Journal of the Georgian Geophysical Society, e-ISSN: 2667-9973, p-ISSN: 1512-1127
Physics of Solid Earth, Atmosphere, Ocean and Space Plasma, v. 24(1), 2021, pp. 44-62

Holiday Climate Index in Kakheti (Georgia)

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ABSTRACT

Data about long-term monthly average values of Holiday Climate Index (HCI) for 12 locations of Kakheti (Akhmeta, Dedoplistskaro, Gombori, Gurjaani, Kvareli, Lagodekhi, Omalo, Sagarejo, Shiraki, Telavi, Tsnori and Udabno) are presented. For 6 stations of this region (Dedoplistskaro, Gurjaani, Kvareli, Lagodekhi, Sagarejo and Telavi) detailed analysis of the monthly, seasonally and annually HCIs values over a 60-year period (1956-2015) are carried out. Comparison of monthly values of HCI and Tourism Climate Index (TCI) for four points of Kakheti (Dedoplistskaro, Kvareli, Sagarejo and Telavi) based on data from 1961 to 2010 are carried out.

Key Words: *Bioclimate, Tourism Climate Index, Holiday Climate Index.*

Introduction

Weather and climate are two factors that in many respects influence on tourism development. Many climate indices for tourism have been applied in past research [1-6]. The most widely known and applied index is the Tourism Climate Index (TCI) proposed by Mieczkowski [7]. In south Caucasus countries, monthly value of TCI be calculated in Georgia, first for Tbilisi [8], then for many other locations of Caucasus (Armenia, Azerbaijan, North Caucasus etc.) [9-16]. For example, the statistical characteristics of the monthly mean, annual and half year values of tourism TCI and its components for four points of Kakheti (Telavi, Dedoplistskaro, Kvareli and Sagarejo) in the period from 1961 through 2010 in [14, 16] are represented. In particular, the changeability of the indicated bioclimatic parameters into 1986÷2010 in comparison with 1961÷1985 is studied, and also the trends of values of TCI for higher enumerated points are investigated.

Despite the TCI's wide application, it has been subject to substantial critiques [17]. The four key deficiencies of the TCI include: (1) the subjective rating and weighting system of climatic variables; (2) it neglects the possibility of an overriding influence of physical climatic parameters (e.g., rain, wind); (3) the low temporal resolution of climate data (i.e., monthly data) has limited relevance for tourist decision-making; and (4) it neglects the varying climatic requirements of major tourism segments and destination types (i.e., beach, urban, winter sports tourism).

To overcome the above noted limitations of the TCI, a Holiday Climate Index (HCI) was developed to more accurately assess the climatic suitability of destinations for tourism. The word "holiday" was chosen to better reflect what the index was designed for (*i.e.*, leisure tourism), since tourism is much broader by definition ("Tourism is a social, cultural and economic phenomenon which entails the movement of people to countries or places outside their usual environment for personal or business/professional purposes" [18-23].

Results of comparison of the holiday climate index and the tourism climate index in Tbilisi are presented in [24]. Comparison of the values and categories of the Tourism Climate Index and Holiday

Climate Index in Tbilisi shows that the intra-annual variation of both indices is similar and has a bimodal form. However, given that the TCI is calculated for the so-called "average tourist" (regardless of gender, age, physical condition), the value and category of this index is lower than the HCI values and categories. In general, HCI more adequately determines the bioclimatic state of the environment for the development of various types of tourism than TCI [24]. The detailed information on the variability of the monthly values of the Holiday Climate Index (HCI) in Tbilisi in 1956-2015 in [25] are presented. It also presents data on the interval forecast of variability of HCI values in Tbilisi for the next few decades.

This study develops a long-term average of HCI for 12 stations of Kakheti region of Georgia (Akhmeta, Dedoplistskaro, Gombori, Gurjaani, Kvareli, Lagodekhi, Omalo, Sagarejo, Shiraki, Telavi, Tsnori and Udabno), detailed analysis of the monthly, seasonally and annually HCIs values over a 60-year period (1956-2015) for 6 stations of this region (Dedoplistskaro, Gurjaani, Kvareli, Lagodekhi, Sagarejo and Telavi) and comparison of monthly values of HCI and TCI for four points of Kakheti (Dedoplistskaro, Kvareli, Sagarejo and Telavi) based on data from 1961 to 2010.

Study Area, Material and Methods

Study area - Kakheti region of Georgia (below - Kakheti). Kakheti is located in the eastern part of Georgia. Area - 11375 km^2, population - 314.7 thous. pers., (including of urban - 71.4 thous. pers.), the capital of region - Telavi (population - 19.8 thous. pers.) [www.geostat.ge].

A visit to Kakheti can be a fascinating experience because of its beautiful mountain landscapes, stunning regions, ancient world temples and monasteries, picturesque valleys and rivers and home to amber grapes that grows under the warmth of the sun. Kakheti is not only famous as a tourism destination, but it is also locally recognized as Georgia's center for winemaking.

Studies for 12 locations of Kakheti (Akhmeta, Dedoplistskaro, Gombori, Gurjaani, Kvareli, Lagodekhi, Omalo, Sagarejo, Shiraki, Telavi, Tsnori and Udabno) are carried out.

Fig. 1 depicts the map of the arrangement of the indicated meteorological stations. Table 1 presents information about coordinates and heights of these 12 meteorological stations, whose data were used in the work. These stations that are located from 223 to 1880 meters above sea level and are open to fresh and pure air because of this.

Fig.1. Locations of 12 meteorological stations in Kakheti.

Table 1. Coordinates and heights of the 12 meteorological stations in Kakheti.

Location (Abbreviation)	Latitude, N°	Longitude, E°	Height, m, a.s.l.
Akhmeta (Akhm)	42.02	45.22	567
Dedoplistskaro (Ded)	41.47	46.08	800
Gombori (Gom)	41.86	45.20	1085
Gurjaani (Gur)	41.75	45.80	410
Kvareli (Kvar)	41.97	45.83	449
Lagodekhi (Lagod)	41.82	46.30	362
Omalo	42.38	45.63	1880
Sagarejo (Sag)	41.73	45.33	802
Shiraki (Shir)	41.40	46.33	555
Telavi (Tel)	41.93	45.48	568
Tsnori	41.63	46.02	223
Udabno (Udab)	41.50	45.47	750

In this work the Holiday Climate Index (HCI) is used. The HCI uses five climatic variables related to the three facets essential to tourism (table 2): thermal comfort (TC), aesthetic (A), and physical (P) facet. The five climatic variables used for the HCI input are maximum air temperature and relative humidity (TC), cloud cover (A), precipitation and wind (P) [12].

The HCI score is calculated according to the following formula: $\mathbf{HCI = 4 \cdot T + 2 \cdot A + 3 \cdot R_d + 1 \cdot W.}$ In tables 2-4 components of Holiday Climate Index, HCI's rating scheme and HCI's category are presented.

Table 2. Components of Holiday Climate Index (HCI).

Facet	Climatic Variable	Index Weighting (%)
Thermal Comfort (TC)	Dry-bulb Temperature (°C): Maximum Temperature (°C)	40%
	Relative Humidity (%): Mean RH	
Aesthetic (A)	Cloud Cover (%)	20%
Physical (P)	Amount of Rain (mm)	30%
	Wind Speed (km/h)	10%

Table 3. HCI's Rating Scheme.

Rating	T - Effective Temperature (°C)	A - Daily Cloud Cover (%)	R_d - Daily Precipitation (mm)	W - Wind Speed (km/h)
10	23÷25	11÷20	0	1÷9
9	20÷22; 26	1÷10; 21÷30	<3	10÷19
8	27÷28	0; 31÷40	3÷5.99	0; 20÷29
7	18÷19; 29÷30	41÷50		
6	15÷17; 31÷32	51÷60		30÷39
5	11÷14; 33÷34	61÷70	6÷8.99	
4	7÷10; 35÷36	71÷80		
3	0÷6	81÷90		40÷49
2	-5÷-1; 37÷39	90÷99	9÷12	
1	<-5	100		
0	>39		>12	50÷70
-1			>25	
-10				>70

Table 4. HCI's Category.

HCI Score	Category (Abbreviation)	HCI Score	Category (Abbreviation)
90÷100	Ideal	**40÷49**	Marginal (Marg.)
80÷89	Excellent (Excell.)	**30÷39**	Unfavorable
70÷79	Very Good	**20÷29**	Very Unfavorable
60÷69	Good	**10÷19**	Extremely Unfavorable
50÷59	Acceptable (Accept.)	**9÷-9; -10÷-20**	Impossible

For the 12 indicated localities the long-term monthly average values of HCI with the use data of Georgian National Environmental Agency are calculated. For 6 stations of this region (Dedoplistskaro, Gurjaani, Kvareli, Lagodekhi, Sagarejo and Telavi) detailed analysis of the monthly, seasonally and annually HCIs values over a 60-year period (1956-2015) are carried out. Comparison of monthly HCI and TCI values for four points of Kakheti (Dedoplistskaro, Kvareli, Sagarejo and Telavi) based on data from 1961-2010 are carried out [14,16].

