საერთაშორისო სამეცნიერო კონფერენცია „ეკოლოგიის თანამედროვე პრობლემები"
შრომები, ISSN 1512-1976, ტ. 7, თბილისი-თელავი, საქართველო, 26-28 სექტემბერი, 2020
International Scientific Conference „Modern Problems of Ecology"
Proceedings, ISSN 1512-1976, v. 7, Tbilisi-Telavi, Georgia, 26-28 September, 2020
Международная научная конференция „Современные проблемы экологии"
Труды, ISSN 1512-1976, т. 7, Тбилиси-Телави, Грузия, 26-28 сентября, 2020

VARIABILITY OF THE ANNUAL SUM OF ATMOSPHERIC PRECIPITATIONS IN KAKHETI IN 1956-2015

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Summary: The results of statistical analysis of data on annual sum of atmospheric precipitation for six points of Kakheti - Telavi, Sagarejo, Kvareli, Gurjaani, Dedoplistskaro and Lagodekhi are presented. The study period from 1956 to 2015. In particular, it was found that the linear trend of precipitation is observed only in Lagodekhi (positive trend) and Sagarejo (weak negative trend). Within the studied time period in 1986-2015, compared with 1956-1985, the average annual sum of precipitation in Sagarejo decreased by 73 mm, and in Lagodekhi it increased by 157 mm. The linear correlation between the P values at the studied stations is significant ($\alpha(R) < 0.01$). The values of R vary from 0.40 (pair Sagarejo - Lagodekhi) to 0.74 (pair Telavi - Kvareli and pair Gurjaani - Kvareli).

Key Words: regional climate change, atmospheric precipitations.

Introduction.

Studies of atmospheric precipitation are important not only in the scientific aspect, but also for many sectors of the economy (agriculture, energy, tourism sector, construction, etc.). Many environmental problems (climate change, ecology, natural disasters, etc.) are associated with the regime of precipitation and the possibility of their regulation [1-6].

In Georgia, instrumental studies of precipitation have been conducted for more than 185 years [7]. In particular, the comparison of monthly and seasonal mean values of precipitations in two thirty years of time (1844-1873 and 1989-2018) in Tbilisi was carried out. It was found that in the indicated periods of time there is a significance increase in atmospheric precipitations in October and November and cold period of year, and a decrease in July and September [7].

In recent years, according to the National Environmental Agency of Georgia, an updated database of monthly sum of atmospheric precipitation up to 2015 has been created for 39 meteorological stations. An analysis of these data over the past 60 years has begun.

The results of statistical analysis of data on monthly precipitation for six points of Kakheti - Telavi, Sagarejo, Kvareli, Gurjaani, Dedoplistskaro and Lagodekhi are presented in [8]. The study period from 1956 to 2015. In particular, it was found that during the indicated period of time in various months of the year in Kakheti at different points the variability of precipitation is quite heterogeneous. So, in 1986-2015, compared with 1956-1985, the regime of precipitation in Kvareli did not change; in Telavi, in the second period of time compared to the first, the monthly precipitation decreased in June and July, and increased in October; in Sagarejo - a decrease in precipitation from June to August and an increase in October; in Gurjaani and Dedoplstskaro - a decrease in rainfall in June; in Lagodekhi an increase in October and November. The statistical analysis of the variability of monthly sums of atmospheric precipitation in Tianeti for the same period of time showed that in January, February, April, and from October to December, the precipitation regime remains unchanged; in March and from May to September, negative linear trends of monthly sum of precipitation are observed [9]. he results of the study [8,9] may be useful for planning works on artificial precipitation [6].

In this work, which presents the continuation of the foregoing studies [8], some results of the changeability of annual sum of atmospheric precipitation in six location of Kakheti in 1956-2015 are represented.

Study area, material and methods.

Study area is Kakheti region of Georgia. Data of the National Environmental Agency of Georgia about annual sum of precipitation (P) in six locations of Kakheti (Telavi, Sagarejo, Kvareli, Gurjaani, Dedoplistskaro and Lagodekhi) in 1956-2015 are used.

