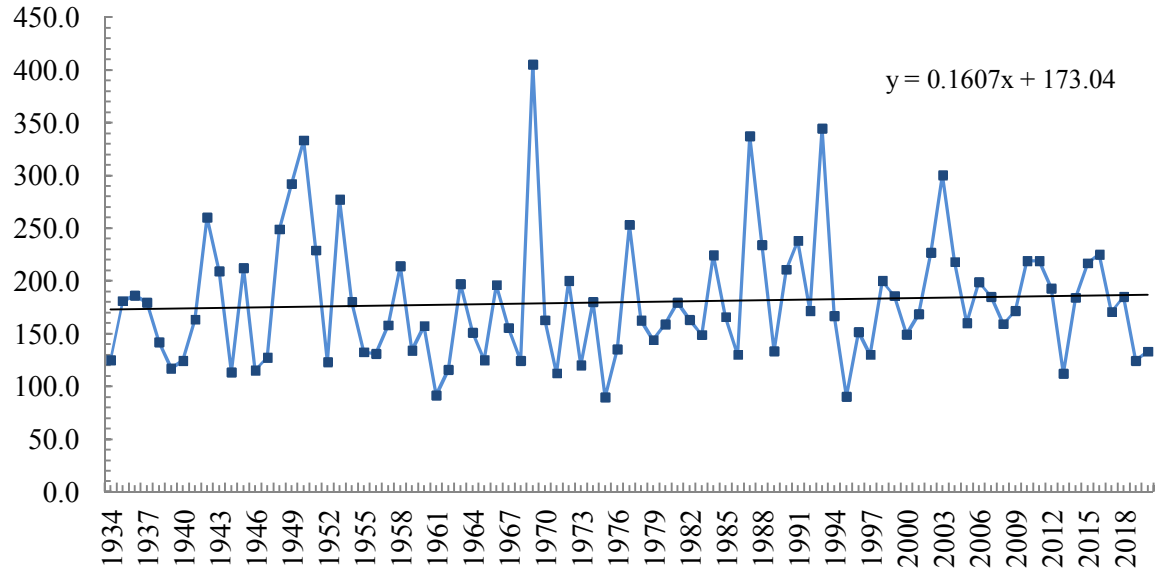

Figure 3. Chronological graph of annual precipitation, *X, mm*

According to research, the most important climatic features include the amount of precipitation in the cold period (October-March) [3]. For the analysis, statistical indicators of atmospheric precipitation were calculated for all months, seasons, and cold and hot periods (Table 3).

Table 3. **Statistical indicators of precipitation**

Months	Min	Average	Max	σ
January	1	17,6	71,7	10,7
February	0,2	21	72,4	12,2
March	0,1	25,7	76	13,5
April	0,2	21,3	85,6	12,8
May	0	20,4	86,7	14,2
June	0	10	46	7,76
July	0	5,4	53	5,32
August	0	3,9	52	5,16
September	0	3,7	28,1	4,41
October	0	15,1	136	13,6
November	0	17,5	108	13,8
December	0	18,4	77	13,6
Yearly	89,5	180,1	405	120,1
October-March	52,7	115,3	249,8	34,41
April-September	16,1	64,8	216	29,72
Winter	6,6	38,6	111	17,7
Spring	18	67,5	208	27,3
Summer	0	19,3	79,3	13,35
Autumn	0	36,3	158,1	21,5

According to Table 3, the lowest rainfall was observed mainly in May-December, and the highest rainfall was observed in October-November. The average precipitation in the cold period is 115,3 mm, the minimum is 52,7 mm, the maximum is 249,8 mm. And, for the warm period (April-September), the average precipitation is 64,8 mm, the minimum is 16,1 mm, and the maximum is 216,0 mm. In the analysis, chronological graphs of precipitation in cold and warm periods and seasons were drawn and their linear trend was calculated (Figures 4, 5 and 6). Analysis of the results showed that the linear trend of winter, spring and summer precipitation is positive, while the linear trend of autumn precipitation is negative.