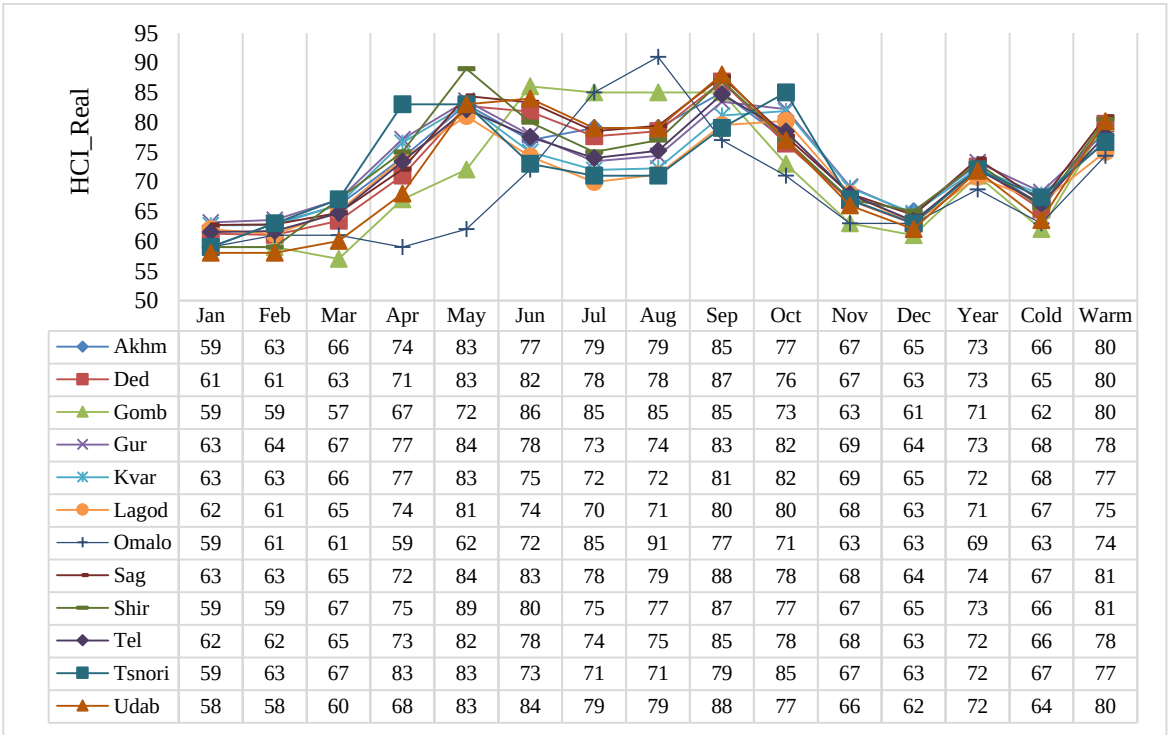
In the work analysis of data is carried out with the use of the standard statistical analysis methods. The following designations will be used below: Mean – average values; Min – minimal values; Max - maximal values; 99%_Low and 99%_Upp - Low and Upper levels of 99% confidence interval of mean values; R^2 - coefficient of determination; R - coefficient of linear correlation.

Results and discussion

Results in the Table 4-18 and Fig. 2-17 are presented.

1. Basic information about HCI for 12 points of Kakheti.

Data about long-term mean of HCI real values at 12 locations of Kakheti in Fig. 2 are presented.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Akhm	59	63	66	74	83	77	79	79	85	77	67	65	73	66	80
Ded	61	61	63	71	83	82	78	78	87	76	67	63	73	65	80
Gomb	59	59	57	67	72	86	85	85	85	73	63	61	71	62	80
Gur	63	64	67	77	84	78	73	74	83	82	69	64	73	68	78
Kvar	63	63	66	77	83	75	72	72	81	82	69	65	72	68	77
Lagod	62	61	65	74	81	74	70	71	80	80	68	63	71	67	75
Omalo	59	61	61	59	62	72	85	91	77	71	63	63	69	63	74
Sag	63	63	65	72	84	83	78	79	88	78	68	64	74	67	81
Shir	59	59	67	75	89	80	75	77	87	77	67	65	73	66	81
Tel	62	62	65	73	82	78	74	75	85	78	68	63	72	66	78
Tsnori	59	63	67	83	83	73	71	71	79	85	67	63	72	67	77
Udab	58	58	60	68	83	84	79	79	88	77	66	62	72	64	80

Fig. 2. Mean of HCI real values at 12 locations of Kakheti.

As follows from Fig. 2 mean monthly values of HCI change from 57 (Gombori, March, Acceptable) to 91 (Omalo, August, Ideal). The variability of HCI values for individual items is as follows:
Akhmeta (59, January – 85, September), Dedoplistskaro (61, January, February – 87, September), Gombori (57, March – 86, June), Gurjaani (63, January – 84, May), Kvareli (63, January, February – 83, May), Lagodekhi (61, February – 81, May), Omalo (59, January, April – 91, August), Sagarejo (63, January, February – 88, September), Shiraki (59, January, February – 89, May), Telavi (62, January, February – 85,September), Tsnori (59, January – 85, October, Udabno (58, January, February – 88, September).

Table 5. Linear correlation coefficient between separated stations on the mean monthly values of HCI (R min = 0.60, α = 0.05; R min = 0.56, α = 0.075; R min = 0.52, α = 0.10; R min = 0.47, α = 0.15).

Location	Akhm	Ded	Gomb	Gur	Kvar	Lagod	Omalo	Sag	Shir	Tel	Tsnori	Udab
Akhm	1	0.97	0.87	0.92	0.89	0.90	0.64	0.97	0.97	0.97	0.82	0.96
Ded	0.97	1	0.91	0.91	0.87	0.89	0.64	1.00	0.96	0.98	0.75	1.00
Gomb	0.87	0.91	1	0.71	0.64	0.66	0.85	0.90	0.78	0.82	0.52	0.93
Gur	0.92	0.91	0.71	1	0.99	0.99	0.38	0.92	0.95	0.97	0.94	0.89
Kvar	0.89	0.87	0.64	0.99	1	1.00	0.32	0.88	0.93	0.95	0.96	0.85
Lagod	0.90	0.89	0.66	0.99	1.00	1	0.35	0.90	0.94	0.96	0.94	0.87
Omalo	0.64	0.64	0.85	0.38	0.32	0.35	1	0.62	0.48	0.53	0.22	0.67
Sag	0.97	1.00	0.90	0.92	0.88	0.90	0.62	1	0.96	0.98	0.76	0.99
Shir	0.97	0.96	0.78	0.95	0.93	0.94	0.48	0.96	1	0.98	0.84	0.94
Tel	0.97	0.98	0.82	0.97	0.95	0.96	0.53	0.98	0.98	1	0.85	0.97
Tsnori	0.82	0.75	0.52	0.94	0.96	0.94	0.22	0.76	0.84	0.85	1	0.72
Udab	0.96	1.00	0.93	0.89	0.85	0.87	0.67	0.99	0.94	0.97	0.72	1

Linear correlation coefficient between separated station on the mean monthly values of HCI changes as follows (Table 5). Akhmeta: 0.64 (Omalo) - 0.97 (Dedoplistskaro, Sagarejo, Shiraki, Telavi); Dedoplistskaro: 0.64 (Omalo) – 1.00 (Sagarejo, Udabno); Gombori: 0.52 (Tsnori) – 0.93 (Udabno); Gurjaani: 0.38 (non sign, Omalo) – 0.99 (Kvareli, Lagodekhi); Kvareli: 0.32 (non sign, Omalo) – 1.00 (Lagodekhi); Lagodekhi: 0.35 (non sign, Omalo) – 1.00 (Kvareli); Omalo: 0.22 (non sign, Tsnori) – 0.85 (Gombori); Sagarejo: 0.62 (Omalo) – 1.00 (Dedoplistskaro); Shiraki: 0.48 (Omalo) – 0.98 (Telavi); Telavi: 0.53 (Omalo) – 0.98 (Dedoplistskaro, Sagarejo, Shiraki); Tsnori: 0.22 (non sign, Omalo) – 0.96 (Kvareli); Udabno: 0.67 (Omalo) – 1.00 (Dedoplistskaro).

Distribution of mean monthly values of TCI for 12 locations of Kakheti by a ninth power of polynomial ($R^2 \geq 0.978$) are described. Coefficients of the equation of the regression of the intra-annual motion of mean monthly values of HCI for these points in Table 6 are presented.

Table 6. Coefficients of the equation of the regression of the intra-annual motion of mean monthly values of HCI for 12 points of Kakheti.

Equation of regress., coefficients	$HCI = a \cdot X^9 + b \cdot X^8 + c \cdot X^7 + d \cdot X^6 + e \cdot X^5 + f \cdot X^4 + g \cdot X^3 + h \cdot X^2 + i \cdot X + j$, (X-Month)										
	a	b	c	d	e	f	g	h	i	j	R^2
Akhm	-7.05E-05	3.81E-03	-8.54E-02	1.02E+00	-7.08E+00	2.82E+01	-6.12E+01	6.11E+01	-9.50E+00	4.65E+01	0.978
Ded	-2.35E-04	1.35E-02	-3.26E-01	4.37E+00	-3.52E+01	1.76E+02	-5.40E+02	9.72E+02	-9.25E+02	4.08E+02	0.996
Gom	-6.56E-05	3.78E-03	-9.19E-02	1.23E+00	-9.81E+00	4.79E+01	-1.41E+02	2.38E+02	-2.10E+02	1.33E+02	0.979
Gur	4.62E-05	2.70E-03	6.75E-02	9.38E-01	7.94E+00	4.22E+01	1.39E+02	2.69E+02	2.74E+02	1.09E+02	0.996
Kvar	2.38E-06	-2.91E-04	1.31E-02	-2.93E-01	3.67E+00	-2.67E+01	1.12E+02	-2.56E+02	2.88E+02	-5.82E+01	0.990
Lagod	-4.37E-05	2.44E-03	-5.61E-02	6.80E-01	-4.68E+00	1.81E+01	-3.67E+01	3.36E+01	-7.02E+00	5.81E+01	0.993
Omalo	1.57E-04	-9.07E-03	2.22E-01	-3.00E+00	2.44E+01	-1.23E+02	3.82E+02	-6.99E+02	6.78E+02	-2.00E+02	0.990
Sag	4.92E-05	2.88E-03	7.19E-02	9.99E-01	8.46E+00	4.49E+01	1.48E+02	2.87E+02	2.92E+02	1.16E+02	0.997
Shir	1.22E-04	7.16E-03	1.79E-01	2.49E+00	2.11E+01	1.12E+02	3.68E+02	7.14E+02	7.27E+02	2.89E+02	0.984
Tel	-1.46E-04	8.30E-03	-1.98E-01	2.59E+00	-2.02E+01	9.72E+01	-2.85E+02	4.89E+02	-4.45E+02	2.23E+02	0.993
Tsnori	2.22E-04	-1.31E-02	3.31E-01	-4.69E+00	4.06E+01	-2.20E+02	7.40E+02	-1.45E+03	1.49E+03	-5.31E+02	0.996
Udab	-2.79E-04	1.61E-02	-3.93E-01	5.30E+00	-4.31E+01	2.17E+02	-6.71E+02	1.22E+03	-1.16E+03	4.95E+02	0.997

In Table 7 information about distribution types of mean monthly values of HCI at 12 locations of Kakheti are provides.