The standard statistical methods are used. The following designations will be used below: Mean – average value of precipitations for 1956-2015; Min – minimal values; Max - maximal values; St Dev - standard deviation; Range - variational scope, (Max – Min); St Err - standard error, (68% - confidence interval of mean values); C_v - coefficient of variation, (%), R^2 - coefficient of determination, R - coefficient of correlation (the minimum value of R with a level of significance = 0.05 is 0.26); 99%_Low and 99%_Upp - 99% of the lower and upper levels of the confidence interval of the average values; (I) - average value of P for 1956-1985 (first period of time); (II) - average value for 1986-2015 (second period of time); α–level of significance. Missing observational data using standard methods were recovered. Comparison of mean values of precipitations in two periods of time was produced with the use of Student's criterion with the level of significance not worse than 0.05.

Results and discussion.

Results in fig. 1 and table 1 clearly are presented.

In fig. 1 the graphs of variability of annual sum of atmospheric precipitation in six locations of Kakheti in 1956-2015 are presented.

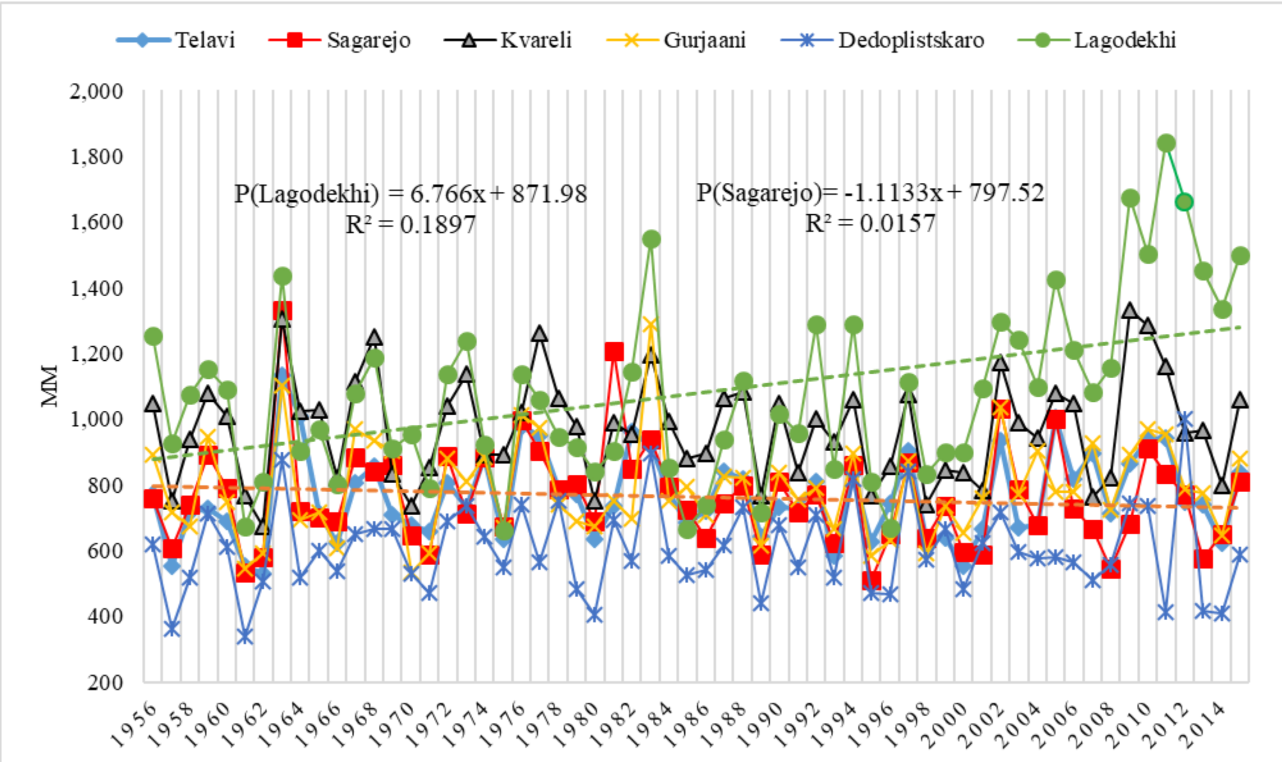

Fig. 1. Changeability of annual sum of atmospheric precipitation in 6 locations of Kakheti in 1956-2015.

