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*CHANGE DYNAMICS OF AIR TEMPERATURE AND ATMOSPHERIC RAIN IN ALIBAY AND ZAGATALA
TERRITORY OF AZERBAIJAN*

Aim: the main aim of the study is exploration of change dynamics of air temperature and atmospheric rain in Alibey and Zagatala territory of Azerbaijan. In the article, the author used the data for 1961-2019 to study possible climatic changes in Alibey and Zagatala on the basis of instrumental observations, as well as studied the specifics of the timing of the distribution of key parameters. One of the most serious problems of humanity today is global climate change. Therefore, the study of the temporal temperature and sediments in the current period is one of the current tasks. Temperature fluctuations and the number of sediments directly affect the stock river and, in general, the hydrological regime. The work analyzes the periodic flow of air temperature and atmospheric sediments. Averaged monthly values of temperature and sediments for decades.

Methodology: Data from 1961-1990 were used to calculate the “norms” based on WTO recommendations. The data of Alibey (absolute height 1540 meters) and Zagatala (absolute height 487 meters) meteorological stations of the former Hydrometeorological Committee and the current National Hydrometeorology Department were used to conduct these analyzes.

Results: Calculated the mean square deviations of air temperature and determined large anomalies (1.5σ). For the considered seasons, years were found with a shortage of sediments and with abundant sediments. It has been established that in the last decade the number of positive temperature anomalies has increased. Sustaining the trend towards warming, with insignificant cooling in the last decade, as well as the absence of significant changes in the regime of sediments. It was found that the world community is seriously concerned about the number of natural disasters, huge losses caused by droughts and fires, which are the result of changes occurring in the surrounding area. It is stated that this fact testifies to the sharp trend of increasing the aridization of the territory, although the observed increase in air temperature is not accompanied by the corresponding increase in atmospheric sediments. The conclusion is that the effective means of preventing the consequences of climate change will be the creation and strengthening of the system of forecasting poverty and climatic services.

Scientific novelty: The increase of air temperature is significantly to cause some early melting of the soil, resulting in an increase in water losses during spring floods

Key words: air temperature, sediments, climate change, Greater Caucasus, deficit of sediments, norm, anomalies.

Introduction. Recent decades have seen global and regional warming. There is also an increase in surface air in Alibey and Zagatala. Climate change affects many natural processes, including the hydrological regime of rivers. Therefore, it is important to identify these changes and assess the extent to which they are caused by climatic features such as temperature and precipitation. [1].

Depending on the geographical location of the area, solar radiation, complex relief in the middle and high mountainous areas, air circulation processes typical of mountainous regions play an important role in the background of the large-scale impact of general air circulation. The lower part of the area has a temperate-warm semi-desert and steppe climate with dry winters, the foothills have a moderate distribution of precipitation and a temperate warm climate with dry winters, and the upper part has a cold climate with humid winters. Local conditions determine the instability of meteorological prices, which affects many sectors of the economy, especially agriculture, resorts, etc. affects. Knowing their change trends allows you to choose the optimal strategy for operational work and reduce losses associated with dangerous temperature changes and lack or excess of precipitation. In the last decade, the problem of climate change has been widely discussed in the world scientific literature, both for individual regions and for the entire globe.

The topography of the earth's surface plays an important role in the distribution of precipitation. The nature of the change in the amount of precipitation depending on the altitude, as is known, has certain regularities, and depends on the exposure of these slopes to the frontal parts, the exposure of the slopes, the steepness of the slopes, etc. depends [3, 7].

Radiation and circulation conditions are the main factors determining the temperature regime, type and movement of air masses, development of frontal processes and atmospheric precipitation for the formation of the climate of a certain area. At the same time, the effect of atmospheric circulation, which

manifests itself in the complex alternation of cold and hot air masses, their interaction in different seasons, is important.

As you know, thermal energy is the basis of all atmospheric processes, and therefore air temperature is one of the most important elements of air and climate. The thermal regime of the air is formed under the influence of both macro-scale and local factors. Macro-scale factors include atmospheric circulation, radiation regime and the nature of the surface cover, latitude of the defined area, degree of continentality and macrorelief. In addition, local conditions also affect the heating regime: meso and microrelief, the nature of vegetation and soils, the proximity of water bodies, etc. This leads to a complex picture of the spatial distribution of temperature. These factors also cause differences in temperature conditions in Azerbaijan [2, 7].

