Regional climate change in the south of Rostov region: a case of arid steppe

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Abstract. The article analyses the changes in some meteorological conditions of the arid steppe for the period 1966 – 2020 in Gigant settlement. This station has continuous verified values of meteorological data. In this work data on temperature and precipitation are analysed. The yearly cycle was divided into the warm (IV – IX months) and cold (X – III months) periods. Trends in temperature and precipitation have been identified. There is an increase in temperature by 1.1°C. The amount of precipitation varies slightly. is associated with uneven water consumption throughout the year.

1 Introduction

Climate change is currently one of the world's hottest topics. Climatic changes are not synchronous, so regional studies are an important part of creating an overall picture of climate change. Regional climatic research is carried out in many regions of Russia and the world [1]. There has been a noticeable increase in the frequency of natural disasters in southern European Russia [1]. The observed increase is believed to be caused by anthropogenic influence [2]. A 0.87 °C increase in air temperature on a global scale during 2005–2015 was identified [3]. The warmest years were 2015 – 2018 due to [4]. It is claimed that the warmest years were 2015-2018 [4]. in high latitudes, global climate changes manifest themselves to a significant extent. In [5] it is noted that global warming has also affected tropical areas, where the temperature has risen by 0.2 – 1 °C. In the future, a temperature increase of 2 °C is predicted [5 - 8].

A special feature is the increase in air temperature at the earth's surface and the intensity of natural hazards. Modern warming is recorded mainly everywhere, while the greatest changes are confined to the territories between 40° and 70° northern latitude [5 - 23]. Climate change is a global phenomenon, but it has significant impacts affecting regional ecosystems [5 - 23].

The south of Russia has an important role in the country's agricultural production. This area is characterized by high heat and moisture deficit, i.e. it is an area of risky agriculture. In this regard, the study of changes in precipitation and temperature regimes is not only theoretical but also of practical importance. The general patterns of changes in meteorological parameters are associated with the flat nature of the terrain, the high arrival of solar radiation, and insufficient moisture supply.

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2 Study area

The first-grain collective farm Gigant was founded in 1928 in the Rostov region in the arid steppe. The high level of solar radiation and insufficient precipitation combined with the flat terrain affect the meteorological features of this area [25 - 27]. Insufficient moisture, hot and dry summers and relatively warm winters are typical for this area [25]. This area is experiencing a significant water shortage. The rivers of the region have been transformed significantly. The main source of recharge is snowmelt water [25 - 27]. Winter precipitation plays a significant role in the humidification of the territory; the study of the dynamics of the distribution of snow reserves is relevant [25 - 32].

The analysis of changes in meteorological characteristics was carried out based on [33, 34]. The period of analysis is from 1966 to 2020. Calculations and graphical constructions are performed in the MS Excel computer program.

3 Results and discussions

The climate in the area is temperate continental. Summer is hot, and the second half of it is dry. Winter is relatively cold, with sharp east and southeast winds, thaws, and ice. The average summer temperature is +23.2 .. 25.3 ° C, average winter temperature is -2.6 .. -6.6 ° C. The average annual precipitation is 450 mm. Rains often fall in the form of short-term showers. Precipitation plays a significant role in the agricultural area with water shortage, Precipitation plays a significant role in the agricultural area with water shortage and insufficient and unstable.

Analysis of the dynamics of air temperature shows that there is a significant increase in the amplitude of annual values (fig. 1). Comparison of the periods 1966-1990 and 1991-2020 shows an increase in the average annual temperature by 1.1 ° C (table 1).

Table 1. Average monthly air temperature and precipitation.

Period	Temperature, °C			Precipitation, mm		
	Annual	XI-III	IV-X	Annual	XI-III	IV-X
1966-1990	**9.7**	**-0.7**	**17.3**	**509**	**195**	**314**
1991-2020	**10.8**	**1.1**	**18.2**	**514**	**193**	**321**
1966-1970	10.1	-0.4	17.8	455	229	225
1971-1980	9.6	-1.0	17.1	518	176	343
1981-1990	9.7	-0.6	17.3	528	197	330
1991-2000	10.0	-0.7	17.5	548	188	360
2001-2010	11.1	2.2	18.3	529	207	322
2011-2020	11.3	1.7	18.9	464	184	281

A steady trend towards an increase in air temperature has been recorded [26-30], which is accompanied by a decrease in the amplitude of fluctuations in the average annual air temperature. The average annual air temperature was below the average annual values in 2003 and 2011 [9]. The anomalous temperatures are noted in 1987 (the coldest year 7.89°C), and 2007 (the warmest was 12.27°C) (fig. 1). Positive trends in temperature changes are observed both in cold and warm period. It should be noted that the period 2001-2020 is characterized by a significant increase in temperature in both the warm and cold periods. The cold period of 2001-2010 is especially different, when the average temperatures were 2.2 °C, with a norm of 1.1 °C.