As follows from this figure, the linear trend of precipitation is observed only in Lagodekhi (positive trend, α (R^2) <0.001) and Sagarejo (weak negative trend, α (R^2) <0.3).

In table 1 the statistical characteristics of P in above indicated locations of Kakheti is presented.

Table 1. Statistical characteristics of annual sum of atmospheric precipitation in 6 locations of Kakheti in 1956-2015

Location	Telavi	Sagarejo	Kvareli	Gurjaani	Dedoplistskaro	Lagodekhi
Mean	764	764	971	789	602	1078
Min	529	510	673	535	338	660
Max	1135	1332	1331	1288	1001	1842
Range	607	823	659	754	663	1182
St Dev	132	155	159	147	135	271
St Err	17	20	21	19	18	35
C_v, (%)	17.2	20.3	16.4	18.6	22.4	25.2
99%_Low	720	712	917	741	558	988
99%_Upp	808	816	1025	837	646	1168
Catalog [10]	*770*	*768*	*991*	*741*	*585*	*1004*
	Difference: (II)-(I), α(t)<0.05					
mm	-3	-73	-11	-7	5	157
Trend	No	(-)	No	No	No	(+)
R	**Correlation Matrix**					
Telavi	1	0.72	0.74	0.70	0.50	0.56
Sagarejo	0.72	1	0.66	0.68	0.62	0.40
Kvareli	0.74	0.66	1	0.74	0.60	0.64
Gurjaani	0.70	0.68	0.74	1	0.63	0.62
Dedoplistskaro	0.50	0.62	0.60	0.63	1	0.47
Lagodekhi	0.56	0.40	0.64	0.62	0.47	1

As follows from this table the annual sum of atmospheric precipitation distribution in Kakheti is rather heterogeneous. In 1986-2015 mean values of P varied from 602 mm (Dedoplistskaro) to 1078 mm (Lagodekhi). The smallest variations of P values in Kvareli (Cv = 16.4%), and the largest - in Lagodekhi (Cv = 25.2%) are observed.

In general, over the past 60 years, the annual values of precipitation in Kakheti has not changed compared to the earlier period. So, within the 99% confidence interval, the average annual values of P in 1956-2015 coincide with the average annual values of precipitation for the six indicated locations of Kakheti presented in the catalog [10].

Within the studied time period in 1986-2015, compared with 1956-1985, the average annual sum of precipitation in Sagarejo decreased by 73 mm (9.6% of the average in 1956-2015), and in Lagodekhi it increased by 157 mm (14.6% of the average in 1956-2015).

The linear correlation between the P values at the studied stations is significant (α(R) < 0.01). The values of R vary from 0.40 (pair Sagarejo - Lagodekhi) to 0.74 (pair Telavi - Kvareli and pair Gurjaani - Kvareli).

Conclusion.

In general, over the past 60 years, the annual values of precipitation in Kakheti has not changed compared to the earlier period. But within the studied time period in 1986-2015, compared with 1956-1985, the average annual sum of precipitation in Sagarejo decreased by 73 mm, and in Lagodekhi it increased by 157 mm. In our view taking into account these results and the results obtained in [8,9] it is expedient to examine a question of an artificial increase of precipitations in certain seasons of the year by active actions on the clouds with using anti-hail service potential [6].