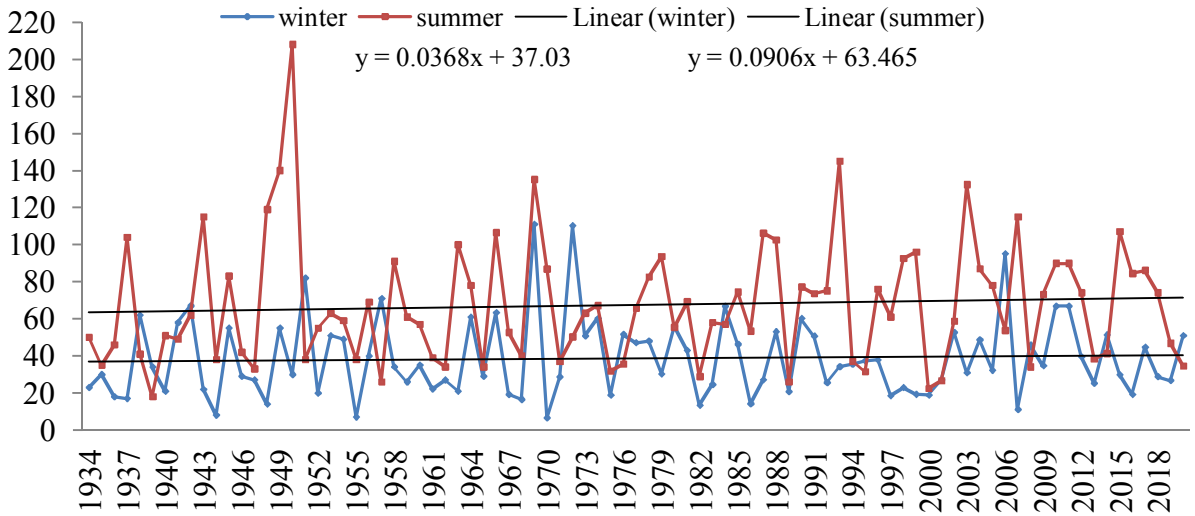

Figure 4. Chronological graph of winter and summer precipitation, *X, mm*

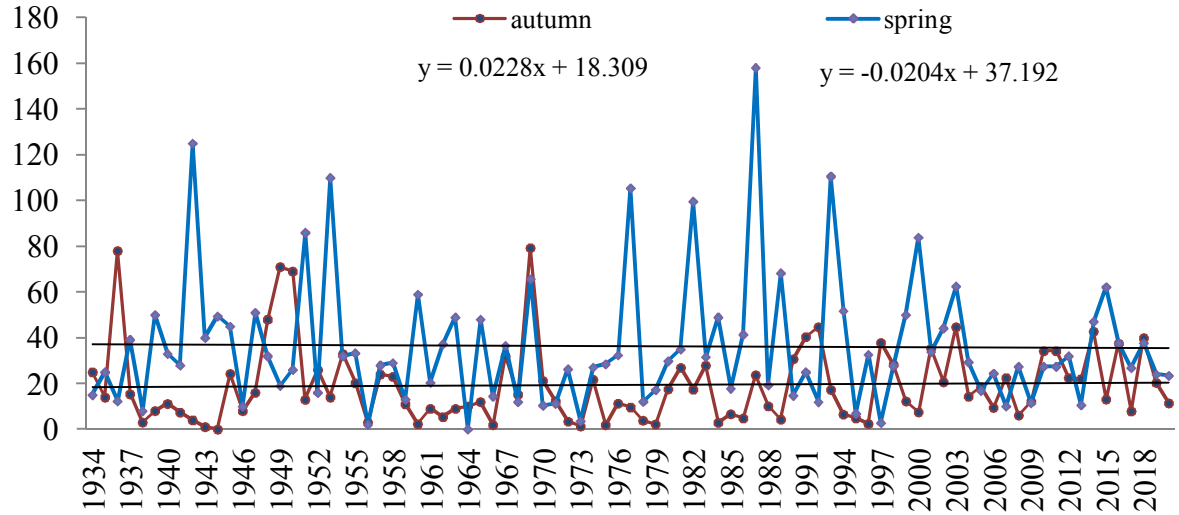

Figure 5. Chronological graph of autumn and spring precipitation, *X, mm*

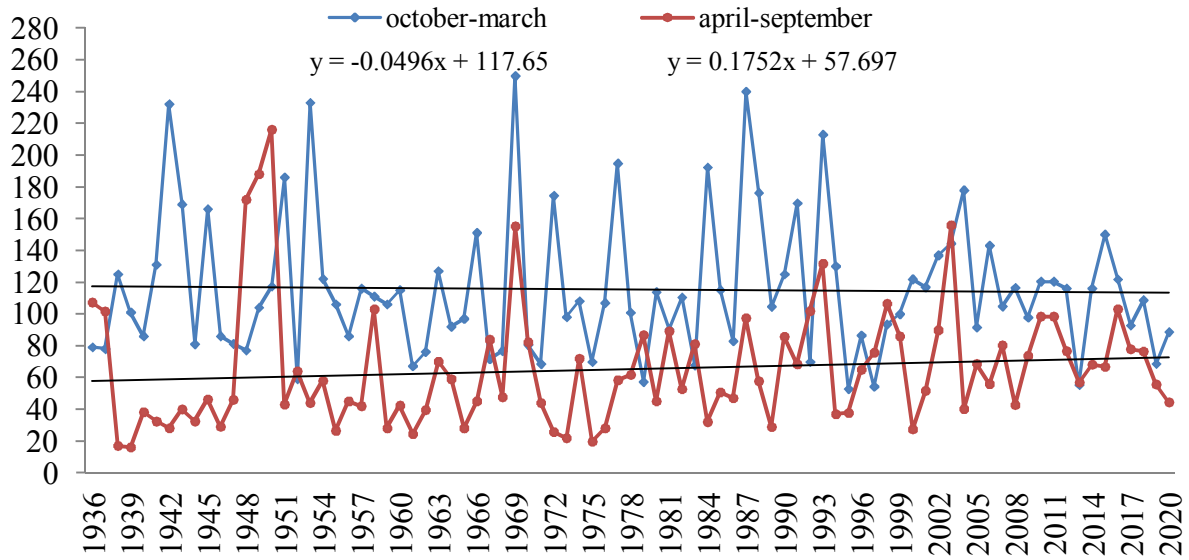

Figure 6. Chronological graph of precipitation in cold and warm periods, *X, mm*

They are for winter (XII-II): y = 0,0368x + 37,03; in spring (III-V): y = -0,0204x + 37,192; in summer (VI-VIII): y = 0,0906x + 63,465; in autumn (IX-XI): y = 0,0228x + 18,309; year: y = 0,0134x + 14,42. The trend in precipitation is greater in winter and summer, smaller in autumn, and negative in spring. That is, 0,03–0,09 mm / y in winter and summer, 0,023 mm / y in autumn, - -0,0204 mm / y in spring, and close to 0,0134 mm per year. This is due to the fact that the current air temperature is rising.

In the cold period (October-March) the linear trend of precipitation (y = -0,0496x + 117,65) is negative, and in the warm period (y = 0,1752x + 57,69) it is positive (Figure 6). The trend for the whole year is positive.

In addition to the above analyzes, changes in atmospheric precipitation over different climatic periods were also considered. The calculation results are shown in Table 4.

Table 4. **Key indicators of average perennial precipitation for different climatic periods**

Period	Yearly	Winter	Summer
1934-1960	180,2	55,0	21,2
1961-1990	173,5	59,5	15,3
1990-2020	186,6	57,8	21,1

Table 4 shows that in the base climate period (1961-1990) the average perennial precipitation decreased by 6,7 mm compared to the previous period, while in the current climate period it increased by 13,1 mm.During the winter, the base climate increased by 4,5 mm compared to the previous period, while the current climate decreased by 1,71 mm. In summer, the average precipitation decreased by 5,9 mm compared to the previous period during the base climate period and increased by 5,8 mm during the current climate period.

Conclusions

The study came to the following main conclusions:

- linear trends of average perennial, average monthly, average summer and winter temperatures have a positive outlook for the selected periods;
- the average, minimum and maximum values of the average monthly temperature for the observation years is July;
- the average annual air temperature in the current climatic period, increased by 1 ° C compared to the base climatic period;

- the lowest precipitation was observed mainly in May-December, the highest precipitation was observed in October-November;

- The trend in the amount of precipitation is greater in winter and summer, smaller in autumn, and negative in spring.

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