Zagatala (absolute height 487 meters), Alibey (absolute height 1540 meters) is located on the southern slope of the Greater Caucasus in Azerbaijan. There are 4 climate types in Zagatala. It is temperate and semi-humid in the plains and foothills, cold and humid in the highlands. 65% of the region has a subtropical climate. The climate is temperate in the plains and cold in the mountains. The duration of snow cover is 30-50 days in Alibey and 28-45 days in Zagatala. The average gradient of snow cover height change every 100 meters is 1.5-2 cm at 400-500 m, 4-6 cm at 2000-3500 m, and 7-8 cm in the protected area. The number of days covered with snow is 85 days in Zagatala, 155 days and more as the altitude increases, 50-55 days in Alibey, and 220 days and more as the altitude increases. The average height of snow cover in Zagatala is 5-10 cm, the maximum height is 45-48 cm, in Alibey the decade is 6-12 cm, the maximum height is 55-60 cm. The amount of solar radiation increases with altitude and is 105-125 kcal cm² / year in Alibey and 127-142 kcal cm² / year in Zagatala. The average duration of sunny hours is 2000-2300 hours in Alibey and 1950-2100 hours in Zagatala. 42% of sunny hours fall in the summer months. 124 kcal of solar radiation falls on 1 square centimeter of the earth's surface per year. The cost of total radiation in Alibey is 125-135 kcal / cm², and the cost of radiation balance is 35-45 kcal / cm². The active temperature fluctuates between 3200 and 40,000 in total. The frost-free period is 245-270 days.

The air temperature decreases with increasing altitude. The average annual temperature is 0-13 ° C depending on the altitude (13.6 ° C according to Zagatala meteorological station), the average monthly temperature in January is 2.4 ° C, in the plains -1 ° C, in the mountains -10 ° C, the average monthly temperature in July is 37.4 ° C, +24 ° C in the plains and +5 ° C in the mountains. According to the Zagatala meteorological station, the absolute maximum temperature is 38 ° C, the absolute minimum is -17.3 ° C. Frosts fall early in the area. The average date of the first autumn frost in the middle mountain falls in the second decade of October, and the average date of the last spring frost in the third decade of April. In some years, the last spring frost occurs in early May. The average annual temperature in Alibey is above 6.5 degrees. Temperatures above 10 degrees are between 2800-3600 degrees. The average annual price is 6-7 degrees, January - 2.6 degrees, July - 16-17.3 degrees. The maximum temperature in Zagatala is usually observed in July and can reach + 38 degrees. The annual amount of evaporation is 824 mm. The annual rainfall in Zagatala is 950 mm, and in Alibey 1000-1500 mm. Rainfall falls mainly during the warm period of the year, especially in May-July.

During the hot period of the year, hail from dangerous atmospheric phenomena mainly depends on unstable air masses during meridian circulation and local orographic factors. According to the Alibey meteorological station, the number of hail days is on average 10, maximum 14 days per year, and according to the Zagatala meteorological station, the number of hail days is on average 4 (1000-2000 m), (2300-2700 m) maximum 8 days, mostly in May-June. The probable number of foggy days during the year reaches 161 days in Alibey, 70 in Zagatala, and 100 at an altitude of 1300-1400 m. Although fog is observed in all seasons of the year, most of it is observed in the cold period of the year. Mountain-valley winds prevail in Zagatala. North-east (44%) and north (11%) are more common. According to the Zagatala meteorological station, the average annual wind speed is 1.2 m / s, often with winds of 15 m / s and more. In summer, local winds are formed in Alibey. This is due to the pressure difference between the mountain and the valley. Perennial winds are northwest (31.1%), south (16.1%), north (34.2%), north (40.9%), northwest (45.5%) and relatively south-east (6.7%), south (26.3%), north (23.7%), north-west (31.6%) in spring, south (22.5%), south-east (10%) in summer, north (32.5%), north-west (17.5%), and in autumn, north (38.5%), south (15.3%), north-west (28.2%) winds are more frequent. According to the Alibey meteorological station, the average annual wind speed is 1.4 m / s, the maximum speed is 40 m / s.

Description of the problem. On a global scale, the frequency of recurrence of extreme values of climate elements has begun to increase. Such cases have manifested themselves in recent decades due to the rapid increase in air temperature, drought processes accompanied by high temperatures and the expansion of forest fires in various countries, and so on. began to manifest itself in the form of [6]. Thus,

studies show that starting from 1980-1982, the main climatic indicators are temperature, precipitation, wind, etc. There are changes in the annual dynamics of factors, and this change has become more characteristic since 1990. In Alibey and Zagatala, the impact of global climate change on the regional side in recent years is fully manifested. Thus, studies show that after about 1990 there are more characteristic changes in the annual dynamics of key climate indicators, and also the frequency of repetition of extreme values of climate elements has begun to increase.