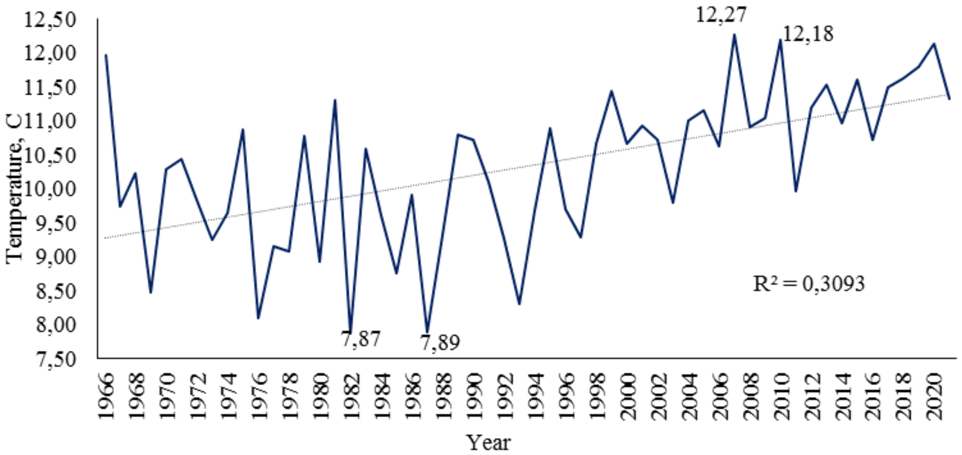


Fig 1. Average annual air temperature (1966 – 2020)

The annual course of air temperature is clearly expressed. The minimum monthly average temperatures are observed in January (-3.6 °C). The highest temperature is observed in July – August (23.3 - 24 °C). Significant changes are observed in the long-term section of average January temperatures from -14.2 °C (1972) to 3.5°C (2007). The period from 1971 to 1980 is the coldest. The increase in the average temperature in January is stable and from 1939 to 2020 amounted to 2.6 °C (Fig. 2). The average temperature in July varied from 20.9 °C (1982, 1992) to 27.7 °C (2001). Since 1971, there has been a steady increase in the average temperature of July from 23.2 to 25.3 °C. Then there is a gradual decrease in temperature. July temperatures significantly exceeding the long-term data were recorded from 2007 to 2017.

Precipitation plays a crucial role in the south of the country, but there are no significant trends. The observation period from 1966 to 2020 is characterized by uneven precipitation throughout the year (Fig.2, 3). The complex nature of precipitation fluctuations is typical for most weather stations in Russia. The minimum amount of precipitation (314 mm) was recorded in 2007, the maximum value (700 mm) in 2016, which significantly exceeds the average annual precipitation. The average annual precipitation increased until 1997, followed by a sharp decrease.

The continental type of annual precipitation is typical with the maximum amount in the warm period (IV-X). On the territory of the Gigant, 62% of precipitation falls during the warm period, and 38% during the cold period. However, there is an unevenness over the years. The almost homogenous distribution of precipitation throughout the year is typical for the period 1966-1979, 49.5% of precipitation falls in summer. For example, the period 1966-1979 is characterized by an almost equal distribution of precipitation throughout the year, 49.5% of precipitation falls in summer. For other periods, the bulk of the precipitation will fall in the summer, and its share varies from 60.9% (2001-2010) to 66% (1991-2000). Humidification of warm and cold half-years in 1939-1960 and 1966-2020 differ by only 4%. The minimum amount of precipitation in Gigant falls in January – March (fig.4). The highest average precipitation is observed in May – July, followed by a decline. During the observation period from 1966 to 2020, the driest year was 2007 (314 mm), and the wettest was 2016 (700 mm).

