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Changeability of the Meteorological Parameters Associated with Some Simple Thermal Indices and Tourism Climate Index in Adjara and Kakheti (Georgia)

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ABSTRACT

The statistical data about the meteorological parameters, associated with some simple thermal indices and Tourism Climate Index (TCI) (mean monthly and mean monthly maximum air temperature, mean monthly and mean monthly minimum air relative humidity, total monthly precipitation, sunshine duration, wind speed) in eight points of Adjara (Batumi, Kobuleti, Khulo, Goderdzi) and Kakheti (Telavi, Dedoplistskaro, Kvareli, Sagarejo) in the period from 1961 through 2010 are represented. In particular, the changeability of the indicated meteorological parameters into 1986÷2010 in comparison with 1986÷2010 for above enumerated points is studied.

Key Words: Meteorological parameters, Tourism Climate Index.

Introduction

In the recent decades in view of the unprecedented rate of growth in the air temperature the problem of climate change on our planet acquired special urgency [1,2]. In this case a change in the air temperature and other climatic elements has essential (spatial) three-dimensional and temporary heterogeneities both in the global (Global Land, Global Land of the Northern and Southern Hemisphere, Zonal territories, etc.) [1-5] and regional (even territory of the small countries with the complex relief) [5-8] scales.

For example, in the work [6] was to identify any possible temperature changes within the last 50 years in the North-Western Italian Alps by examining data from 16 high-altitude weather stations in the period 1961-2010. The analysis of the temperature values showed an increase in temperature, particularly at high altitudes sites. In fact, the stations located above 1600 m a.s.l. revealed a rise in temperatures and a decrease in the number of cold periods. For the maximum temperatures have been observed greater increases in spring and winter, for minimum temperatures in the summer.

This problem great value has also in Georgia, because of the variety of climatic regions in its territory. In particular, the research carried out shows that during last decades the mean temperature in the Eastern Georgia is rising and in Western Georgia it is decreasing [9-12].

For the steady development of different areas of national economy, including health resort- tourist industry, accounting for climate change has vital importance.

Since the health resort- tourist potential of locality in many respects is determined by its bioclimatic conditions, it is important to reveal the existing and forthcoming variations in these conditions under the effect of climate change

In particular, information about the changeability of the different simple thermal indices and Tourism Climate Index developed by Mieczkowski TCI [13] in the recent decades in different countries (including some locations of Georgia) is represented in [8,14-22].

Simple thermal indices include more than one meteorological parameter and consider the combined

action on the human organism of the air temperature, humidity, wind speed etc. [23-29]. For determining of mean monthly values of TCI following data are necessary: mean and mean maximum air temperature, mean and mean minimum relative humidity, precipitation, sunshine duration and wind speed [13].

In this work results of investigating of changeability of the mean monthly values of meteorological parameters, used for determining of TCI values [13] and different simple thermal indices [23-29, etc.] on the territories of Adjarian Autonomous Republic (below – Adjara) and Kakheti in the period from 1961 through 2010 are represented.

Study Area, material and methods

Studies for four cities of Adjara (Batumi, Kobuleti, Khulo, Goderdzi) and four cities of Kakheti (Telavi, Dedoplistskaro, Kvareli, Sagarejo) are carried out. Table 1 presents information about coordinates and heights of the locality of 8 meteorological stations (below – point) in Adjara and Kakheti, whose data were used in the work. Fig. 1 for the clarity depicts the map of the arrangement of the indicated meteorological stations.

Table 1

Coordinates and heights of the 8 meteorological stations in Adjara and Kakheti

Location	Latitude, N°	Longitude, E°	Height, m, a.s.l.
Adjara			
Batumi	41.64	41.64	9
Kobuleti	41.82	41.78	3
Khulo	41.64	42.3	921
Goderdzi	41.63	42.52	2025
Kakheti			
Telavi	41.93	45.48	568
Dedoplistskaro	41.47	46.08	800
Kvareli	41.97	45.83	449
Sagarejo	41.73	45.33	802

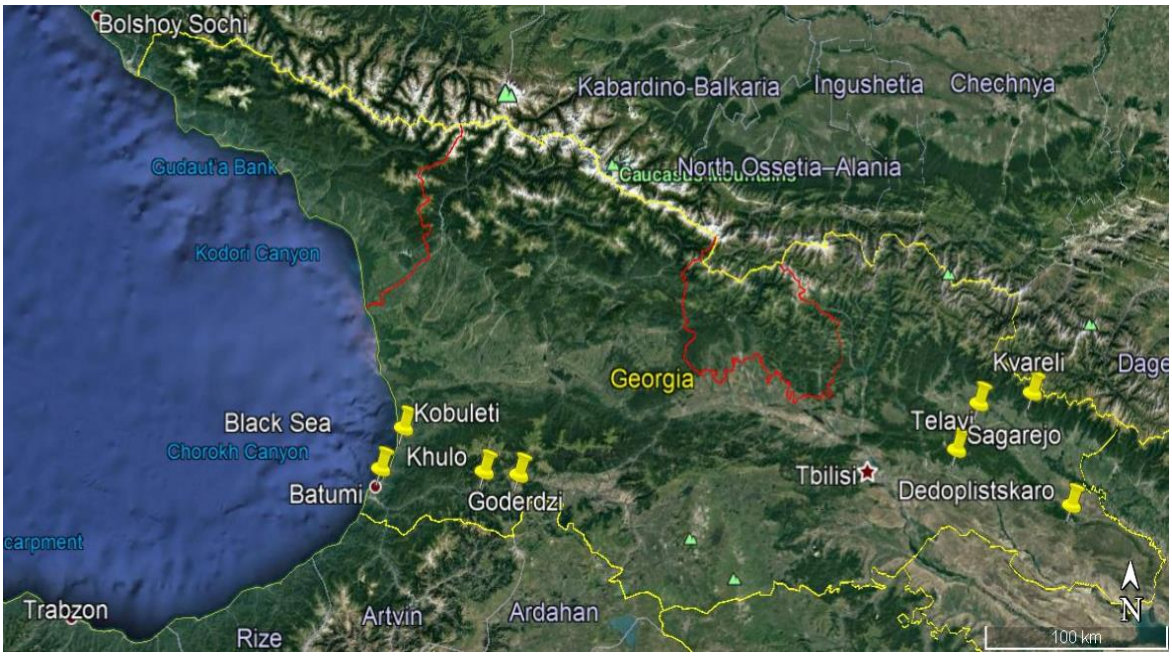

Fig. 1. Locations of eight meteorological stations in Adjara and Kakheti

In the work data of Georgian National Environmental Agency about monthly mean values of meteorological parameters in the period from 1961 through 2010 are used.

For the data analysis the standard statistical methods of the studies were used [30]. Designations and reduction – conventional. The difference between the mean values of the meteorological parameters into 1986-2010 and 1961-1985 with the use of Student's criterion was determined (level of significance not worse than 0.15).

The following designations are used below: T_{mean} - mean air temperature (°C), T_{max} - mean maximum air temperature (°C), RH_{mean} - mean relative humidity (%), RH_{min} - mean minimum relative humidity (%), P sum precipitation - (mm), S_d - daily sunshine duration (hour), V - mean wind speed (m/s).

ΔT_{mean} ….. ΔV - the difference between the mean values of the meteorological parameters into 1986-2010 and 1961-1985.

Results and discussion

Results in the Table 2-8 and Fig. 2-15 are presented.

Mean air temperature

Detailed information about the mean annual, half year and monthly air temperature (T_{mean}) in eight points of Adjara and Kakheti in Table 2 and in Fig. 2 are represented.

In particular, averaged on the stations Batumi and Kobuleti (coast of Black sea) the air temperature in all months of cold half-year on 0.6-2.5 °C above average the value of T_{mean} in Kakheti. In the warm half-year vice versa - on the average to the station in Kakheti of the value of T_{mean} on 0.3-2.4 °C it is higher than in Batumi and Kobuleti (Table 2).

Table 2

Data of T_{mean} (°C) in eight locations of Adjara and Kakheti

Location	All data					Mean 1961-2010	
	Mean Year	Mean Cold	Mean Warm	Min	Max	Min	Max
Batumi	14.5	10.1	19.0	1.8	26.5	6.9	22.8
Kobuleti	13.9	8.9	18.9	1.7	26.5	5.5	23.1
Khulo	10.4	5.1	15.7	-4.1	23.5	1.2	19.1
Goderdzi	2.6	-3.3	8.5	-12.3	17.4	-7.7	12.5
Telavi	12.3	5.6	19.0	-4.8	27.5	1.2	23.5
Dedoplistskaro	11.0	4.1	17.8	-6.0	26.3	-0.2	22.6
Kvareli	13.0	6.2	19.7	-4.1	27.6	1.8	24.1
Sagarejo	11.4	4.9	17.9	-5.0	26.2	0.7	22.4

The intra-annual distribution of the values of T_{mean} for both geographical regions takes the classical form, characteristic for the northern hemisphere - unimodal distribution close to the symmetrical. January is the coldest month for all eight points, whereas August is the hottest month in Adjara, and in Kakheti - July (Fig.2).