Information and methods. Data from 1961-2019 were used to study possible climate change in Alibey and Zagatala on the basis of instrumental observations. In these studies, air temperature and atmospheric precipitation are the main indicators of climatic processes, as well as the most commonly used characteristics of the humidity regime, so the changing trends of these elements were studied and their stable climatic characteristics called "norm" were determined. Data from 1961-1990 were used to calculate the "norms" based on WHO recommendations. The data of Alibey (absolute height 1540 meters) and Zagatala (absolute height 487 meters) meteorological stations of the former Hydrometeorological Committee and the current National Hydrometeorology Department were used to conduct these analyzes.

Volatility of air temperature and precipitation is an important factor. It is characterized by the following statistical parameters: anomaly, standard deviation, coefficient of variation, asymmetry and excess coefficients. Statistical features of the average monthly temperature were studied by S. Safarov, Y. Hadiyev, S. Khalilov, M. Musayeva, G. N. Chichasov and other scientists [2, 4, 5]. One of the main features of temperature and precipitation variability is the standard deviation.

$$s = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n-1}}$$

This value is more favorable than the variance, because it is determined by the average deviation. The standard deviation indicates the deviation of the arithmetic mean in the series of variations [2, 3, 4].

The generally accepted classification is used to determine the lack of precipitation and the months of extreme precipitation (precipitation - less than 80%, normal precipitation - from 80% to 120%, extreme precipitation - more than 120%).

One feature of Ri is not enough, but it is also necessary to know the probability P of the event:

$$P = \frac{R_i}{R} 100\%$$

Here, Ri is the amount of precipitation for a given month, mm; R - average amount of precipitation for a given month, mm.

Practical part. The intensity of seasonal and annual changes in temperature and precipitation in Azerbaijan is characterized by large daily and annual amplitudes. The orographic location of the area affects the intensity and duration of precipitation [7]. Currently, there is a change in precipitation due to global warming. It is important to study the temporal course of temperature. Table 1 shows the seasonal average values of air temperature for the decades of 1961-2019.

Table 1.

Average values of air temperature (t, °C) and atmospheric precipitation (R, mm) for decades (Alibey MS)

period	winter		spring		summer		autumn	
	t, °C	R, mm	t, °C	R, mm	t, °C	R, mm	t, °C	R, mm
1961-1970	-1.0	46.2	4.3	134.2	14.3	127.5	6.8	86.7
1971-1980	-3.3	34.0	4.8	74.7	15.0	80.4	7.0	64.6
1981-1990	-2.5	49.8	5.1	113.6	14.9	146.2	6.7	111.4
1991-2000	-2.7	56.5	4.3	91.5	15.2	134.8	6.7	116.2
2001-2010	-1.9	47.2	5.5	113.9	16.0	129.9	8.4	143.1
2011-2020	-1.7	46.5	6.1	135.8	16.7	134.5	7.4	114.7

According to Table 1, the temperature has risen in recent decades, as well as in winter. For example, in the winter of 1971-1980, the average temperature was -3.3 °C, while in the last decade it ranged from -1.9 °C to -1.7 °C. If we look at the decades, we see that in recent years, the negative temperature in winter has fallen compared to the previous decade. The same trend is observed in the temporary course of precipitation. The amount of precipitation has changed in a similar way to the temperature. The temporary

course of average air temperature and atmospheric precipitation in Alibey for the winter season is shown in Figure 1.