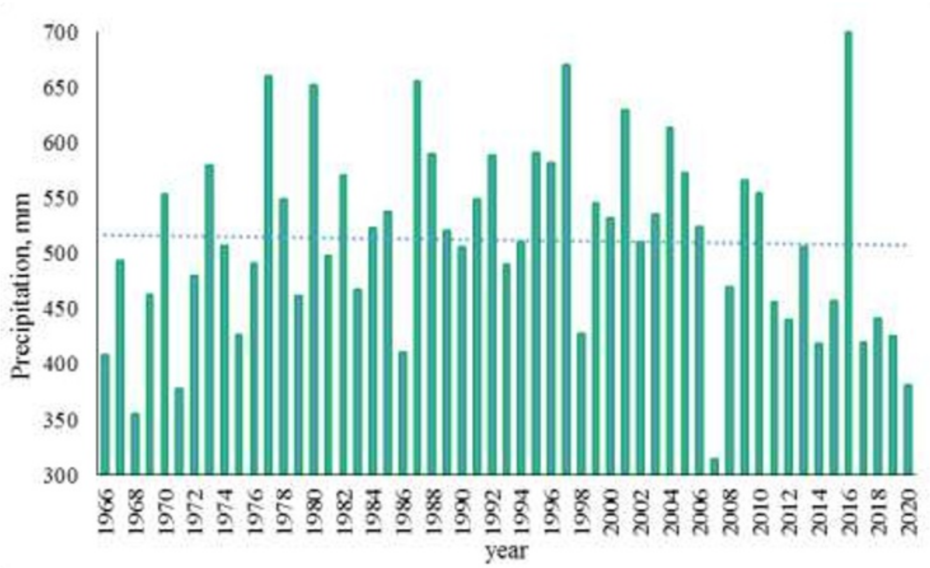
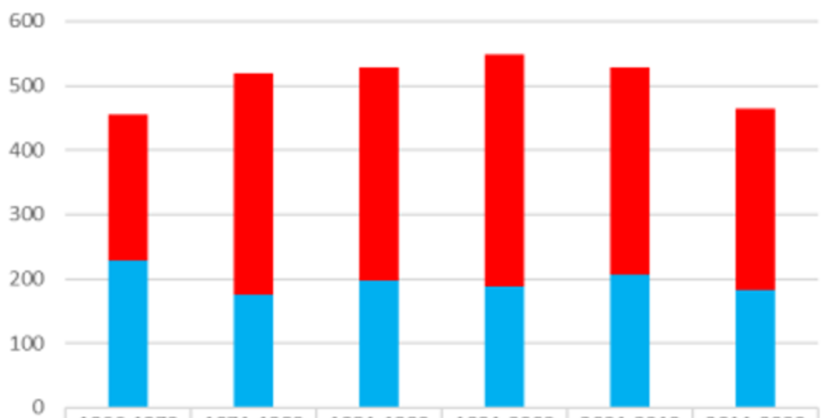


Fig.2. Distribution of precipitation (1966 - 2017)



	1966-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2020
warm	225	343	330	360	322	281
cold	229	176	197	188	207	184

Fig.3. Dynamics of precipitation by seasons (1966 - 2017)

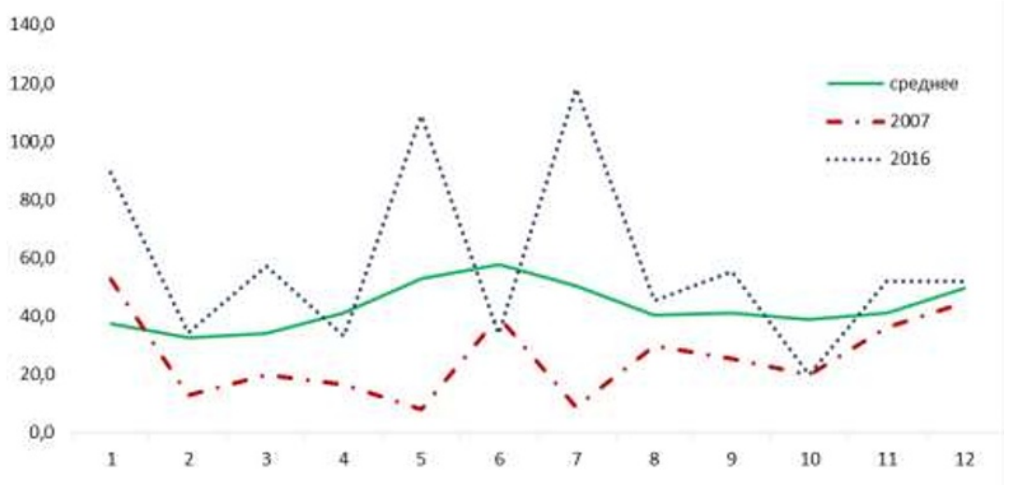


Fig. 4. Annual change of precipitation (mm), MS Gigant

Precipitation occurs in various forms, but liquid precipitation prevails, which amounts to 76-90% per year. Solid precipitation plays a smaller role, and their share is 7-18%.

4 Conclusion

The changes in temperature and precipitation over the period from 1966 to 2020 were studied. The general trends of climate change are preserved for various weather stations. The issue of precipitation changes in conditions of insufficient and unstable humidification becomes especially relevant. A steady warming trend has been revealed at this station. The increase in the average air temperature was 1.2 ° C. There were no significant changes in the precipitation regime, except for a significant decrease in precipitation over the period 2004-2015. The minimum amount of precipitation was in 2007 (314 mm), and the maximum in 2016 (700 mm). The increasing aridization of the climate causes concern not only due to the increase in drought and fires but also changes in grain yields.

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