In different months the significant changeability of the mean monthly air temperature for the investigated points of Adjara in 16 cases is observed (for all cases - increase in the values of ΔT_{mean}), and for Kakheti - in 22 cases (including for 20 cases - an increase in the values of ΔT_{mean}).

Let us examine in more detail the nature of the changeability of the values of ΔT_{mean} in separate points (Fig. 3).

Batumi - increase in the values of ΔT_{mean} (July- October); Kobuleti and Goderdzi - increase (June-October); Khulo – increase (July, August). In Adjara a maximum and minimum increase in this parameter is observed in Kobuleti (1.6 °C August and 0.5 °C, June).

Telavi - decrease of the values of ΔT_{mean} (-0.5 °S, May), increase (June, August - October); Dedoplistskaro - decrease (-0.6 °S, May), increase (March, June - October); Kvareli and Sagarejo - increase of the values of ΔT_{mean} (March, June, August - October). In Kakheti a maximum increase of the indicated

parameter into Dedoplistskaro (1.7 °C, August), and minimum - in Telavi and Kvareli (0.6 °C, September) is observed.

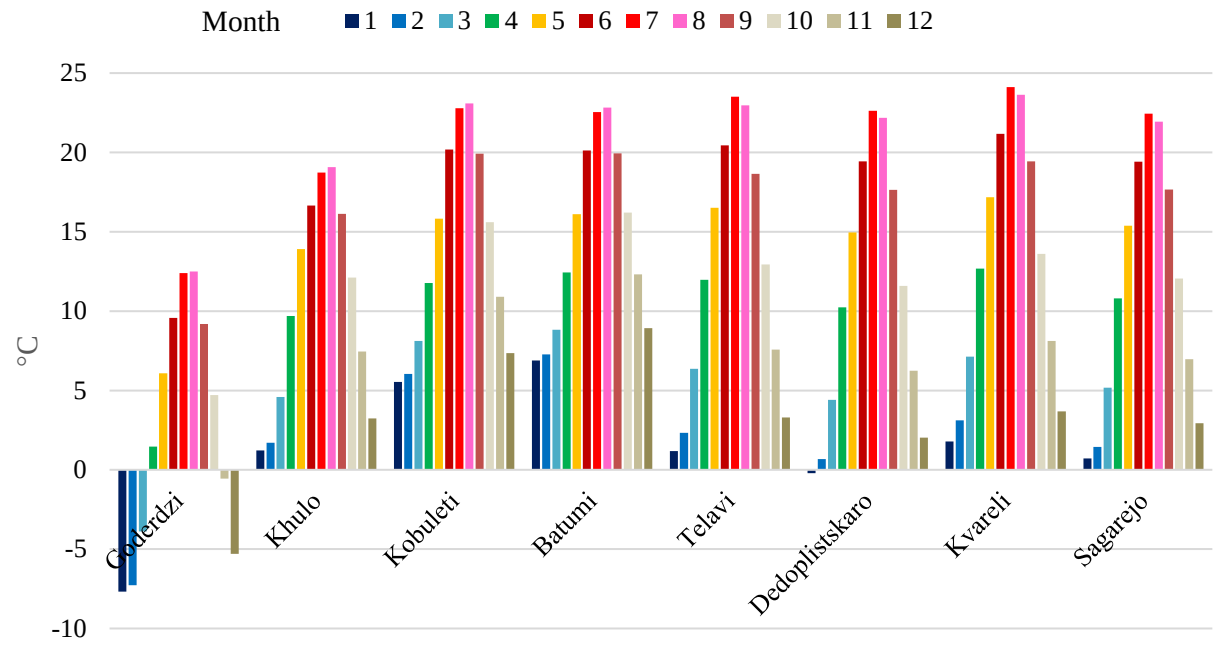

Fig. 2. Mean values of T_{mean} in eight locations of Adjara and Kakheti in 1961-2010

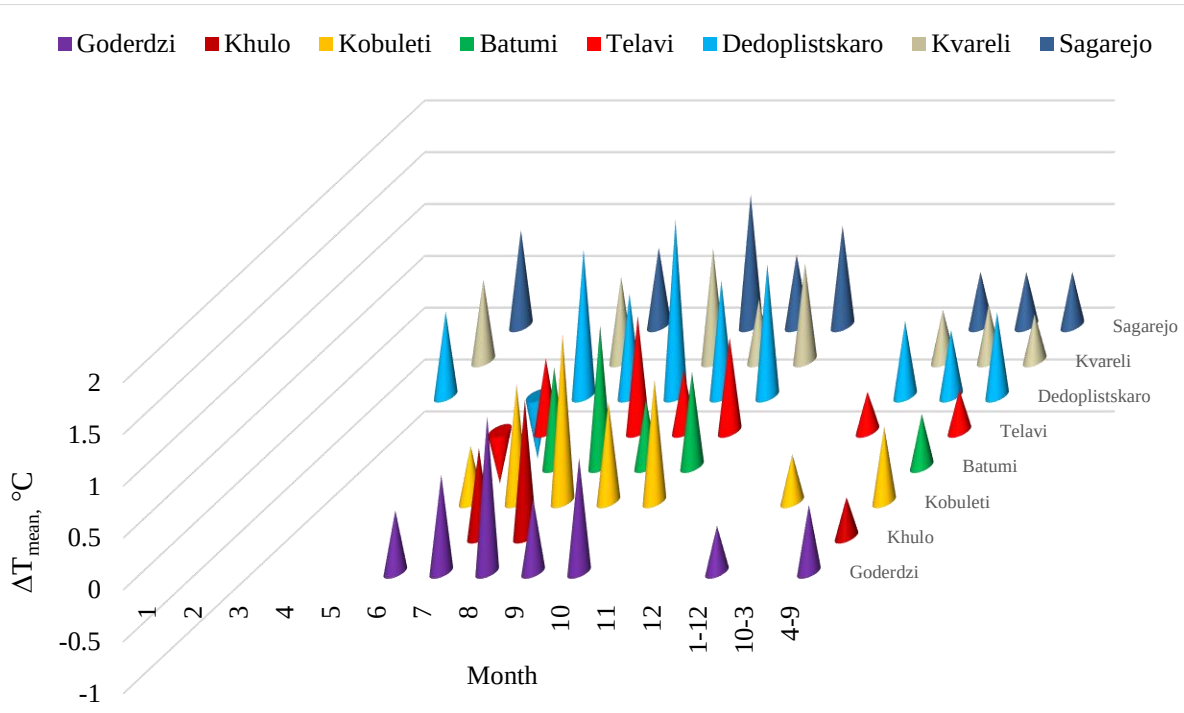

Fig. 3. Difference between the mean values of T_{mean} into 1986-2010 and 1961-1985 in eight locations of Adjara and Kakheti

Thus, in both investigated regions is noted the explicit process of the warming-up of climate. In Adjara the values of ΔT_{mean} are varied from 0.5 to 1.6 °C, amplitude - 1.1 °C, while in Kakheti - from -0.6 to 1.7 °C, amplitude - 2.3 °C. On the average to the station with the significant changeability of the mean monthly air temperature in Adjara the value of ΔT_{mean} grows on 1.0 °C, while in Kakheti - on 0.8 °C.

Mean maximum air temperature

Data about the mean annual, half year and monthly maximum air temperature (T_{max}) in table 3 and Fig. 4 are represented.

Averaged on the stations of Batumi and Kobuleti value of T_{max} from April through October on 0.6-2.2 °C above average the value of the maximum air temperature in Kakheti. The average to the station in Kakheti value of T_{max} on 0.6-3.6 °C it is higher than in the Batumi and Kobuleti in the warm half-year (Table 3).

Table 3

Data of T_{max} (°C) in eight locations of Adjara and Kakheti

Location	All data					Mean 1961-2010	
	Mean Year	Mean Cold	Mean Warm	Min	Max	Min	Max
Batumi	18.7	14.4	23.0	5.1	30.5	10.8	26.4
Kobuleti	18.7	14.1	23.3	5.8	31.1	10.4	27.0
Khulo	16.0	9.9	22.1	-0.1	31.4	5.3	25.4
Goderdzi	6.8	0.3	13.4	-9.2	23.4	-4.6	17.5
Telavi	17.7	10.5	24.9	0.0	34.6	5.7	29.4
Dedoplistskaro	16.4	9.2	23.7	-0.8	34.0	4.6	28.5
Kvareli	18.7	11.4	26.0	0.3	35.5	6.6	30.6
Sagarejo	17.0	10.0	24.0	-0.8	33.3	5.4	28.4