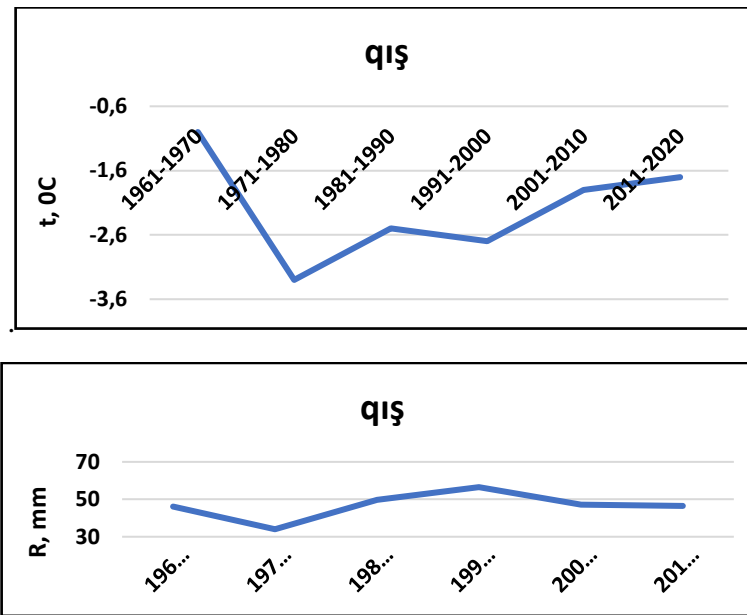


Figure 1. Average values of air temperature (t , 0C) and atmospheric precipitation (R , mm) in winter in Alibey

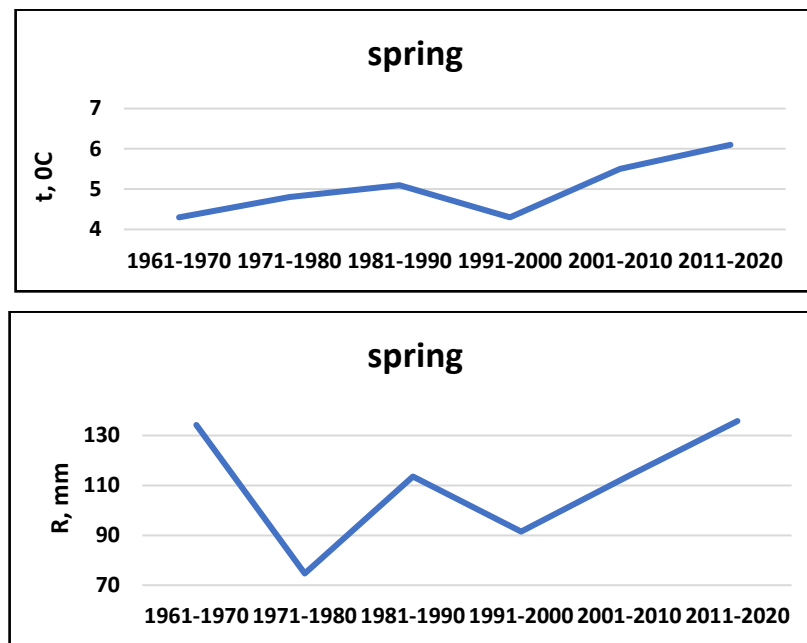


Figure 2. Average values of air temperature (t , 0C) and atmospheric precipitation (R , mm) in spring in Alibey

According to Figure 2, an increase in temperature is observed in spring. In spring, the average temperature was almost evenly distributed until the 4th decade (4.3 ... 4.8 ° C), then increased slightly in the 5th and 6th decades (5.5 ... 6.1 ° C). The maximum price was 6.1 ° C in 2011-2020, and the minimum price was 4.3 ° C in 1961-1970. Low average temperatures were observed in March, April and May in this decade. The maximum value of precipitation in spring was 135.8 mm (2011-2020). The minimum values are 74.7 mm in 1971-1980. There has been a slight decrease in rainfall over the last 30 years. A comparison of the average values of the first decade with the results of the latter shows a significant increase in temperature.