As follows from this Table in general bimodal distribution type of HCI is observed (10 locations from 12). For stations Akhmeta, Dedoplistskaro, Sagarejo, Shiraki and Telavi the first and second extremum in HCI distribution fall on May and September respectively; for stations Gurjaani, Kvareli and Lagodekhi - on May and September-October; for Tsnori - on April-May and October and for Udabno - on May-June and September.

For Gombori unimodal distribution type of HCI with plateau in June-September is observed; for Omalo - unimodal distribution type with maximum in August.

Table 7. Distribution types of mean monthly values of HCI at 12 locations of Kakheti.

Location	Distribution type	First extremum	Second extremum	Location	Distribution type	First extremum	Second extremum
Akhmeta	Bimodal	May	Sep	**Omalo**	Unimodal	Aug	
Dedoplistskaro				**Sagarejo**	Bimodal	May	Sep
Gombori	Unimodal, plateau	June-Sept		**Shiraki**			
Gurjaani	Bimodal	May	Sep-Oct	**Telavi**			
Kvareli				**Tsnori**		Apr-May	Oct
Lagodekhi				**Udabno**		May-Jun	Sep

In Table 8 and 9 data about categories of mean monthly and seasonal values of HCI at 12 locations of Kakheti in cold and warm period are presented.

Table 8. Categories of mean monthly and seasonal values of HCI at 12 locations of Kakheti in cold period.

Location	Jan	Feb	Mar	Oct	Nov	Dec	Cold	Year
Akhmeta	Accept.	Good	Good	Very Good	Good	Good	Good	Very Good
Dedoplistskaro	Good							
Gombori	Accept.	Accept.	Accept.					
Gurjaani	Good	Good	Good	Excell.				
Kvareli								
Lagodekhi								
Omalo	Accept.			Very Good				Good
Sagarejo	Good							Very Good
Shiraki	Accept.	Accept.						
Telavi	Good	Good						
Tsnori	Accept.			Excell.				
Udabno		Accept.		Very Good				

Table 9. Categories of mean monthly and seasonal values of HCI at 12 locations of Kakheti in warm period.

Location	Apr	May	Jun	Jul	Aug	Sep	Warm
Akhmeta	Very Good	Excell.	Very Good	Very Good	Very Good	Excell.	Excell.
Dedoplistskaro			Excell.				
Gombori	Good	Very Good		Excell.	Excell.		
Gurjaani	Very Good	Excell.	Very Good	Very Good	Very Good		Very Good
Kvareli							
Lagodekhi							
Omalo	Accept.	Good		Excell.	Ideal	Very Good	
Sagarejo	Very Good	Excell.	Excell.	Very Good	Very Good	Excell.	Excell.
Shiraki							
Telavi			Very Good				Very Good
Tsnori	Excell.					Very Good	
Udabno	Good		Excell.			Excell.	Excell.

As follows from these Tables, categories of mean monthly and seasonal values of HCI at 12 locations of Kakheti changes from Acceptable to Ideal.

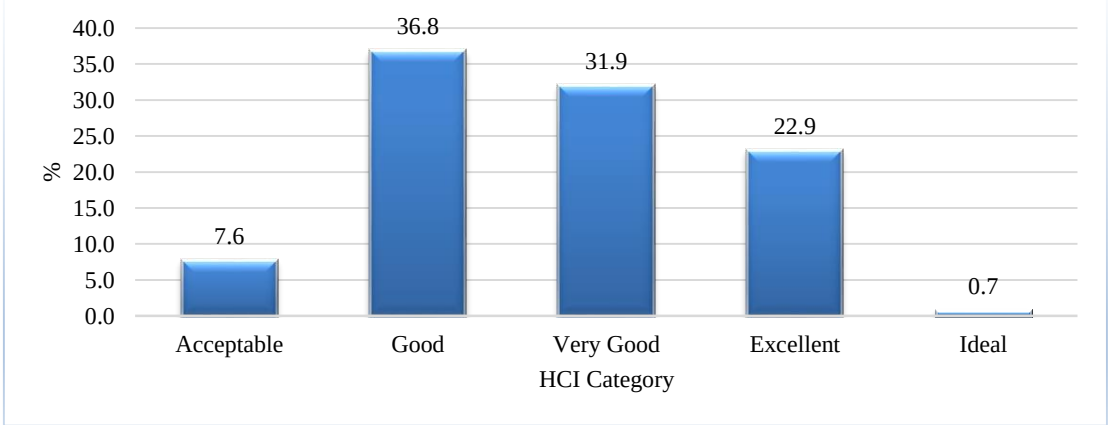
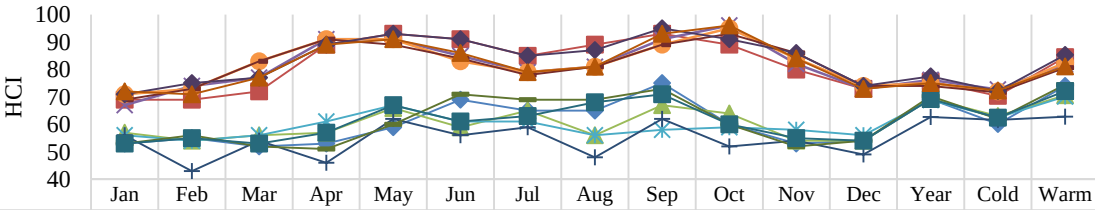


Fig. 3. Repetition of mean monthly HCI category at 12 locations of Kakheti.

In Fig. 3 information about repetition of mean monthly HCI category at 12 locations of Kakheti is presented. So, as follows from Tables 8, 9 and Fig. 3 in Kakheti there are favorable conditions for the development of tourism and resorts throughout the year.

2. Analysis of HCI and HCI components at 6 points of Kakheti in 1956-2015.

Detailed analysis of HCI and HCI components at 6 points of Kakheti from 1956 to 2015 in Fig. 4-15 and Tables 10-15 are presented.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Ded Min	53	55	52	53	59	69	65	65	75	60	53	54	69	60	74
Ded Max	69	69	72	89	93	91	85	89	93	89	80	73	76	70	85
Gur Min	57	54	56	57	66	59	65	56	67	64	54	54	69	63	71
Gur Max	67	74	77	91	91	85	79	81	91	96	82	73	76	73	82
Kvar Min	56	54	56	61	67	61	61	56	58	59	58	56	69	63	70
Kvar Max	71	73	83	91	91	83	79	81	89	95	84	74	75	72	83
Lagod Min	56	43	54	46	62	56	59	48	62	52	54	49	63	62	63
Lagod Max	69	73	83	91	89	84	78	81	89	93	86	74	74	72	81
Sag Min	53	56	52	51	60	71	69	69	73	60	52	54	70	62	75
Sag Max	71	75	77	89	93	91	85	87	95	91	86	74	78	72	85
Tel Min	53	55	53	57	67	61	63	68	71	60	55	54	69	63	72
Tel Max	72	71	77	89	91	86	79	81	93	96	84	73	75	72	81

Fig. 4. Min and Max values of HCI at 6 locations of Kakheti in different months and season in 1956-2015.

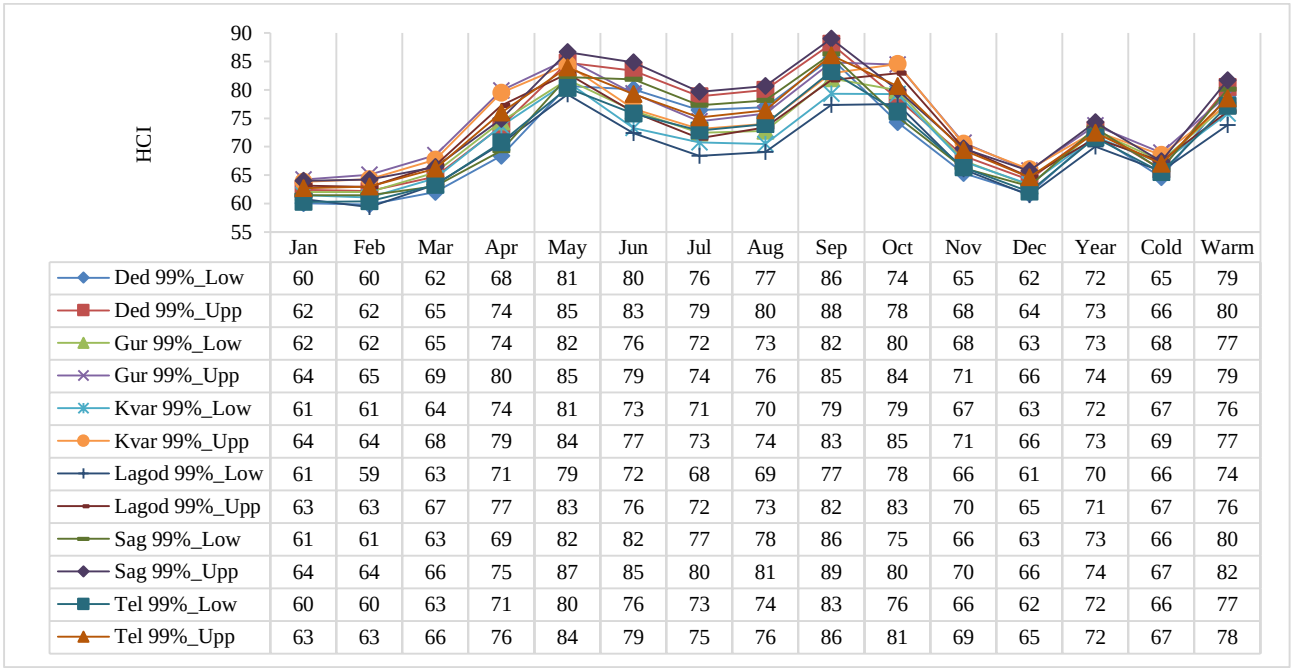
In Fig. 4 and Tables 10,11 data about Min and Max values of HCI and these categories at 6 locations of Kakheti in different months and season in 1956-2015 are presented. As follows from these Fig. and Tables values of HCI in 6 locations of Kakheti changes from 43 (Lagodekhi, February, Marginal) to 96 (Telavi, October, Ideal).