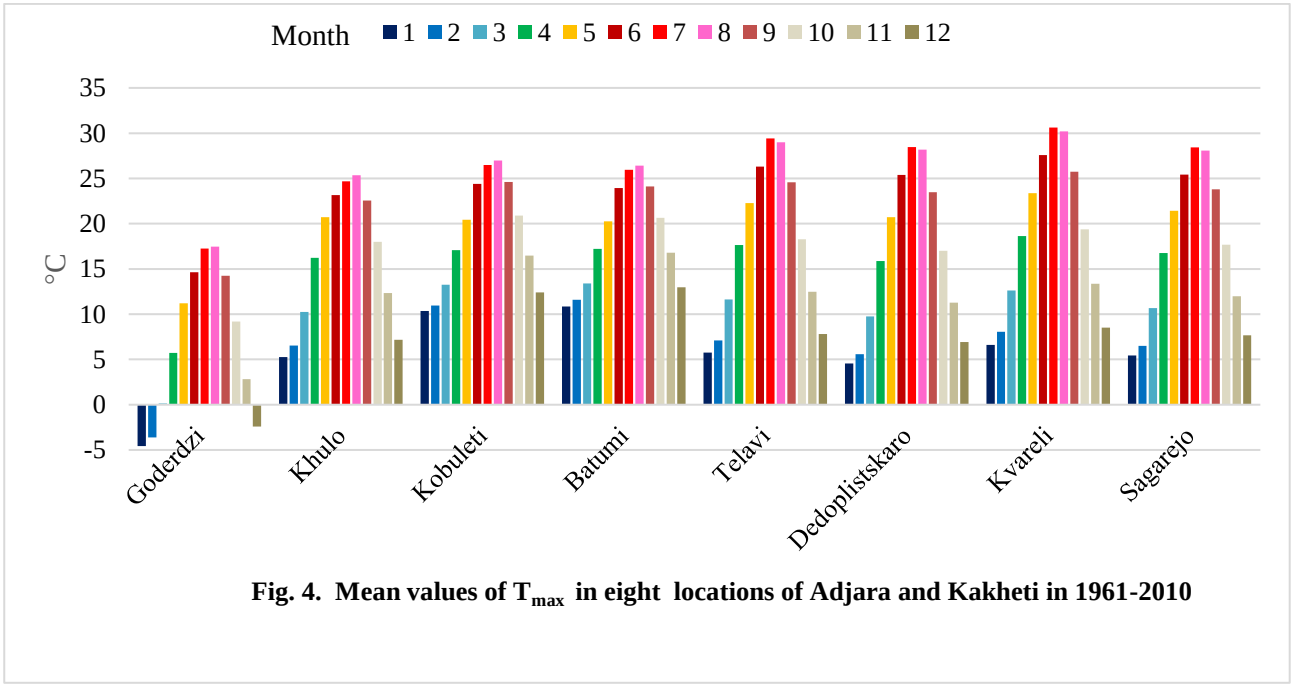

Fig. 4. Mean values of T_{max} in eight locations of Adjara and Kakheti in 1961-2010

The intra-annual distribution values of T_{max} is analogous to the motion of the values of T_{mean} for all 8 points of Adjara and Kakheti (Fig. 4). As in the preceding case, the smallest values of T_{max} for all eight points during January are observed, and the greatest values of T_{max} in Adjara during August, and in Kakheti - during July are observed (Fig. 4).

The changeability of the mean monthly maximum air temperature for four points of Adjara in 11 cases (including for 10 cases - increase of the values of ΔT_{max}), and for Kakhetii - in 18 cases (including for 17 cases - an increase on the values of ΔT_{max}) are observed.

The information about the changeability of the values of ΔT_{max} in separate points is presented lower (Fig. 5).

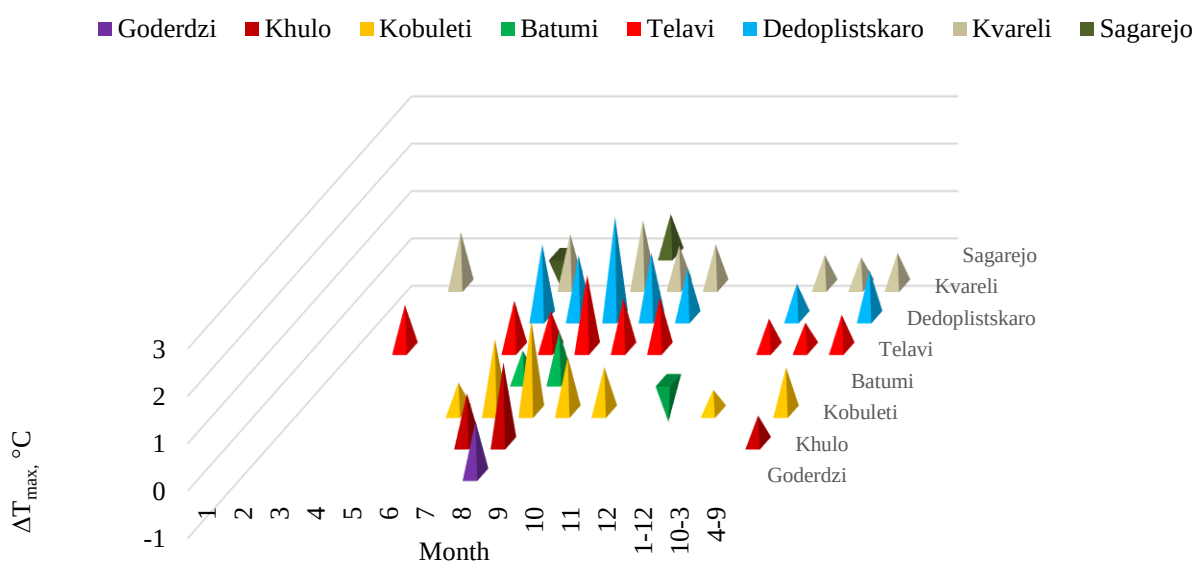

Fig. 5. Difference between the mean values of T_{max} into 1986-2010 and 1961-1985 in eight locations of Adjara and Kakheti

Batumi - increase of the values of ΔT_{max} (July, August), decrease (-0.9 °C, November); Kobuleti - increase (June - October); Khulo - increase (July, August); Goderdzi - increase (August). In Adjara a maximum increase of the values of ΔT_{max} into Kobuleti (1.9 °C, August), the minimum - in Kobuleti and by Batumi (0.6 °C, June and July respectively) are observed.

Telavi – increase of the values of ΔT_{max} (March, June- October); Dedoplistskaro - increase (June-October); Kvareli - increase (March, June, August - October); Sagarejo - decrease (-0.7 °C, May), increase (August). In Kakheti the greatest increase of the values of ΔT_{max} is noted into Dedoplistskaro (2.1 °C, August), smallest - in Telavi and Kvareli (0.8 °C, July and September respectively).

As a whole, in Adjara the values of ΔT_{max} change from -0.9 to 1.9 °C, amplitude - 2.8 °C, while in Kakheti - from -0.7 to 2.1 °C, amplitude - also 2.8 °C. On the average to the station with the significant changeability of the mean monthly maximum air temperature in Adjara the values of ΔT_{max} grows on 1.0 °C, while in Kakheti - on 1.1 °C.

Mean air relative humidity

Data about the mean annual, half year and monthly air relative humidity (RH_{mean}) in Table 4 and Fig. 6 are represented.

Averaged for Batumi and Kobuleti the air relative humidity from March through October by 1.7-15.1% higher than the values of RH_{mean} in Kakheti. During November and December the values of RH_{mean} in Batumi and Kobuleti for 1.6 and 0.3 % are lower than on the average for four points of Kakheti. During January the differences is not observed (Table 4).

Table 4

Data of RH_{mean} (%) in eight locations of Adjara and Kakheti

Location	All data					Mean 1961-2010	
	Mean Year	Mean Cold	Mean Warm	Min	Max	Min	Max
Batumi	75.2	71.3	79.0	54.6	89.0	67.5	80.7
Kobuleti	82.6	82.1	83.1	72.7	90.0	80.4	84.2
Khulo	71.9	70.2	73.7	38.2	91.0	65.6	79.0
Goderdzi	87.5	88.9	86.0	61.3	99.6	83.3	91.9
Telavi	70.3	73.2	67.4	46.5	88.5	64.7	75.8
Dedoplistskaro	76.1	79.9	72.3	44.1	95.4	67.7	81.4
Kvareli	75.2	79.4	71.1	51.4	91.6	68.0	81.9
Sagarejo	67.1	69.7	64.4	46.0	90.0	61.6	72.9

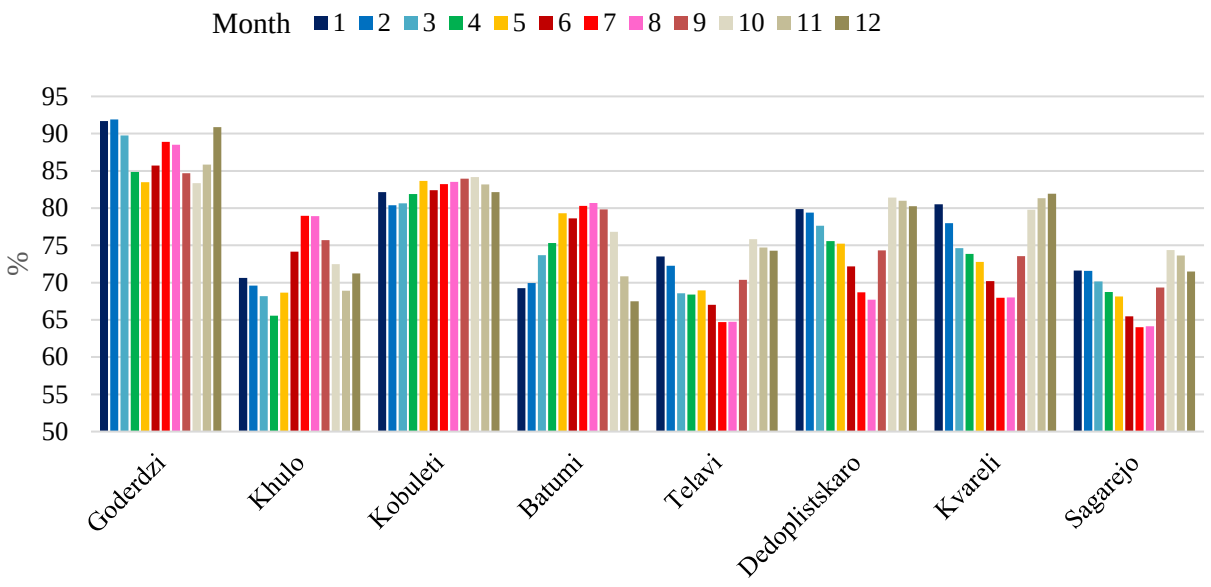

Fig. 6. Mean values of RH_{mean} in eight locations of Adjara and Kakheti in 1961-2010

The intra-annual distribution of mean monthly air relative humidity in Batumi significantly differs from the intra-annual motion of the values of RH_{mean} in Kobuleti, Khulo, Goderdzi and four points of Kakheti (Fig. 6).