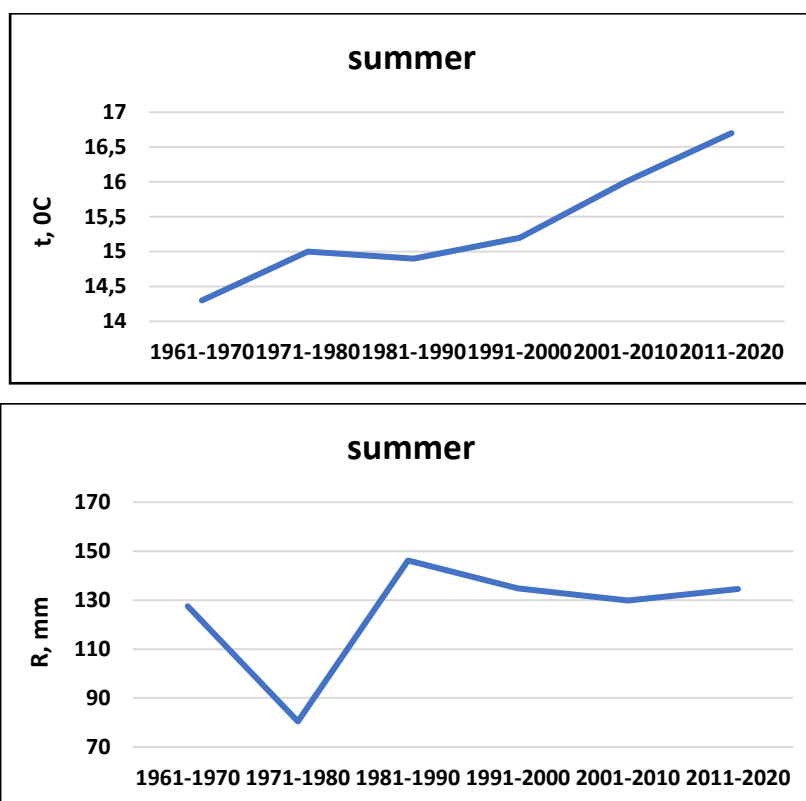


Figure 3. Average values of air temperature (t , °C) and atmospheric precipitation (R , mm) in Alibey during summer

Figure 3 shows the average temperature and precipitation in Alibey in summer. Based on average summer prices, temperatures and precipitation have increased over the past decade. In summer, the average temperature varied in the range of 14.3-16.7 ° C for decades, and the maximum average temperature was observed in the last decade (2011-2020), which was 16.7 ° C. The average minimum temperature in summer was observed in 1961-1970 and was 14.3 ° C. The amount of rainfall was uneven. The minimum price was observed in 1971-1980 and was 80.4mm, while the maximum price was observed in 1981-1990 and was 146.2mm. Fortunately, that the amount of precipitation decreased in 2001-2010 against the background of rising temperatures.

There is no significant deviation in the temporal course of air temperature and average precipitation in autumn (Figure 4). The average temperature ranged from 6.7 ° C (in the 3rd decade) to 8.4 ° C (in the 5th decade). Since 2001-2010, there has been a steady upward trend in temperature. Average precipitation varies from 64.6 to 143.1 mm. The amount of precipitation decreased to some extent in 1971-1980, and has increased again in recent decades.

Long-term forecasting of precipitation and temperature anomalies is one of the most important and complex tasks of meteorology. Many scientific works are mainly devoted to anomalies that study synoptic methods of long-term forecasting. Table 2 shows the recurrence (number of cases) of large positive (N+) and negative (N-) air temperature anomalies for Alibey.

Large air temperature anomalies are unevenly distributed. The highest values of anomalies are observed in winter and spring. In summer, the number of anomalies above the standard deviation is 21-23. Considering the decades, the number of negative anomalies prevailed in the first decades (from 1961 to 1970), and the last decades were dominated by positive anomalies. The air temperature and statistical characteristics of precipitation were calculated for the studied period. Table 3 shows the square root of the calculated values of temperature and precipitation calculated according to formula (1) for the period under study.