Table 10. Categories of Min and Max values of HCI at 6 locations of Kakheti in cold period in 1956-2015.

Location	Parameter	Jan	Feb	Mar	Oct	Nov	Dec	Cold	Year
Ded	**Min**	Accept. Good	Accept.	Accept. Very Good	Good	Accept. Excell.	Accept. Very Good	Good Very Good	Good Very Good
Ded	**Max**		Good		Excell.				
Gur	**Min**		Accept. Very Good		Good				
Gur	**Max**				Ideal				
Kvar	**Min**	Accept.		Accept. Excell.	Accept. Ideal		Marg.		
Kvar	**Max**	Very Good					Very Good		
Lagod	**Min**	Accept.	Marg.						
Lagod	**Max**	Good	Very Good						
Sag	**Min**	Accept. Very Good	Accept. Very Good	Accept. Very Good	Good Ideal		Accept. Very Good		Very Good
Sag	**Max**								
Tel	**Min**								Good
Tel	**Max**								Very Good

Table 11. Category of Min and Max values of HCI at 6 locations of Kakheti in warm period in 1956-2015.

Location	Parameter	Apr	May	Jun	Jul	Aug	Sep	Warm
Ded	**Min**	Accept.	Accept.	Good	Good	Good	Very Good	Very Good Excell.
Ded	**Max**	Excell.	Ideal	Ideal	Excell.	Excell.	Ideal	
Gur	**Min**	Accept.	Good Ideal	Accept.	Good Very Good	Accept. Excell.	Good	
Gur	**Max**	Ideal		Excell.			Ideal	
Kvar	**Min**	Good		Good			Accept.	
Kvar	**Max**	Ideal		Excell.			Excell.	
Lagod	**Min**	Marg.	Good	Accept.	Accept.	Marg.	Good	Good
Lagod	**Max**	Ideal	Excell.	Excell.	Very Good	Excell.	Excell.	Excell.
Sag	**Min**	Accept. Excell.	Good Ideal	Very Good	Good	Good Excell.	Very Good Ideal	Very Good Excell.
Sag	**Max**			Ideal	Excell.			
Tel	**Min**			Good	Good			
Tel	**Max**			Excell.	Very Good			



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Ded 99%_Low	60	60	62	68	81	80	76	77	86	74	65	62	72	65	79
Ded 99%_Upp	62	62	65	74	85	83	79	80	88	78	68	64	73	66	80
Gur 99%_Low	62	62	65	74	82	76	72	73	82	80	68	63	73	68	77
Gur 99%_Upp	64	65	69	80	85	79	74	76	85	84	71	66	74	69	79
Kvar 99%_Low	61	61	64	74	81	73	71	70	79	79	67	63	72	67	76
Kvar 99%_Upp	64	64	68	79	84	77	73	74	83	85	71	66	73	69	77
Lagod 99%_Low	61	59	63	71	79	72	68	69	77	78	66	61	70	66	74
Lagod 99%_Upp	63	63	67	77	83	76	72	73	82	83	70	65	71	67	76
Sag 99%_Low	61	61	63	69	82	82	77	78	86	75	66	63	73	66	80
Sag 99%_Upp	64	64	66	75	87	85	80	81	89	80	70	66	74	67	82
Tel 99%_Low	60	60	63	71	80	76	73	74	83	76	66	62	72	66	77
Tel 99%_Upp	63	63	66	76	84	79	75	76	86	81	69	65	72	67	78

Fig. 5. Low and Upper levels of 99% confidence interval of mean values of HCI at six locations of Kakheti in 1956-2015.

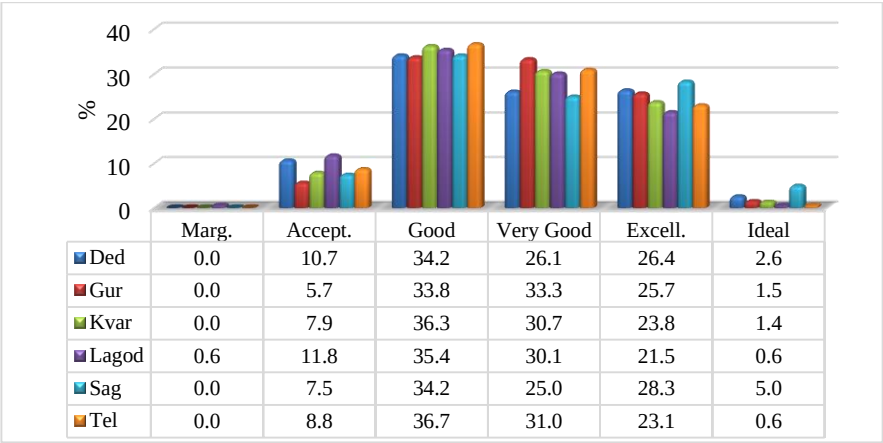
Table 12. Category of Low and Upper levels of 99% confidence interval of mean values of HCI at 6 locations of Kakheti in cold period in 1956-2015.

Location	Parameter	Jan	Feb	Mar	Oct	Nov	Dec	Cold	Year
Ded	**99%_Low**	Good	Good	Good	Very Good	Good	Good	Good	Very Good
Ded	**99%_Upp**								
Gur	**99%_Low**				Excell.	Good			
Gur	**99%_Upp**					Very Good			
Kvar	**99%_Low**				Very Good	Good Very Good			
Kvar	**99%_Upp**				Excell.				
Lagod	**99%_Low**		Accept.		Very Good				
Lagod	**99%_Upp**		Good		Excell.				
Sag	**99%_Low**		Good		Very Good				
Sag	**99%_Upp**				Excell.				
Tel	**99%_Low**				Very Good	Good			
Tel	**99%_Upp**				Excell.				

Table 13. Category of Low and Upper levels of 99% confidence interval of mean values of HCI at 6 locations of Kakheti in warm period in 1956-2015.

Location	Parameter	Apr	May	Jun	Jul	Aug	Sep	Warm
Ded	**99%_Low**	Good	Excell.	Excell.	Very Good	Very Good	Excell.	Very Good
Ded	**99%_Upp**	Very Good				Excell.		Excell.
Gur	**99%_Low**	Very Good		Very Good		Very Good		Very Good
Gur	**99%_Upp**	Excell.					Very Good	
Kvar	**99%_Low**	Very Good					Excell.	
Kvar	**99%_Upp**							
Lagod	**99%_Low**		Very Good		Good	Good	Very Good	
Lagod	**99%_Upp**		Excell.		Very Good	Very Good	Excell.	
Sag	**99%_Low**	Good	Excell.	Excell.	Very Good	Very Good	Excell.	Excell.
Sag	**99%_Upp**	Very Good			Excell.	Excell.		
Tel	**99%_Low**	Very Good		Very Good	Very Good	Very Good		Very Good
Tel	**99%_Upp**							

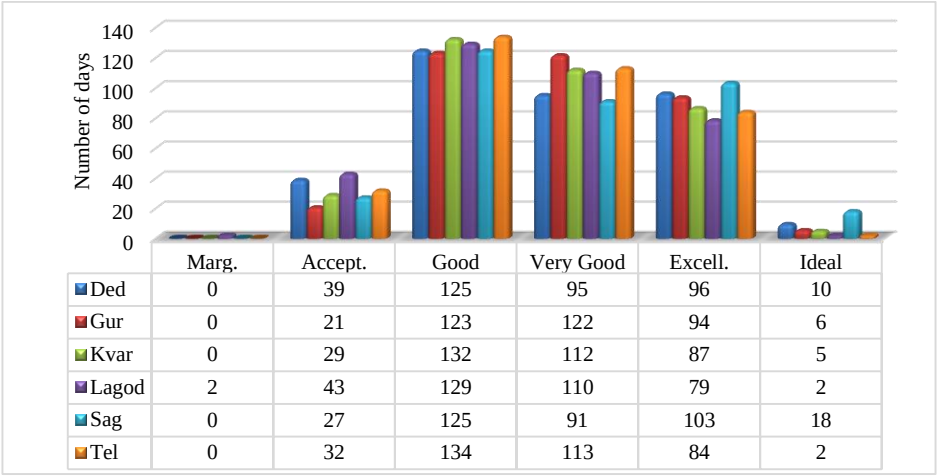
In Fig. 5 and Tables 12,13 information about 99%_Low and 99%_Upp levels of mean values of HCI and these categories at 6 locations of Kakheti in different months and season in 1956-2015 are presented. As follows from these Fig. and Tables values of HCI in 6 locations of Kakheti changes from 43 (Lagodekhi, February, Marginal) to 96 (Telavi, October, Ideal). As follows from these Fig. and Tables values of HCI in 6 locations of Kakheti changes from 59 (Acceptable) to 89 (Excellent).



	Marg.	Accept.	Good	Very Good	Excell.	Ideal
Ded	0.0	10.7	34.2	26.1	26.4	2.6
Gur	0.0	5.7	33.8	33.3	25.7	1.5
Kvar	0.0	7.9	36.3	30.7	23.8	1.4
Lagod	0.6	11.8	35.4	30.1	21.5	0.6
Sag	0.0	7.5	34.2	25.0	28.3	5.0
Tel	0.0	8.8	36.7	31.0	23.1	0.6

Fig. 6. Repetition of monthly values of TCI categories at six locations of Kakheti in 1956-2015.

In Fig. 6 data about repetition of monthly values of TCI category at six locations of Kakheti in 1956-2015 are presented. The variability of this repetition for separate locations of Kakheti is as follows: Dedoplistskaro (2,6%, Ideal – 34.2%, Good), Gurjaani (1,5%, Ideal – 33,8% Good), Kvareli (1,4%, Ideal – 36.3%, Good), Lagodekhi (0,6%, Marginal, Ideal – 35.4%, Good), Sagarejo (5,0%, Ideal – 34.2%, Good), Telavi (0,6%, Ideal – 36.7%, Good).