In Batumi the distribution of RH_{mean} it is close to the unimodal with the plateau (greatest values) from May through September (79-81%) and the minimum in January - December (68-69%); amplitude - 13%. In Kobuleti this distribution is close to the uniform with the maximum during October (84%) and the minimum during February (80%); amplitude - 4 %. In Khulo distribution of RH_{mean} is unimodal with the weak peaks on the edges, has maximum during July-August (79%) and smallest values during April and November (69%); amplitude - 10 %. In the point Goderdzi this distribution is close to the wave with the basic maximum in January - February (92%), the second maximum during July - August (89%) and two minimums - during May and October (83%); amplitude - 9 %.

In Kakheti for all points the intra-annual distribution of RH_{mean} takes the form of the asymmetrical inverted bell, with the right displacement. For the indicated points of Kakheti in the intra-annual course of relative humidity the minimum is observed in July-August (64-69 %), and the greatest values of RH_{mean} - in winter (72-81%); amplitude - 17 %.

In different months the significant changeability of the mean monthly air relative humidity for the indicated points of Adjara in 16 cases (including for 8 cases - increase of the values of ΔRH_{mean}) are observed, and for Kakheti - in 24 cases (including for 14 cases - an increase of the values of ΔRH_{mean}).

The changeability of the values of ΔRH_{mean} in the separate points is the following (Fig. 7).

Batumi - increase of the values of ΔRH_{mean} (January), decrease (May, July - September); Kobuleti - increase (June), decrease (July - September); Khulo - decrease (September); Goderdzi - increase (February-April, June, July, December). In Adjara a maximum increase of the values of ΔRH_{mean} is observed in Goderdzi (3.1 %, April), minimum - in Kobuleti (0.8 %, June).

Telavi - decrease of the values of ΔRH_{mean} (March), increase (October - December); Dedoplistskaro - decrease (March); Kvareli - increase (all months, except July); Sagarejo - decrease (February- September). In Kakhetii a maximum increase of the values of ΔRH_{mean} is observed in Kvareli (5.4 %, January), minimum - in Kvareli and Telavi (2.5 %, September and October respectively). The greatest decrease of the values of ΔRH_{mean} is observed into Sagarejo (-5.8 %, March), smallest - also into Sagaredzho (-2.1 %, May).

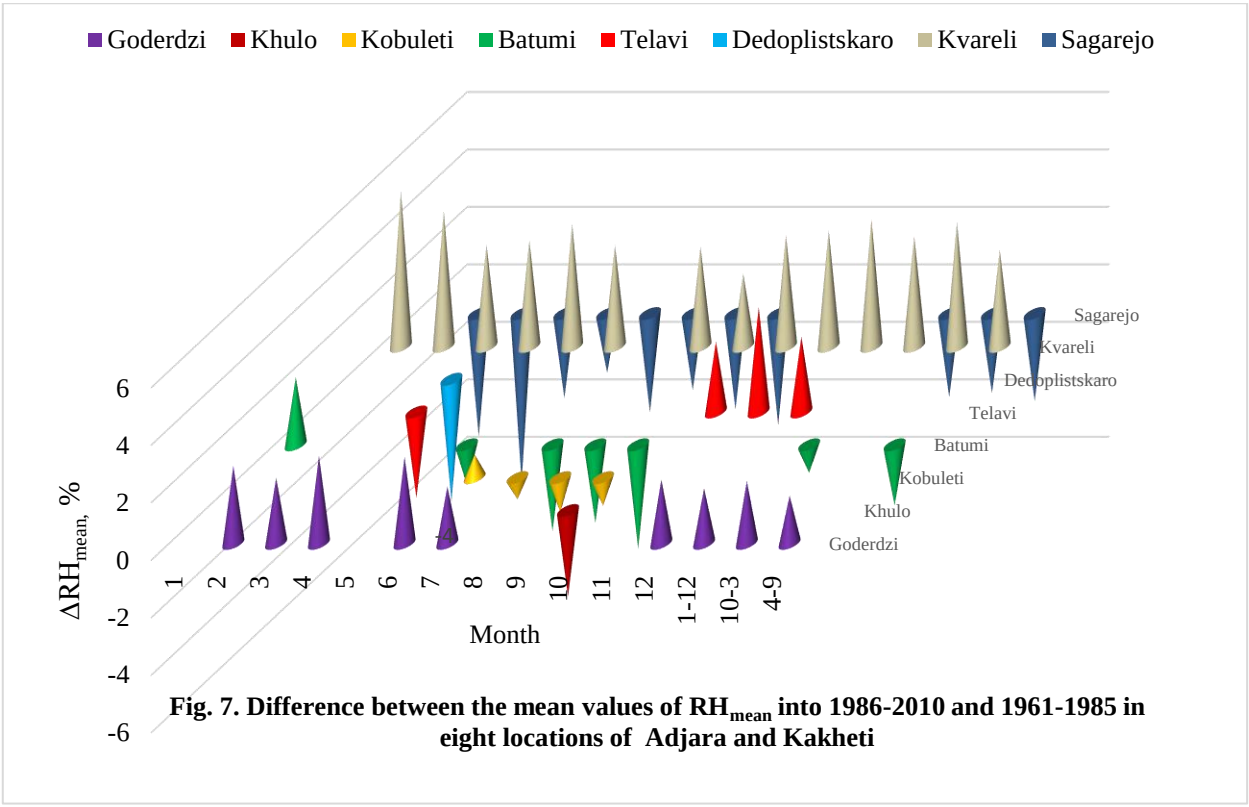

Fig. 7. Difference between the mean values of RH_{mean} into 1986-2010 and 1961-1985 in eight locations of Adjara and Kakheti

In Adjara the values of ΔRH_{mean} varyed from -3.6 to 3.1 %, amplitude - 6.7 %, while in Kakheti - from -5.8 to 5.4 %, amplitude - 11.2%. On the average to the station with the significant changeability of the average monthly air relative humidity in Adjara the value of ΔRH_{mean} grows by 0.1 %, while in Kakheti - to 0.7 %.

Mean minimum air relative humidity

Data about the mean annual, half year and monthly minimum air relative humidity (RH_{min}) in Table 5 and Fig. 8 are represented.

Average for Batumi and Kobuleti the minimum air relative humidity for all months of year by 1.8-18.7% is higher than the values of RH_{min} in Kakheti.

Table 5

Data of RH_{min} (%) in eight locations of Adjara and Kakheti

Location	All data					Mean 1961-2010	
	Mean Year	Mean Cold	Mean Warm	Min	Max	Min	Max
Batumi	69.2	66.4	71.9	48.4	82.1	63.8	73.7
Kobuleti	73.5	72.3	74.6	57.2	85.3	71.4	76.5
Khulo	60.8	62.2	59.4	33.2	86.8	53.2	66.9
Goderdzi	80.4	84.2	76.7	48.0	99.3	72.8	89.5
Telavi	56.9	61.6	52.2	32.0	78.2	48.7	65.5
Dedoplistskaro	63.7	67.9	59.5	36.2	88.5	55.4	69.8
Kvareli	60.3	66.1	54.5	32.9	87.0	51.4	70.9
Sagarejo	53.7	57.7	49.7	31.4	78.8	46.8	60.3