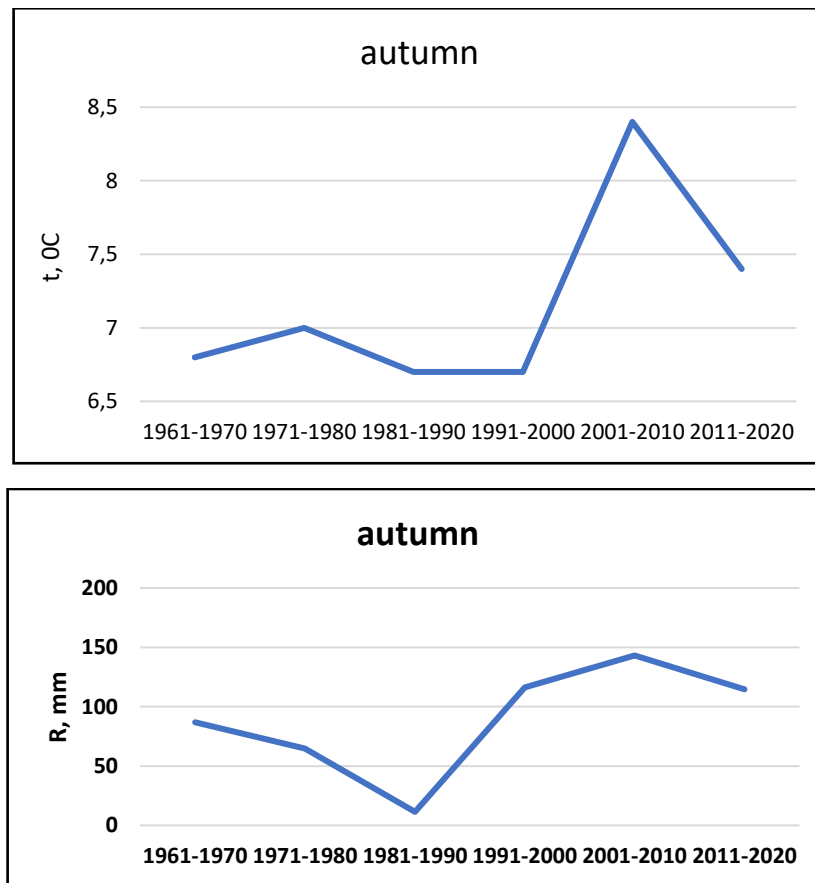


Figure 4. Average values of air temperature (t , 0C) and atmospheric precipitation (R , mm) in Alibey during summer

Table 2.

Number of cases with large positive ($N+$) and negative ($N-$) air temperature anomalies in Alibey

Seasons															
winter				spring				summer				autumn			
$ A1 \geq \sigma$		$ A1 \geq 1,5\sigma$		$ A1 \geq \sigma$		$ A1 \geq 1,5\sigma$		$ A1 \geq \sigma$		$ A1 \geq 1,5\sigma$		$ A1 \geq \sigma$		$ A1 \geq 1,5\sigma$	
+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
35	36	10	19	34	36	20	17	23	21	6	8	32	28	9	7

Table 3.

Average square deviation of air temperature and precipitation

Months	σ_T	σ_T	σ_R	σ_R
	Alibey	Zagatala	Alibey	Zagatala
January	2,2	1.8	51.3	24.4
February	2,4	2.5	25.6	26.4
March	2,5	2.1	21.8	32.0
April	2,6	1.9	31.2	48.7
May	2,1	1.6	44.4	59.6
June	1,7	1.7	64.2	74.4
July	1,4	2.0	70.6	60.4
August	2.1	2.1	95.9	72.3
September	2.2	2.2	76.5	61.1
October	1.5	1.9	89.8	54.2
November	2.3	2.0	84.1	43.5
December	2.9	1.8	56.9	30.2

According to Table 3, the maximum value of the average square deviation of temperature in Alibey was in December (2.9), in Zagatala in February (2.5), the minimum in Alibey in July (1.4) and in Zagatala in May (1.6). The standard deviation decreases from the cold period to the warm period, which indicates a decrease in temperature variability. The maximum standard deviation of precipitation was in Alibey in August (95.9), in Zagatala in June (74.4), the minimum value in Alibey in March (21.8) and in Zagatala in January (24.4). The total number of precipitation deficiencies and extreme cases was determined according to the formula (2) for all seasons of the year.

Table 4

The amount of extreme humidity and drought according to the seasons

Season	Shortrage		Extreme humidity	
	Alibey	Zagatala	Alibey	Zagatala
winter	72	77	53	51
spring	56	59	45	56
summer	67	89	59	57
autumn	87	81	53	60

According to Table 4, in all seasons of the year, especially in autumn, there is a lack of precipitation in Alibey, and in summer in Zagatala. The highest values of extreme humidity are in Alibey in summer and in Zagatala in autumn. Based on the analysis of average values of temperature and precipitation, it is possible to make a reliable weather forecast for the future.

The result. Analyzing the change in air temperature and precipitation in the study area, a steady warming trend was identified with some warming of the last decade, as well as the absence of significant changes in precipitation patterns. This fact indicates an increasing trend of aridization of the area, as the increase in air temperature is not accompanied by a corresponding increase in atmospheric precipitation. The standard deviation of air temperature was calculated and large anomalies (1.5σ) were identified. Lack of rainfall and years of extreme rainfall were found for the seasons under review. It has been found that the number of positive temperature anomalies has increased in recent decades. In mountainous areas (including the study area), snow reserves increase due to increased rainfall in winter, which leads to increased water flow in spring in the face of rising temperatures. The increase of air temperature is significantly to cause some early melting of the soil, resulting in an increase in water losses during spring floods. In general, the flow of rivers increases with increasing rainfall and temperature, and vice versa.

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