	Marg.	Accept.	Good	Very Good	Excell.	Ideal
Ded	0	39	125	95	96	10
Gur	0	21	123	122	94	6
Kvar	0	29	132	112	87	5
Lagod	2	43	129	110	79	2
Sag	0	27	125	91	103	18
Tel	0	32	134	113	84	2

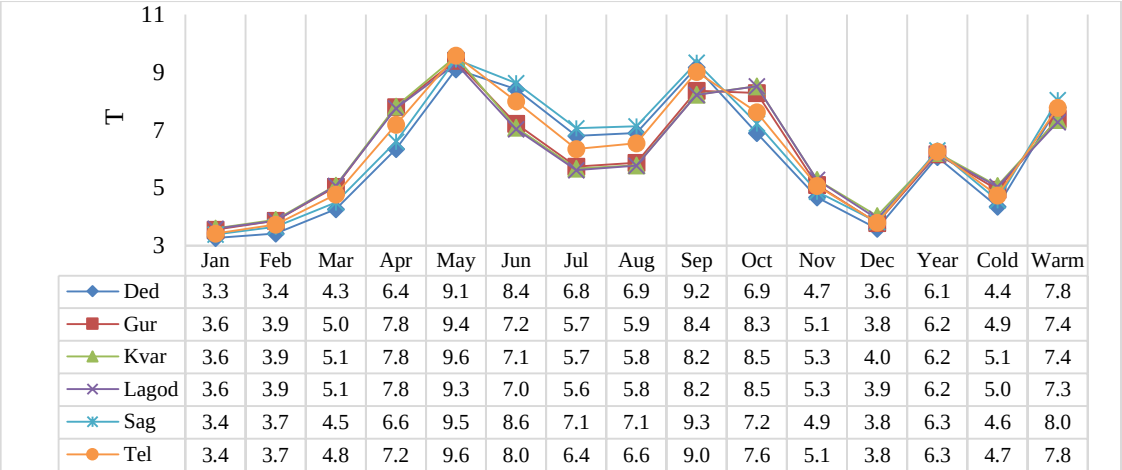
Fig. 7. Number of days in year of various categories of HCI at six locations of Kakheti in 1956-2015.

Respectively the variability of number of days in year of various categories of HCI for separate locations of Kakheti is as follows (Fig. 7): Dedoplistskaro (10, Ideal – 125, Good), Gurjaani (6, Ideal – 123, Good), Kvareli (5, Ideal – 132, Good), Lagodekhi 2, Marginal, Ideal – 129, Good), Sagarejo (18, Ideal – 125, Good), Telavi (2, Ideal – 134, Good).

In Table 14 and Fig. 8-11 data about Min, Max and mean values of HCI components at six locations of Kakheti are presented. As follows from these Table and Fig. the monthly values of HCI components changes from 0 (Rd, Lagodekhi) to 10 (all components, all locations). The monthly mean values of HCI components changes from 3.3 (T, Lagodekhi) to 10 (W, all locations besides Lagodekhi).

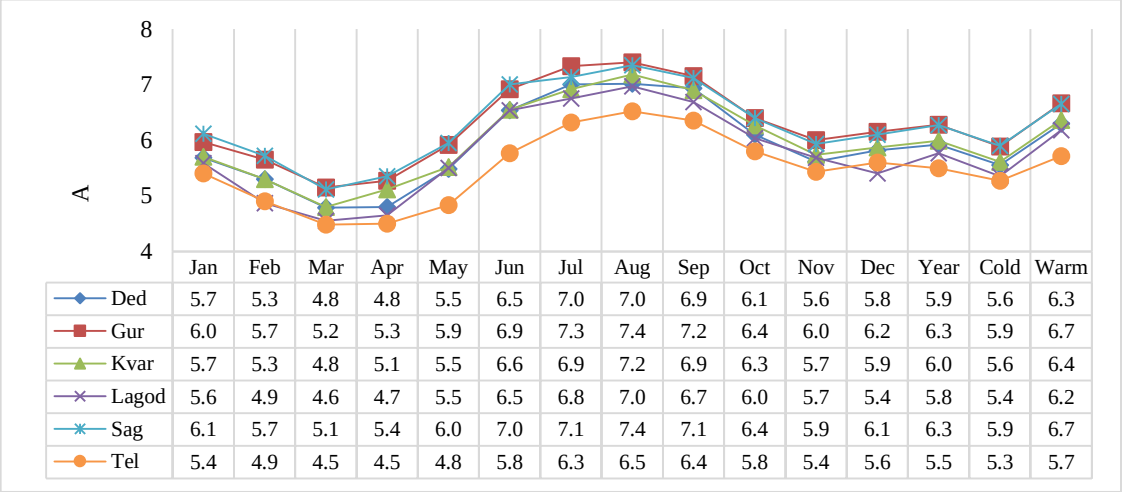
Table 14. Data of Min and Max values of HCI components at six locations of Kakheti.

Parameter	All data		Mean monthly 1956-2015		All data		Mean monthly 1956-2015	
	Min	Max	Min	Max	Min	Max	Min	Max
	Dedoplistskaro				Lagodekhi			
T	2	10	3.3	9.2	2	10	3.6	9.3
A	2	10	4.8	7.0	2	10	4.6	7.0
Rd	5	10	8.4	9.0	0	10	7.7	9.0
W	9	10	9.8	10	8	10	9.6	9.9
	Gurjaani				Sagarejo			
T	2	10	3.6	9.4	2	10	3.4	9.5
A	3	10	5.2	7.4	3	10	5.1	7.4
Rd	2	10	8.1	9.0	2	10	8.3	9.0
W	10	10	10	10	9	10	9.9	10
	Kvareli				Telavi			
T	2	10	3.6	9.6	2	10	3.4	9.6
A	3	10	4.8	7.2	1	10	4.5	6.5
Rd	2	10	7.9	9.0	5	10	8.0	9.0
W	10	10	10	10	9	10	9.9	10



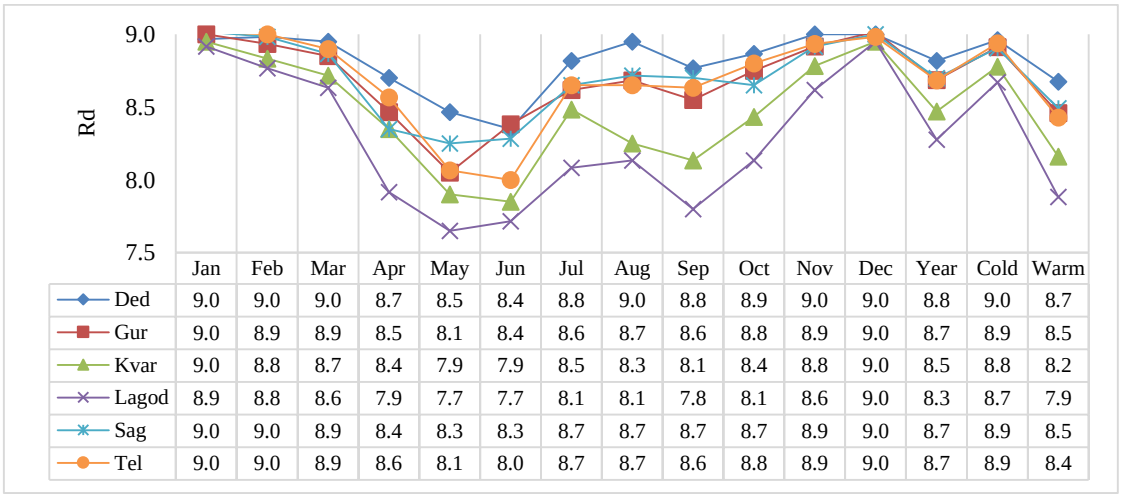
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Ded	3.3	3.4	4.3	6.4	9.1	8.4	6.8	6.9	9.2	6.9	4.7	3.6	6.1	4.4	7.8
Gur	3.6	3.9	5.0	7.8	9.4	7.2	5.7	5.9	8.4	8.3	5.1	3.8	6.2	4.9	7.4
Kvar	3.6	3.9	5.1	7.8	9.6	7.1	5.7	5.8	8.2	8.5	5.3	4.0	6.2	5.1	7.4
Lagod	3.6	3.9	5.1	7.8	9.3	7.0	5.6	5.8	8.2	8.5	5.3	3.9	6.2	5.0	7.3
Sag	3.4	3.7	4.5	6.6	9.5	8.6	7.1	7.1	9.3	7.2	4.9	3.8	6.3	4.6	8.0
Tel	3.4	3.7	4.8	7.2	9.6	8.0	6.4	6.6	9.0	7.6	5.1	3.8	6.3	4.7	7.8

Fig. 8. Mean monthly and seasonal values of T component of HCI at six locations of Kakheti in 1956-2015.