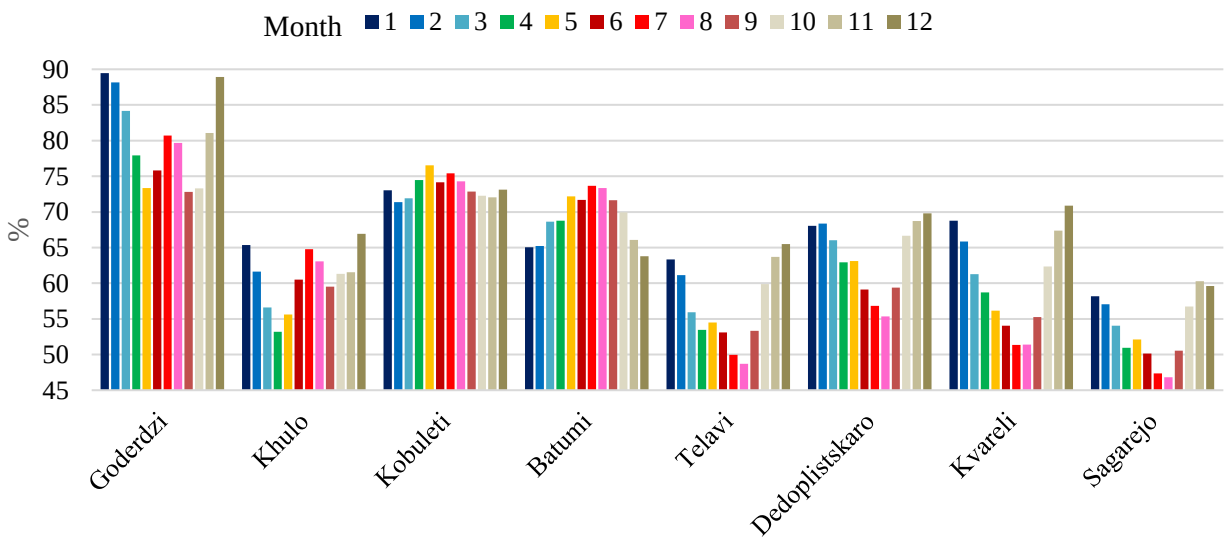

Fig. 8. Mean values of RH_{min} in eight locations of Adjara and Kakheti in 1961-2010

In Batumi distribution of RH_{min} is close to the unimodal with the maximum during July (74%) and the minimum during December (64%); amplitude - 10 %. As in the preceding case, in Kobuleti this distribution closely to the uniform with the maximum during May (77%) and the minimum during February (71 %); amplitude - 6%. In Khulo the intra-annual distribution of RH_{min} takes the form of asymmetrical wave with the maximum during December (67 %) and the smallest value during April (53 %); amplitude - 14 %. In Goderdzi this distribution it takes the form of the convex inverted bell with the basic maximum in December - January (89%), the second maximum during July - August (80-81 %) and two minimums - during May and September - October (73%); amplitude - 8 % (Fig. 8).

For all points of Kakheti the intra-annual distribution of RH_{min} is similar to the motion of RH_{mean} (Fig. 6). In the intra-annual course of minimum relative humidity the smallest values it is observed in July-August (47-57 %), and the greatest values of RH_{mean} - in winter (57-71 %); amplitude - 24 % (Fig. 8).

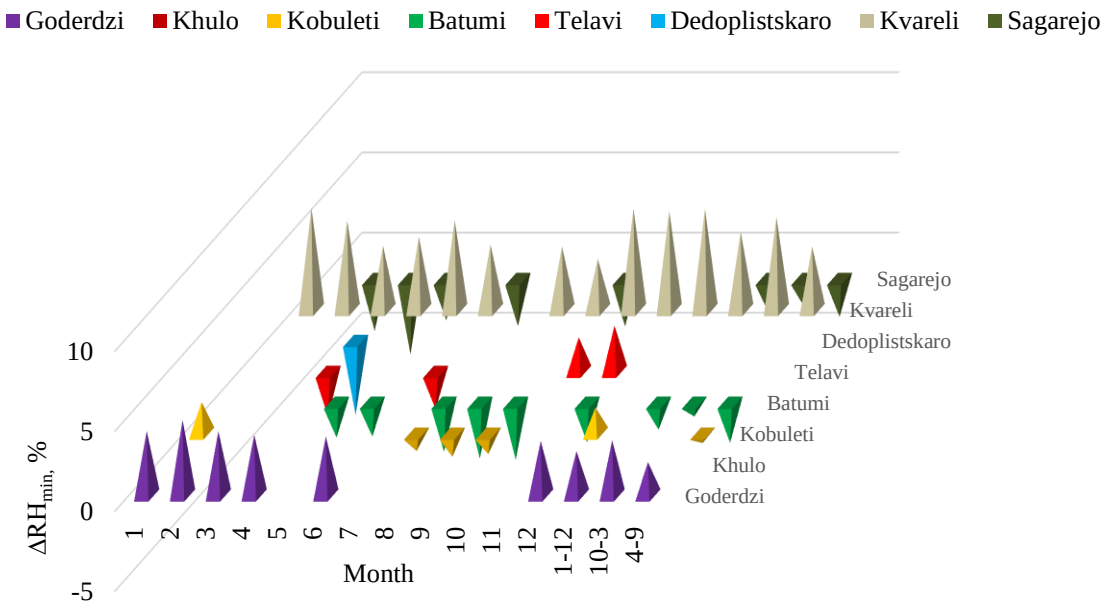

Fig. 9. Difference between the mean values of RH_{min} into 1986-2010 and 1961-1985 in eight locations of Adjara and Kakheti

In different months the significant changeability of the mean monthly minimum air relative humidity for four points of Adjara is observed in 17 cases (including for 8 cases - increase of the values of ΔRH_{min}), and for Kakheti - in 21 case (including for 13 cases - an increase of the values of ΔRH_{min}).

In the separate points the nature of the changeability of the values of ΔRH_{min} is following (Fig. 9).

Batumi - decrease of the values of ΔRH_{min} (April, May, July - September, November); Kobuleti - increase (January, December), decrease (July- September); Khulo - changes are not meant; Goderdzi - increase (January - April, June, December). In Adjara a maximum increase of the values of ΔRH_{min} is observed in Goderdzi (4.7 %, February), minimum - in Kobuleti (1.6 %, December). The greatest decrease of the values of ΔRH_{min} is observed in Batumi (-3.6 %, September), smallest - in Kobuleti (-1.1 %, July).

Telavi - decrease of the values of ΔRH_{min} (March, June), increase (October, November); Dedoplistskaro - decrease (March); Kvareli - increase (all months, except July); Sagarejo - decrease (February- April, June, September). In Kakheti a maximum increase of the values of ΔRH_{min} is observed in Kvareli (6.4 %, January), minimum - in Telavi (2.2 %, October). The greatest decrease of the values of ΔRH_{min} is observed into Sagarejo (-4.7 %, March), smallest - in Telavi (-2.3 %, June).

In Adjara values of ΔRH_{min} changes from -3.6 to 4.7 % (amplitude - 8.3 %), while in Kakheti - from -4.7 to 6.4 % (amplitude - 11.1 %). On the average to the station with the significant changeability of the mean monthly minimum air relative humidity in Adjara the value of ΔRH_{min} grows by 0.4 %, while in Kakheti - to 1.7 % (Fig. 9).

Sum of atmospheric precipitations

Data about mean annual, half year and monthly minimum monthly total precipitation (P) in table 6 and Fig. 10 are represented.

Averaged for the Batumi and Kobuleti monthly total precipitation from January through April and from June through December on 7.2-143.7 mm higher than the values of P in Kakheti. Only during May value of P in Batumi and Kobuleti on 21.9 mm lower than on the average for four points of Kakheti.

Table 6

Data of P (mm) in eight locations of Adjara and Kakheti

Location	All data					Mean 1961-2010	
	Mean Year	Mean Cold	Mean Warm	Min	Max	Min	Max
Batumi	207.4	244.3	170.5	0.0	657.8	89.6	310.1
Kobuleti	194.2	216.6	171.8	10.0	627.9	86.1	286.2
Khulo	116.3	148.6	83.9	0.5	627.6	68.1	174.5
Goderdzi	108.8	114.6	102.9	7.7	361.4	82.2	130.2
Telavi	64.2	41.5	86.9	0.0	240.1	25.6	113.6
Dedoplistskaro	50.8	35.7	65.9	0.0	213.8	24.3	96.8
Kvareli	80.8	57.5	104.0	0.0	313.9	36.2	126.9
Sagarejo	64.0	45.5	82.5	0.0	286.6	28.5	104.7

In Batumi and Kobuleti the intra-annual distribution total precipitation takes the form of the asymmetrical inverted bell with the left displacement and with the plateau from the right edge. In Batumi the minimum of value P is observed during May (90 mm) and greatest values - in September - December (290-310 mm); amplitude - 220 mm. In Kobuleti this distribution has the more clearly expressed maximum during September (286 mm) and a minimum also during May (86 mm); amplitude - 200 mm. In Khulo distribution of P has the type of the flattened inverted bell with the convexity during June (94 mm) and plateau in November - December (171-174 mm). It is observed by the minimum of values of P during July-August (68-69 mm); amplitude - is 106 mm. In Goderdzi this distribution has a nature, similar to the two-wave, with basic maximum during June and October (125 and 130 mm), and by two minimums - during April and August (82 and 95 mm); amplitude - 48 mm (Fig. 10).

For all points of Kakheti the intra-annual motion of monthly total precipitation takes the bimodal form with the left asymmetry, with the extrema in May-June (89-127 mm) and in August - October (53-94 mm) and by the minimum - in December- January (25-47 mm); amplitude - 102 mm (Fig. 10).