References

1. Tavartkiladze K., Begalishvili N., Kharchilava J., Mumladze D., Amiranashvili A., Vachnadze J., Shengelia I., Amiranashvili V. Contemporary Climate Change in Georgia. Regime of Some Climate Parameters and Their Variability. // Monograph, ISBN 99928-885-4-7, Tbilisi, 2006, 177 p., (in Georgian).
2. Varazanashvili O., Tsereteli N., Amiranashvili A., Tsereteli E., Elizbarashvili E., Dolidze J., Qaldani L., Saluqvadze M., Adamia Sh., Arevadze N., Gventcadze A. // Vulnerability, Hazards and Multiple Risk Assessment for Georgia, Natural Hazards, Vol. 64, Number 3 (2012), 2021-2056, DOI: 10.1007/s11069-012-0374-3, http://www.springerlink.com/content/9311p18582143662/fulltext.pdf
3. Amiranashvili A.G. Special Features of Changeability of Daily Sum of Precipitation in Tbilisi in 1957-2006. // Journal of the Georgian Geophysical Society, Issue B. Physics of Atmosphere, Ocean and Space Plasma, v.18B, Tbilisi, 2015, pp.81-91.
4. Amiranashvili A.G. Increasing Public Awareness of Different Types of Geophysical Catastrophes, Possibilities of Their Initiation as a Result of Terrorist Activity, Methods of Protection and Fight With Their Negative Consequences. Engaging the Public to Fight Consequences of Terrorism and Disasters. // NATO Science for Peace and Security Series E: Human and Societal Dynamics, vol. 120. IOS Press, Amsterdam•Berlin•Tokyo•Washington, DC, ISSN 1874-6276, 2015, pp.155-164. http://www.nato.int/science; http://www.springer.com; http://www.iospress.nl
5. Kartvelishvili L., Amiranashvili A., Megrelidze L., Kurdashvili L. Turistul-rekreatsiuli resursebis shepaseba klimat'is tsvlilebis ponze.// Gamomtsemloba "Mtsignobari", ISBN 978-9941-485-01-5, Tbilisi, 2019, 161 gv., http://217.147.235.82/bitstream/1234/293074/1/turistulRekreaciuliResursebisShefasebaKlimatisCvlilebebis Fonze.pdf
6. Amiranashvili A., Chikhladze V., Dzodzuashvili U., Ghlonti N., Sauri I., Telia Sh., Tsintsadze T. Weather Modification in Georgia: Past, Present, Prospects for Development. // Int. Sc. Conf. "Natural Disasters in Georgia: Monitoring, Prevention, Mitigation". Proc., ISBN 978-9941-13-899-7, Publish House of Iv. Javakhishvili Tbilisi State University, December 12-14, Tbilisi, 2019, pp. 216-222.
7. Amiranashvili A. Changeability of Air Temperature and Atmospheric Precipitations in Tbilisi for 175 Years. // Int. Sc. Conf. "Natural Disasters in Georgia: Monitoring, Prevention, Mitigation". Proc., ISBN 978-9941-13-899-7, Publish House of Iv. Javakhishvili Tbilisi State University, December 12-14, Tbilisi, 2019, pp. 86-90.
8. Bliadze T., Gvasalia G., Kirkitadze D., Mekoshkishvili N. Changeability of the Atmospheric Precipitations Regime in Kakheti in 1956-2015. // Int. Sc. Conf. "Natural Disasters in Georgia: Monitoring, Prevention, Mitigation". Proc., ISBN 978-9941-13-899-7, Publish House of Iv. Javakhishvili Tbilisi State University, December 12-14, Tbilisi, 2019, pp.72-75.
9. Amiranashvili A., Bliadze T., Kartvelishvili L. Statistical Characteristics of Monthly Sums of Atmospheric Precipitations in Tianeti (Georgia) in 1956-2015. // Trans. of Mikheil Nodia institute of Geophysics, ISSN 1512-1135, Publish House of Iv. Javakhishvili Tbilisi State University, vol. 70, Tb., 2019, pp. 112-118, (in Russian).
10. Spravochnik po klimatu SSSR, vyp. 14, chast' 4, Gidrometeoizdat, Leningrad, 1970, 427 s.