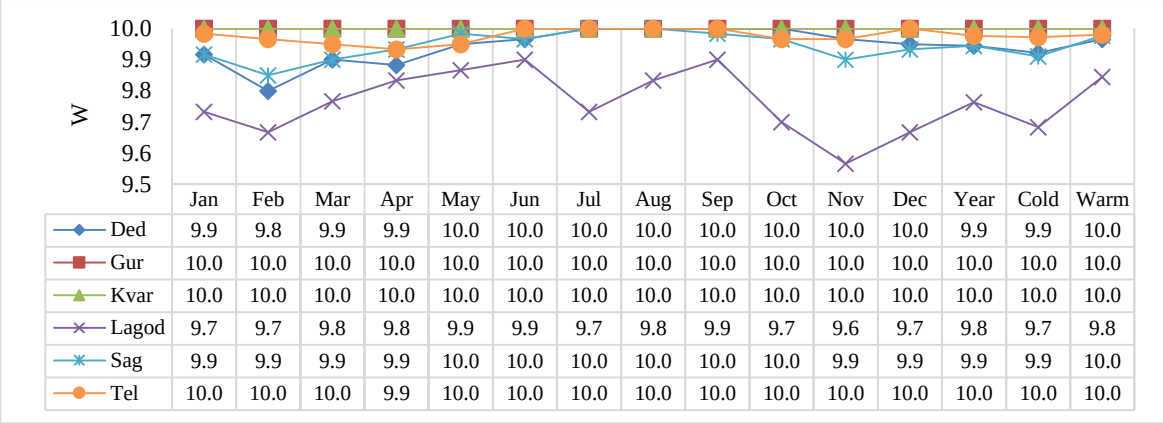
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Ded	5.7	5.3	4.8	4.8	5.5	6.5	7.0	7.0	6.9	6.1	5.6	5.8	5.9	5.6	6.3
Gur	6.0	5.7	5.2	5.3	5.9	6.9	7.3	7.4	7.2	6.4	6.0	6.2	6.3	5.9	6.7
Kvar	5.7	5.3	4.8	5.1	5.5	6.6	6.9	7.2	6.9	6.3	5.7	5.9	6.0	5.6	6.4
Lagod	5.6	4.9	4.6	4.7	5.5	6.5	6.8	7.0	6.7	6.0	5.7	5.4	5.8	5.4	6.2
Sag	6.1	5.7	5.1	5.4	6.0	7.0	7.1	7.4	7.1	6.4	5.9	6.1	6.3	5.9	6.7
Tel	5.4	4.9	4.5	4.5	4.8	5.8	6.3	6.5	6.4	5.8	5.4	5.6	5.5	5.3	5.7

Fig. 9. Mean monthly and seasonal values of A component of HCI at six locations of Kakheti in 1956-2015.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Ded	9.0	9.0	9.0	8.7	8.5	8.4	8.8	9.0	8.8	8.9	9.0	9.0	8.8	9.0	8.7
Gur	9.0	8.9	8.9	8.5	8.1	8.4	8.6	8.7	8.6	8.8	8.9	9.0	8.7	8.9	8.5
Kvar	9.0	8.8	8.7	8.4	7.9	7.9	8.5	8.3	8.1	8.4	8.8	9.0	8.5	8.8	8.2
Lagod	8.9	8.8	8.6	7.9	7.7	7.7	8.1	8.1	7.8	8.1	8.6	9.0	8.3	8.7	7.9
Sag	9.0	9.0	8.9	8.4	8.3	8.3	8.7	8.7	8.7	8.7	8.9	9.0	8.7	8.9	8.5
Tel	9.0	9.0	8.9	8.6	8.1	8.0	8.7	8.7	8.6	8.8	8.9	9.0	8.7	8.9	8.4

Fig. 10. Mean monthly and seasonal values of Rd component of HCI at six locations of Kakheti in 1956-2015.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Ded	9.9	9.8	9.9	9.9	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.9	9.9	10.0
Gur	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Kvar	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Lagod	9.7	9.7	9.8	9.8	9.9	9.9	9.7	9.8	9.9	9.7	9.6	9.7	9.8	9.7	9.8
Sag	9.9	9.9	9.9	9.9	10.0	10.0	10.0	10.0	10.0	10.0	9.9	9.9	9.9	9.9	10.0
Tel	10.0	10.0	10.0	9.9	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Fig. 11. Mean monthly and seasonal values of W component of HCI at six locations of Kakheti in 1956-2015.

Intra-annual distribution of mean monthly values of T component of HCI at six locations of Kakheti (Fig. 8), as well HCI (Fig. 2, Table 7), bimodal distribution type of this parameter is observed. The first extremum of T component for all locations in May is observed (range of change: 9.1, Dedoplistskaro – 9.6, Kvareli, Telavi). The second extremum of T component for Dedoplistskaro, Sagarejo and Telavi in September is observed, for Gurjaani, Kvareli and Lagodekhi – in September-October. Range of change for Dedoplistskaro, Sagarejo and Telavi is as follow: 9.0, Telavi – 9.3, Sagarejo. Range of change for Gurjaani, Kvareli and Lagodekhi is as follow: 8.2, Kvareli, Lagodekhi – 8.5, Kvareli, Lagodekhi.

Intra-annual distribution of mean monthly values of A component of HCI at six locations of Kakheti (Fig. 9) unimodal distribution type of this parameter is observed. The Max values of A component for all locations, besides Dedoplistskaro, in August is observed (range of change: 6.5, Telavi – 7.4, Gurjaani, Sagarejo). In Dedoplistskaro unimodal distribution type with plateau of A value is observed (7.0, July-August).

Intra-annual variation of mean monthly values of Rd component of HCI at six locations of Kakheti (Fig. 10) is not very significant. Range of change for separate locations is as follow. Dedoplistskaro: 8.4, June – 9.0, November-March, August; Gurjaani: 8.1, May – 9.0, December, January; Kvareli: 7.9, May, June – 9.0, December, January; Lagodekhi: 7.7, May, June – 9.0, December; Sagarejo: 8.3, May, June –9.0, December – February; Telavi: 8.0, June – 9.0, December – February.

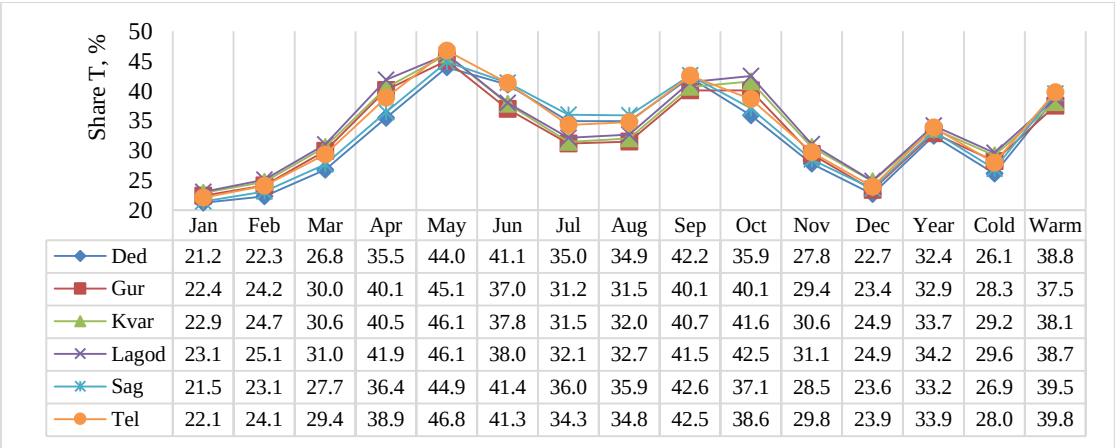
Intra-annual variation of mean monthly values of W component of HCI at six locations of Kakheti (Fig. 11) is not significant - range of change for all stations – from 9.6 to 10.0.

In Table 15 and Fig. 12-15 data about Min, Max and mean values of share of HCI components in HCI values at six locations of Kakheti are presented. As follows from these Table and Fig. the monthly values of share of HCI components changes from 0% (Share Rd, Lagodekhi) to 60.6% (Share T, Gurjaani, Lagodekhi). The monthly mean values of share of HCI components changes from 11.4% (Share W, Sagarejo) to 46.8% (Share T, Telavi).

Intra-annual distribution of mean monthly values of Share of T component of HCI value at six locations of Kakheti (Fig. 12), as well HCI and T (Fig. 2, 8, Table 7), bimodal distribution type of this parameter is observed. Range of change of Share of T component of HCI value for all stations (first extremum) is as follow: 44.0%, Dedoplistskaro – 46.8%, Telavi. Range of change of Share of T component of HCI value (second extremum) for Dedoplistskaro, Sagarejo and Telavi is as follow: 42.2%, Dedoplistskaro – 42.6%, Sagarejo. Range of change for Gurjaani, Kvareli and Lagodekhi is as follow: 40.1, Gurjaani – 42.5%, Lagodekhi.

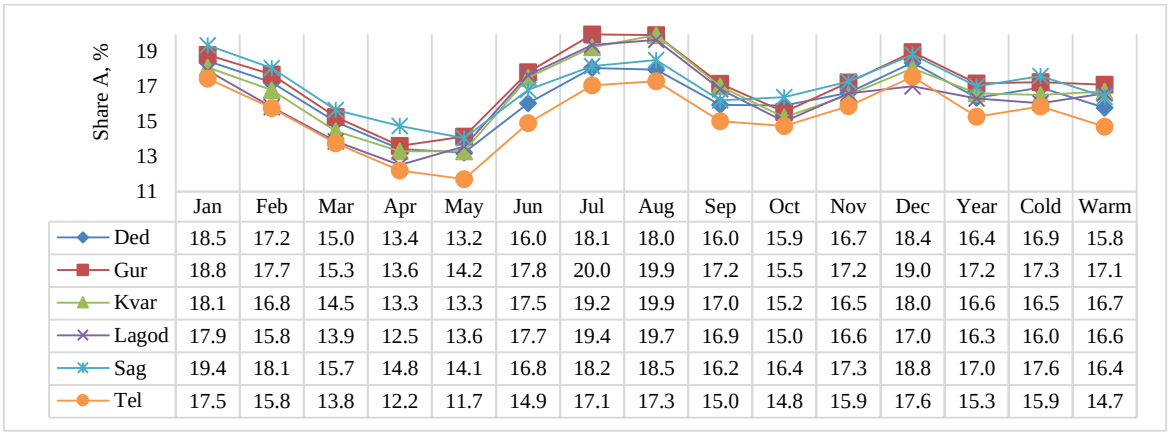
Table 15. Data of Min and Max values of share of HCI components in HCI value at six locations of Kakheti, (%)

Parameter	All data		Mean monthly 1956-2015		All data		Mean monthly 1956-2015	
	Min	Max	Min	Max	Min	Max	Min	Max
	Dedoplistskaro				Lagodekhi			
Share T	12.3	53.3	21.2	44.0	13.1	60.6	23.1	46.1
Share A	7.5	30.8	13.2	18.5	7.4	29.2	12.5	19.7
Share Rd	19.0	50.9	30.3	44.3	0	50.9	28.1	43.3
Share W	10.0	19.2	11.5	16.2	9.0	23.3	12.2	15.9
	Gurjaani				Sagarejo			
Share T	13.1	60.6	22.4	45.1	15.1	60.0	21.5	44.9
Share A	8.5	27.4	13.6	20.0	9.4	26.9	14.1	19.4
Share Rd	9.1	47.4	28.7	42.9	10.0	50.9	29.2	43.3
Share W	10.4	18.5	12.0	15.9	10.0	19.6	11.4	15.9
	Kvareli				Telavi			
Share T	12.1	60.0	22.9	46.1	14.5	54.8	22.1	46.8
Share A	7.5	27.3	13.3	19.9	3.6	27.4	11.7	17.6
Share Rd	10.0	49.1	28.5	43.0	20.5	50.9	29.3	44.1
Share W	10.5	18.5	12.1	16.0	10.2	18.9	11.8	16.3