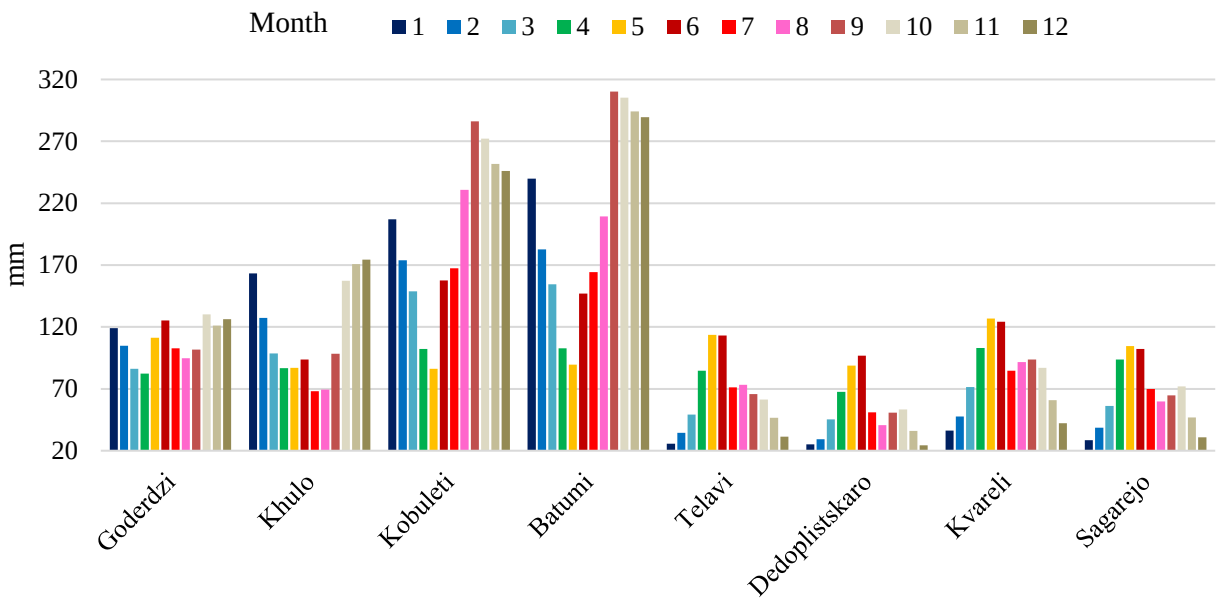

Fig. 10. Mean values of P in eight locations of Adjara and Kakheti in 1961-2010

In different months the significant changeability of mean monthly total precipitation for four points of Adjara is observed in 10 cases (including only for 3 cases - increase in the values of ΔP), and for Kakheti - in all in 6 cases (including only for 2 cases - an increase in the values of ΔP).

In the separate points the following changeability of mean monthly total precipitation is observed (Fig. 11).

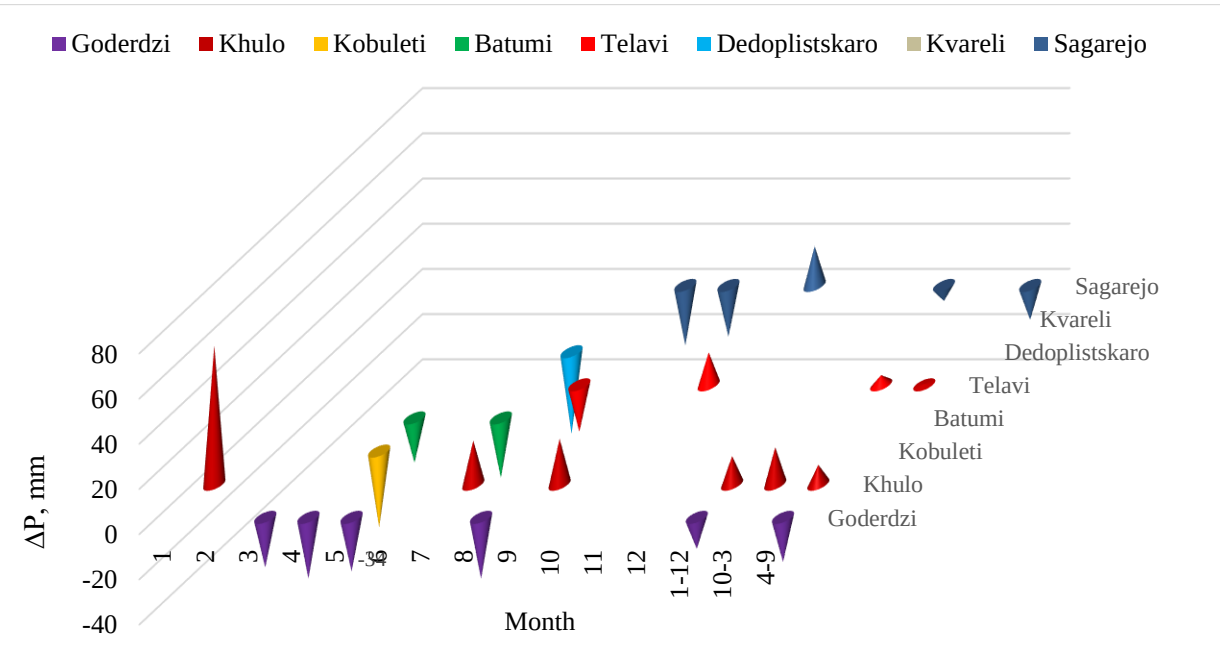

Fig. 11. Difference between the mean values of P into 1986-2010 and 1961-1985 in eight locations of Adjara and Kakheti

Batumi - decrease of the values of ΔP (April, June); Kobuleti - decrease (April); Khulo - increase (January, July, September); Goderdzi - decrease (March- May, August). In Adjara a maximum increase of the values of ΔP is observed into Khulo (61 mm, January), the minimum - also in Khulo (19 mm, July). The greatest decrease of the values of ΔP is observed into Kobuleti (-34 mm, April), the smallest - in Batumi (-20 mm, April).

Telavi - decrease of the values of ΔP (July), increase (October); Dedoplistskaro - decrease (June); Kvareli - the significant changes is not observed; Sagarejo - decrease (July, August), increase (October). In Kakheti a maximum increase in the values of ΔP is observed into Sagarejo (17 mm, October), minimum - in Telavi (14 mm, October). The greatest decrease of the values of ΔP is observed into Dedopltstskaro (-36 mm, June), smallest - in Telavi (-21 mm, July).

In Adjara the values of ΔP is varied from -34 to 61 mm (amplitude - 95 mm), while in Kakheti - from -36 to 17 mm (amplitude - 53 mm). On the average to the station with the significant variability of monthly precipitation in Adjara the value of ΔP diminishes on 8 mm, while in Kakheti - on 12 mm.

Monthly daily sunshine duration

The data about the mean annual, half year and monthly daily sunshine duration (S_d) in Table 7 and Fig. 12 are represented.

Averaged for Batumi and Kobuleti monthly daily sunshine duration during April and from September through November by 0.2-0.7 hour of higher than the values of S_d in Kakheti; during February the differences is not observed. In the remaining months of value of S_d in Batumi and Kobuleti for 0.3-2.5 hour lower than on the average for four points of Kakheti.

Table 7

Data of S_d (hour) in eight locations of Adjara and Kakheti

Location	All data					Mean 1961-2010	
	Mean Year	Mean Cold	Mean Warm	Min	Max	Min	Max
Batumi	5.2	4.0	6.4	1.2	9.8	3.2	7.5
Kobuleti	5.2	4.0	6.5	1.2	10.2	3.1	7.9
Khulo	5.6	4.4	6.7	1.2	10.0	3.3	7.7
Goderdzi	5.4	4.2	6.6	1.2	9.7	3.3	7.3
Telavi	5.7	4.2	7.3	1.5	12.0	3.6	8.5
Dedoplistskaro	5.7	4.1	7.3	1.3	11.6	3.4	8.4
Kvareli	5.8	4.0	7.6	1.3	11.7	3.2	8.8
Sagarejo	6.1	4.6	7.6	2.1	11.9	3.9	8.9