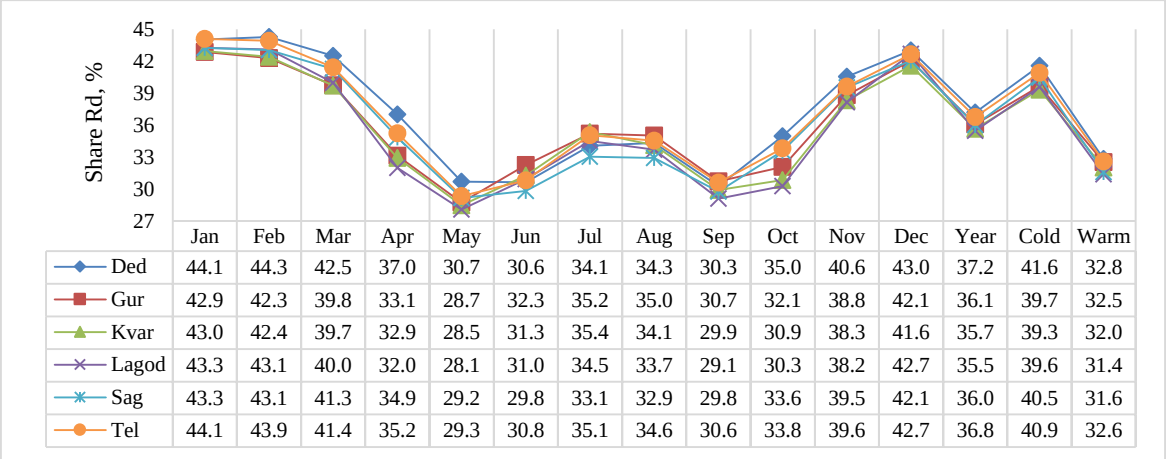
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Ded	21.2	22.3	26.8	35.5	44.0	41.1	35.0	34.9	42.2	35.9	27.8	22.7	32.4	26.1	38.8
Gur	22.4	24.2	30.0	40.1	45.1	37.0	31.2	31.5	40.1	40.1	29.4	23.4	32.9	28.3	37.5
Kvar	22.9	24.7	30.6	40.5	46.1	37.8	31.5	32.0	40.7	41.6	30.6	24.9	33.7	29.2	38.1
Lagod	23.1	25.1	31.0	41.9	46.1	38.0	32.1	32.7	41.5	42.5	31.1	24.9	34.2	29.6	38.7
Sag	21.5	23.1	27.7	36.4	44.9	41.4	36.0	35.9	42.6	37.1	28.5	23.6	33.2	26.9	39.5
Tel	22.1	24.1	29.4	38.9	46.8	41.3	34.3	34.8	42.5	38.6	29.8	23.9	33.9	28.0	39.8

Fig. 12. Share of mean monthly and seasonal values of T component in HCI value at six locations of Kakheti in 1956-2015.



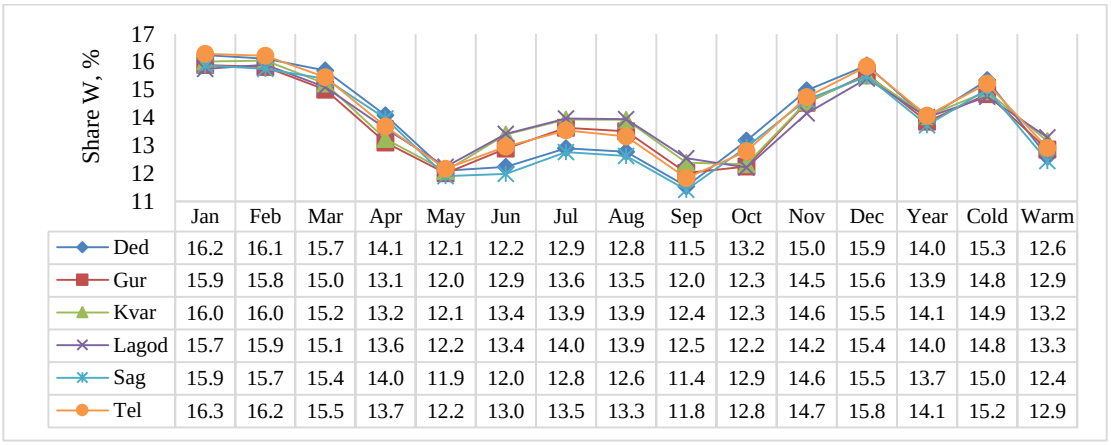
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Ded	18.5	17.2	15.0	13.4	13.2	16.0	18.1	18.0	16.0	15.9	16.7	18.4	16.4	16.9	15.8
Gur	18.8	17.7	15.3	13.6	14.2	17.8	20.0	19.9	17.2	15.5	17.2	19.0	17.2	17.3	17.1
Kvar	18.1	16.8	14.5	13.3	13.3	17.5	19.2	19.9	17.0	15.2	16.5	18.0	16.6	16.5	16.7
Lagod	17.9	15.8	13.9	12.5	13.6	17.7	19.4	19.7	16.9	15.0	16.6	17.0	16.3	16.0	16.6
Sag	19.4	18.1	15.7	14.8	14.1	16.8	18.2	18.5	16.2	16.4	17.3	18.8	17.0	17.6	16.4
Tel	17.5	15.8	13.8	12.2	11.7	14.9	17.1	17.3	15.0	14.8	15.9	17.6	15.3	15.9	14.7

Fig. 13. Share mean monthly and seasonal values of A component in HCI value in six locations of Kakheti in 1956-2015.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Ded	44.1	44.3	42.5	37.0	30.7	30.6	34.1	34.3	30.3	35.0	40.6	43.0	37.2	41.6	32.8
Gur	42.9	42.3	39.8	33.1	28.7	32.3	35.2	35.0	30.7	32.1	38.8	42.1	36.1	39.7	32.5
Kvar	43.0	42.4	39.7	32.9	28.5	31.3	35.4	34.1	29.9	30.9	38.3	41.6	35.7	39.3	32.0
Lagod	43.3	43.1	40.0	32.0	28.1	31.0	34.5	33.7	29.1	30.3	38.2	42.7	35.5	39.6	31.4
Sag	43.3	43.1	41.3	34.9	29.2	29.8	33.1	32.9	29.8	33.6	39.5	42.1	36.0	40.5	31.6
Tel	44.1	43.9	41.4	35.2	29.3	30.8	35.1	34.6	30.6	33.8	39.6	42.7	36.8	40.9	32.6

Fig. 14. Share mean monthly and seasonal values of Rd component in HCI value at six locations of Kakheti in 1956-2015.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Ded	16.2	16.1	15.7	14.1	12.1	12.2	12.9	12.8	11.5	13.2	15.0	15.9	14.0	15.3	12.6
Gur	15.9	15.8	15.0	13.1	12.0	12.9	13.6	13.5	12.0	12.3	14.5	15.6	13.9	14.8	12.9
Kvar	16.0	16.0	15.2	13.2	12.1	13.4	13.9	13.9	12.4	12.3	14.6	15.5	14.1	14.9	13.2
Lagod	15.7	15.9	15.1	13.6	12.2	13.4	14.0	13.9	12.5	12.2	14.2	15.4	14.0	14.8	13.3
Sag	15.9	15.7	15.4	14.0	11.9	12.0	12.8	12.6	11.4	12.9	14.6	15.5	13.7	15.0	12.4
Tel	16.3	16.2	15.5	13.7	12.2	13.0	13.5	13.3	11.8	12.8	14.7	15.8	14.1	15.2	12.9

Fig. 15. Share of mean monthly and seasonal values of W component in HCI value at six locations of Kakheti in 1956-2015.

Intra-annual distribution of mean monthly values of Share of A components of HCI value at six locations of Kakheti (Fig. 13), as well HCI, T and Share T (Fig. 2, 8, 12, Table 7), have a bimodal type. For Dedoplistskaro, Gurjaani, Kvareli and Telavi first extremum of Share of A distribution in January and December is observed, for Lagodekhi and Sagarejo – in January. The second extremum of this distribution for all stations in July-August is observed.

Range of change of Share of A component of HCI value for all stations (first extremum) is as follow: 17.5%, Telavi – 19.0%, Gurjaani; Lagodekhi and Sagarejo – 17.9% and 19.4% respectively. Range of change of Share of A component of HCI value for all stations (second extremum) is as follow: 17.1%, Telavi – 20.0%, Gurjaani.

Intra-annual distribution of mean monthly values of Share of Rd and Share of W components of HCI value at all locations of Kakheti (Fig. 14, 15) have a bimodal type. Whereinto for both distributions, the first and second extremumes coincide in time: December-February and July-August respectively. It should be noted that in both cases the summer extremum is significantly lower than the winter one.

Range of change of Share of Rd component of HCI value for all stations (first extremum) is as follow: 41.6%, Kvareli – 44.3%, Dedoplistskaro. Range of change of Share of Rd component of HCI value for all stations (second extremum) is as follow: 32.9%, Sagarejo – 35.4%, Kvareli.

Range of change of Share of W component of HCI value for all stations (first extremum) is as follow: 15.4%, Lagodekhi – 16.3%, Telavi. Range of change of Share of W component of HCI value for all stations (second extremum) is as follow: 12.6%, Sagarejo – 14.0%, Lagodekhi.

Range of change of different components of HCI for all station in year, cold and warm seasons is as follow respectively.