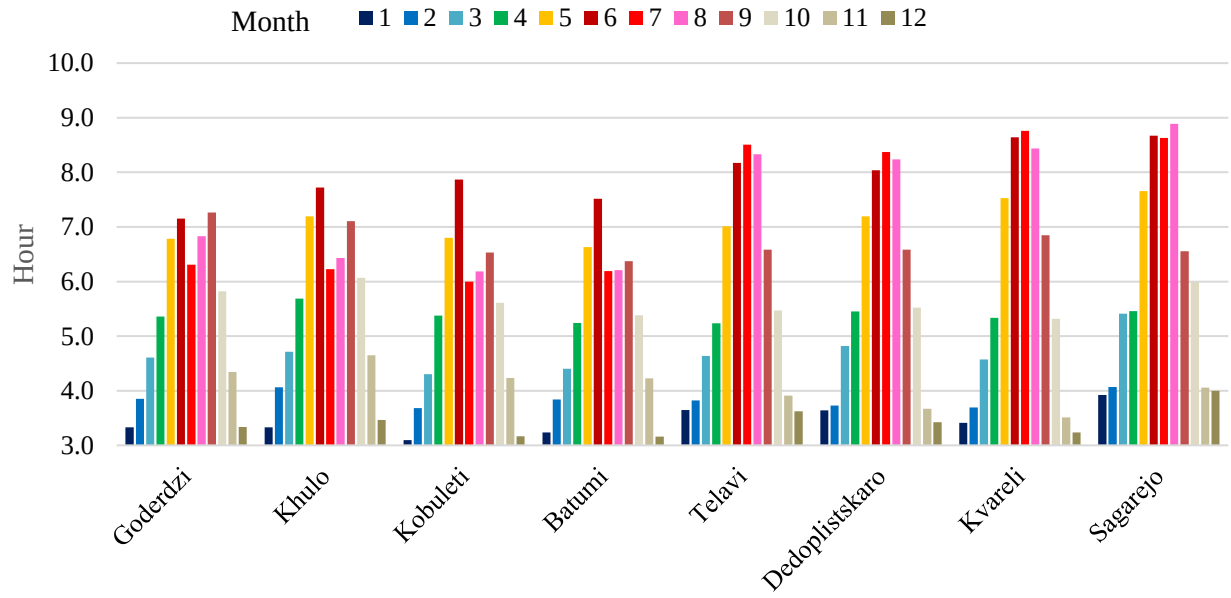

Fig. 12. Mean values of S_d in eight locations of Adjara and Kakheti in 1961-2010

In Adjara the intra-annual distribution of monthly daily sunshine duration takes the bimodal form with the extrema during June and September, respectively: Batumi - 7.5 and 6.4 hour; Kobuleti - 7.9 and 6.5 hour; Khulo - 7.7 and 7.1 hour; Goderdzi - 7.2.and 7.3 hour. Minimum values of S_d for all points of Adjara are observed in December - January (3.1-3.5 hour). Amplitude: Batumi - 4.4 hour, Kobuleti - 4.8 hour, Khulo - 4.4 hour, Goderdzi - 3.9 hour (Fig. 12).

In Kakheti intra-annual distribution of S_d for all points takes the single-modal form close to the symmetrical with the plateau during June-August. Values of S_d in these months comprise: in Telavi - 8.2-8.5 hour; Dedoplistskaro - 8.0-8.4 hour; Kvareli - 8.4-8.8 hour; Sagarejo - 8.6-8.9 hour. The smallest values of S_d in Kakheti in December - January (3.2-4.0 hour) are observed. Amplitude: Telavi - 4.9 hour; Dedoplistskaro - 5.0 hour; Kvareli - 5.5 hour; Sagarejo - 5.0 hour (Fig. 12).

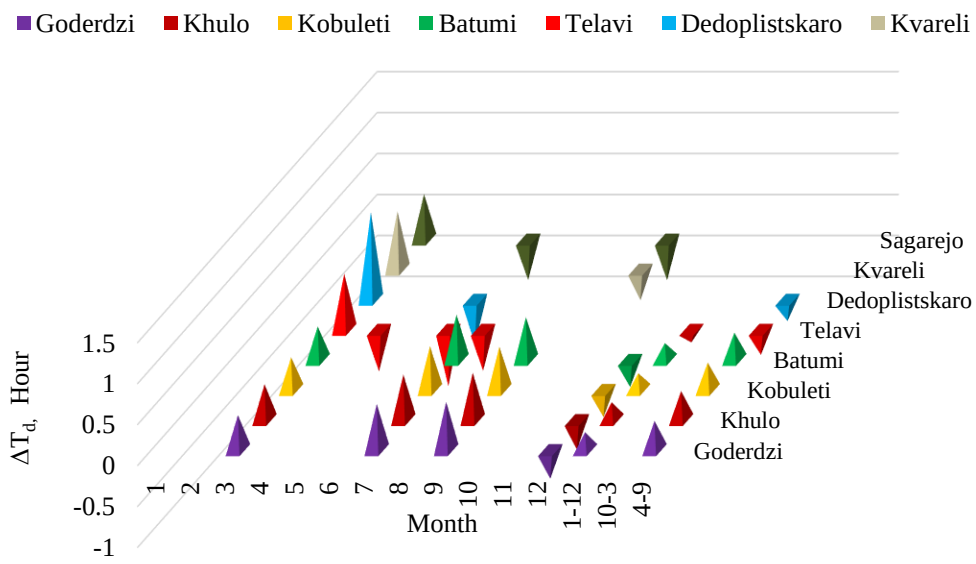

Fig. 13. Difference between the mean values of S_d into 1986-2010 and 1961-1985 in eight locations of Adjara and Kakheti

In different months the significant changeability of the values of ΔS_d for four points of Adjara is observed in 16 cases (including for 12 cases - increase in the values of ΔS_d), and for Kakheti - in 11 cases (including only for 4 cases - an increase in the values of ΔS_d for all points during March).

The changeability of the values of ΔS_d in the separate points is the following (Fig. 13).

Adjara - an increase of the values of ΔS_d is observed for all points during March, July and September (range - from 0.4 to 0.6 hour), and decrease, also for all points - during December (range - from -0.3 to - 0.4 hour).

Telavi – increase of the values of ΔS_d (March), decrease (April, June, July); Dedoplistskaro - increase (March), decrease (June); Kvareli - increase (March), decrease (October); Sagarejo - increase (March), decrease (June, October). In Kakheti a maximum increase of the values of ΔS_d is observed into Dedoplistskaro (1.1 hour, March), minimum - into Sagarejo (0.6 hour, March). The greatest decrease of the values of ΔS_d is observed in Telavi (-0.7 hour, June), smallest - in Kvareli (-0.4 hour, October).

In Adjara the values of ΔS_d change from -0.4 to 0.6 hours (amplitude - 1.0 hour), while in Kakheti - from -0.7 to 1.1 hour (amplitude - 1.8 hour). On the average to the station with the significant changeability of mean monthly daily sunshine duration in Adjara the value of ΔS_d grows by 0.3 hour, while in Kakheti - it diminishes for 0.1 hour.

Mean wind speed

Data about mean annual, half year and monthly values of wind speed (V) in Table 8 and Fig. 14 are represented.

Averaged for Batumi and Kobuleti wind speed for all months of year on 0.8-1.5 m/s is higher than the values of V in Kakheti.

Table 8

Data of V (m/s) in eight locations of Adjara and Kakheti

Location	All data					Mean 1961-2010	
	Mean Year	Mean Cold	Mean Warm	Min	Max	Min	Max
Batumi	1.7	1.8	1.7	0.5	3.0	1.5	2.1
Kobuleti	3.0	3.1	2.9	1.4	5.9	2.6	3.5
Khulo	1.9	2.1	1.7	0.7	3.8	1.5	2.3
Goderdzi	4.8	5.4	4.2	1.9	9.6	4.0	6.3
Telavi	1.4	1.3	1.5	0.3	3.2	1.2	1.7
Dedoplistskaro	1.5	1.5	1.5	0.2	4.6	1.3	1.8
Kvareli	0.9	0.9	1.0	0.2	2.1	0.7	1.1
Sagarejo	1.6	1.6	1.5	0.4	4.4	1.4	1.7

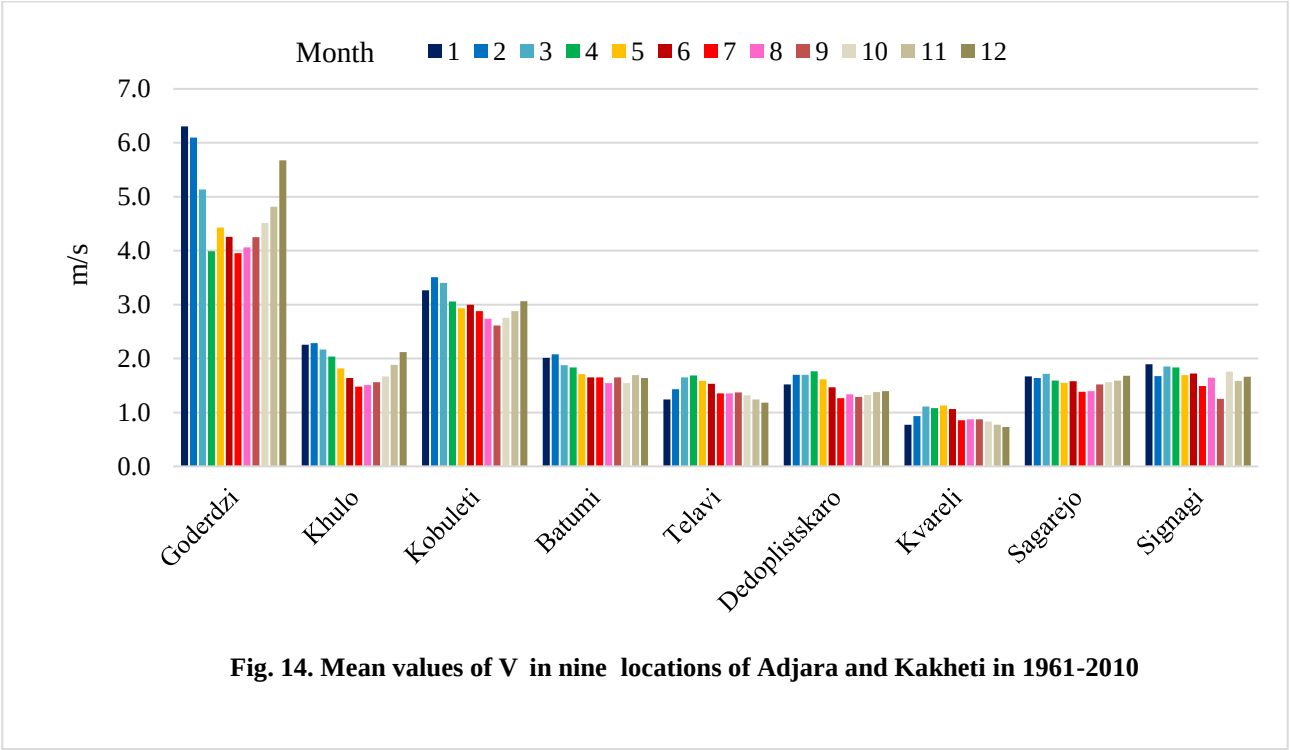

Fig. 14. Mean values of V in nine locations of Adjara and Kakheti in 1961-2010

In Batumi the intra-annual distribution of mean monthly value of wind speed is close to the uniform. In Kobuleti this distribution takes the form of weak asymmetrical wave. In Khulo distribution of values of V has the type of the flattened inverted bell. In Goderdzi this distribution takes the form of the asymmetrical inverted bell with the convexity in May-June. Boundary values of V respectively comprise: in Batumi - 2.1 m/s (October) and 1.5 m/s (August), the amplitude - 0.6 m/s; Kobuleti - 3.5 m/s (January) and 2.6 m/s (September), amplitude - 0.9 m/s; Khulo - 2.3 m/s (January) and 1.5 m/s (July, August), amplitude - 0.8 m/s; Goderdzi - 6.3 m/s (January) and 4.0 m/s (April, August), amplitude - 2.3 m/s (Fig. 14).

In Kakheti the intra-annual distribution of values of V for Telavi takes the form close to the unimodal with the left asymmetry. In Dedoplistskaro and Kvareli this distribution is close to the bimodal, also with the left asymmetry. In Sagarejo the intra-annual distribution of values of V takes the form of the asymmetrical inverted bell with the extrema during December-February and the minimum during July-August (Fig. 14).

In different months of the significant changeability of mean monthly wind speed for the investigated points of Adjara are observed in 30 cases (including for 27 cases - decrease of values of ΔV), and for Kakheti - in 44 cases (decrease of values of ΔV for all points). In the separate points the changeability of values of ΔV is following (Fig. 15).

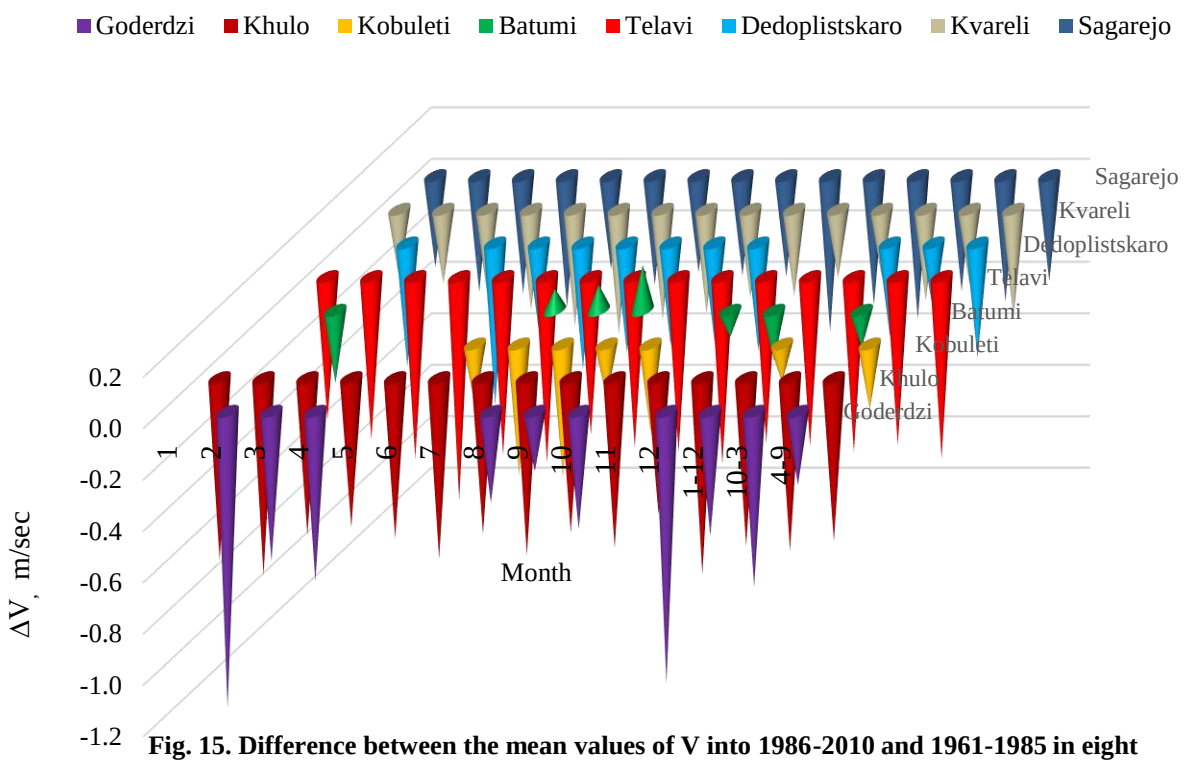

Fig. 15. Difference between the mean values of V into 1986-2010 and 1961-1985 in eight locations of Adjara Kakheti

Batumi - decrease of values of ΔV (February, November, December), increase (July - September); Kobuleti - decrease (June - October); Khulo - decrease (all months); Goderdzi - decrease (February - April, August - October, December). In Adjara a maximum and minimum increase of the values of ΔV is observed in Batumi (0.2 m/s, September and 0.1 m/s, July, August). The greatest decrease of values of ΔV is observed in Goderdzi (-1.2 m/s, February), smallest - in Batumi (-0.1 m/s, November).

In Kakheti at all stations is noted the decrease of values of ΔV, in Telavi, Kvareli and Sagarejo - for all months, into Dedoplistskaro - during February and from May through October. In Adjara values of ΔV are varied from -1.2 to 0.2 m/s (amplitude - 1.4 m/s), while in Kakheti - from -0.9 to -0.3 m/s (amplitude - 0.6 m/s). On the average to the station with the significant changeability of wind speeds both in Adjara and in Kakheti values of ΔV decrease on 0.5 m/s.

Conclusion

The carried out analysis again testifies about the variety of the climatic conditions of the Georgia and their uniqueness. Even in the limits of one and the same locality on the adjacent points are essential differences in the values of different meteorological parameters and their changeability. Accordingly, this causes the need for a detailed study of the climatic and connected with them bioclimatic conditions and their changeability in different geographical regions of the Georgia both from the point of view of action to the health of population and in the aspect of the development of different branches of the national economy of state, including of health resort- tourist industry.

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ზოგიერთ მარტივ თერმულ ინდექსსა და ტურიზმის კლიმატურ ინდექსში შემავალი მეტეოროლოგიური პარამეტრების ცვლილების დადგენა აჭარასა და კახეთის რეგიონში

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რეზიუმე

წარმოდგენილია ზოგიერთ მარტივ თერმულ ინდექსსა და ტურიზმის კლიმატურ ინდექსში შემავალი მეტეოროლოგიური პარამეტრების (ჰაერის საშუალო თვიური და საშუალო თვიური მაქსიმალური ტემპერატურა, ჰაერის საშუალო თვიური და საშუალო მინიმალური თვიური ტენიანობა, ატმოსფერულ ნალექთა ჯამი, მზის ნათების ხანგრძლივობა, ქარის სიჩქარე) სტატისტიკური მახასიათებლები აჭარასა და კახეთის რეგიონში 1961-2010 წწ. დაკვირვების პერიოდისათვის. კერძოდ, შესწავლილია აღნიშნული მეტეოროლოგიური პარამეტრების ცვლილება 1986÷2010 წლებში 1961÷1985 წლებთან შედარებით.

Изменчивость метеорологических параметров, ассоциированных с некоторыми простыми термальными индексами и климатическим индексом туризма, в Аджарии и Кахетии (Грузия)

А.Г. Амиранашвили, Л.Г. Картвелишвили, Т.В. Хахуташвили, Л.Д. Мегрелидзе

Резюме

Представлены статистические данные о метеорологических параметрах, ассоциированных с некоторыми простыми термальными индексами и климатическим индексом туризма (среднемесячная и среднемесячная максимальная температура воздуха, среднемесячная и среднемесячная минимальная относительная влажность воздуха, месячная сумма осадков, продолжительность солнечного сияния, скорость ветра) в восьми пунктах Аджарии (Батуми, Кобулети, Хуло, Годердзи) и (Кахетии Телави, Дедоплисцкаро, Кварели, Сагареджо) в период с 1961 по 2010 гг. В частности, изучена изменчивость указанных метеорологических параметров в 1986÷2010 гг. по сравнению с 1961÷1985 гг. для перечисленных выше пунктов.