T component (Fig. 8). Year: 6.1, Dedoplistskaro – 6.3, Sagarejo, Telavi; cold season: 4.4, Dedoplistskaro – 5.1, Kvareli; warm season: 7.3, Lagodekhi – 8.0, Sagarejo.

A component (Fig. 9). Year: 5.5, Telavi – 6.3, Gurjaani, Sagarejo; cold season: 5.3, Telavi – 5.9, Gurjaani, Sagarejo; warm season: 5.7, Telavi – 6.7, Gurjaani, Sagarejo.

Rd component (Fig. 10). Year: 8.3, Lagodekhi – 8.8, Dedoplistskaro; cold season: 8.7, Lagodekhi – 9.0, Dedoplistskaro; warm season: 7.9, Lagodekhi – 8.7, Dedoplistskaro.

W component (Fig. 11). Year: 9.8, Lagodekhi – 10.0, Gurjaani, Kvareli, Telavi; cold season: 9.7, Lagodekhi – 10.0, Gurjaani, Kvareli, Telavi; warm season: 9.8, Lagodekhi – 10.0, all other locations.

Share of T component (Fig. 12, %). Year: 32.4, Dedoplistskaro – 34.2, Lagodekhi; cold season: 26.1, Dedoplistskaro – 29.6, Lagodekhi; warm season: 37.5, Gurjaani – 39.8, Telavi.

Share of A component (Fig. 13, %). Year: 15.3, Telavi – 17.2, Gurjaani; cold season: 15.9, Telavi – 17.6, Sagarejo; warm season: 14.7, Telavi – 17.1, Gurjaani.

Share of Rd component (Fig. 14, %). Year: 35.5, Lagodekhi – 37.2, Dedoplistskaro; cold season: 39.3, Kvareli – 41.6, Dedoplistskaro; warm season: 31.4, Lagodekhi – 32.8, Dedoplistskaro.

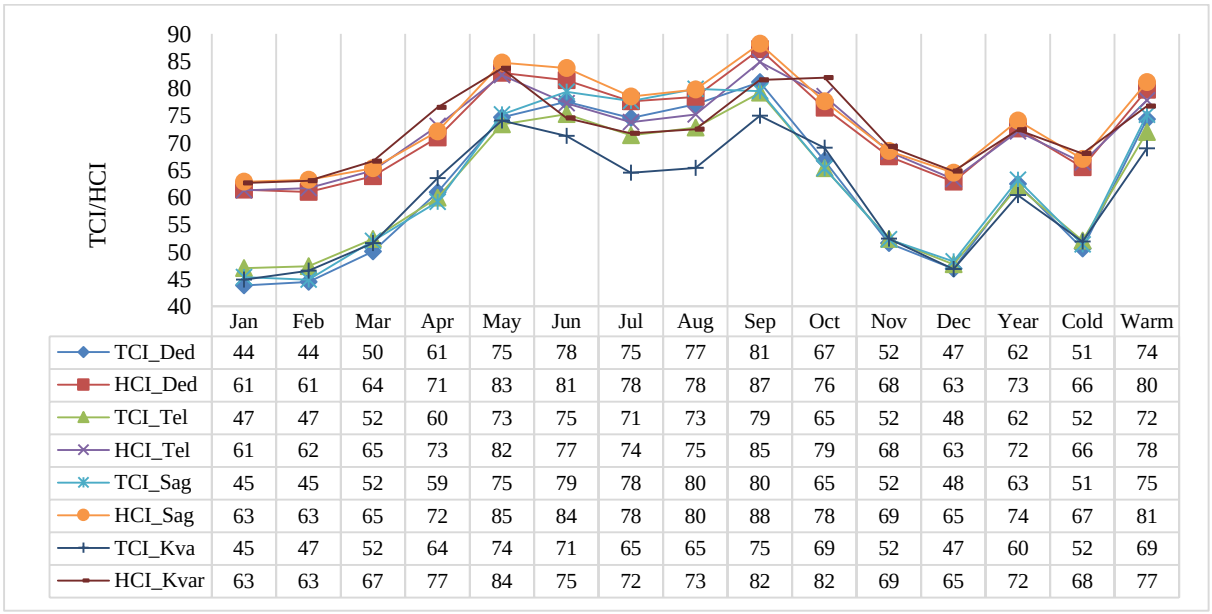
Share of W component (Fig. 15, %). Year: 13.7, Sagarejo – 14.1, Kvareli, Telavi; cold season: 14.8, Gurjaani, Lagodekhi – 15.3, Dedoplistskaro; warm season: 12.4, Sagarejo – 13.3, Lagodekhi.

3. Comparison of TCI and HCI at four location of Kakheti in 1961-2010.

Comparison of TCI and HCI values in many investigations are provided [17, 18, 20, 22, 23]. In Georgia, an analogous study conducted for Tbilisi [24].

Comparison of TCI and HCI at four location of Kakheti (Dedoplistskaro, Kvareli, Sagarejo and Telavi) in 1961-2010 is provided below (Fig. 16, 17, Table 16-18).

In Fig. 16 data about mean monthly and seasonal values of TCI and HCI at four locations of Kakheti in 1961-2010 are presented.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
TCI_Ded	44	44	50	61	75	78	75	77	81	67	52	47	62	51	74
HCI_Ded	61	61	64	71	83	81	78	78	87	76	68	63	73	66	80
TCI_Tel	47	47	52	60	73	75	71	73	79	65	52	48	62	52	72
HCI_Tel	61	62	65	73	82	77	74	75	85	79	68	63	72	66	78
TCI_Sag	45	45	52	59	75	79	78	80	80	65	52	48	63	51	75
HCI_Sag	63	63	65	72	85	84	78	80	88	78	69	65	74	67	81
TCI_Kva	45	47	52	64	74	71	65	65	75	69	52	47	60	52	69
HCI_Kvar	63	63	67	77	84	75	72	73	82	82	69	65	72	68	77

Fig. 16. Comparison of mean monthly and seasonal values of TCI and HCI at four location of Kakheti in 1961-2010.

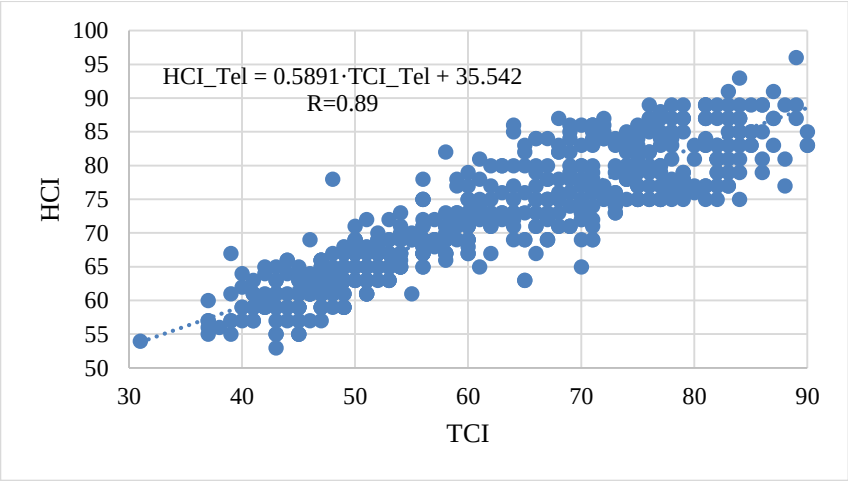


Fig. 17. Linear correlation and regression between monthly values of TCI and HCI in Telavi in 1961-2010.

HCI_Ded = 0.5886·TCI_Ded + 35.869, (R=0.93); HCI_Kvar = 0.584·TCI_Kvar + 37.127, (R=0.88); HCI_Sag = 0.587·TCI_Sag + 36.969, (R=0.92); For all values of R, $\alpha<0.005$.

Comparison of the values and categories of the Tourism Climate Index [7] and Holiday Climate Index (Fig. 16, 17, Table 16-18) shows that the intra-annual variation of both indices is similar and has a bimodal form. Linear correlation between monthly values of TCI and HCI is high (Fig. 17, example for Telavi) and change from 0.88 (Kvareli) to 0.93 (Dedoplistskaro).

Table 16. Comparison of TCI and HCI categories at four location of Kakheti in cold period of year in 1961-2010.

Month	Jan	Feb	Mar	Oct	Nov	Dec	Cold	Year
TCI_Ded	Marg. Good	Marg. Good	Accept. Good	Good Very Good	Accept. Good	Marg. Good	Accept. Good	Good Very Good
HCI_Ded								
TCI_Tel								
HCI_Tel								
TCI_Sag								
HCI_Sag								
TCI_Kvar				Good				
HCI_Kvar				Excell.				

Table 17. Comparison of TCI and HCI categories at four location of Kakheti in warm period of year in 1961-2010.

Month	Apr	May	Jun	Jul	Aug	Sep	Warm
TCI_Ded	Good	Very Good Excell.	Very Good	Very Good	Very Good	Excell.	Very Good
HCI_Ded	Very Good		Excell.				
TCI_Tel	Accept. Very Good		Very Good			Very Good Excell.	
HCI_Tel							
TCI_Sag			Very Good				Very Good
HCI_Sag			Excell.				Excell.
TCI_Kvar	Good		Very Good	Good	Good		Good
HCI_Kvar	Very Good			Very Good	Very Good		Very Good

Comparison of TCI and HCI categories shows, that in cold months, season and year HCI categories on 1-2 step higher than TCI categories (Table 16). Difference on 2 step in the following cases are observed: TCI_Marginal → HCI_Good, in January, February, December for all stations; TCI_Good →

HCI_Excellent, in October, for Kvareli. Difference on 1 step: TCI_ Acceptable → HCI_Good, in March, November, Cold season, for all stations; TCI_Good → HCI_Very Good in October for Dedoplistskaro, Telavi, Sagarejo and in year, for all stations.

Comparison of TCI and HCI categories in warm months and season shows, that HCI categories either the same than TCI categories, or 1-2 steps higher (Table 17).

Difference on 2 step in the following case is observed: TCI_ Acceptable → HCI_Very Good, in April for Telavi and Sagarejo.

Difference on 1 step: TCI_ Good → HCI_Very Good, in April, for Dedoplistskaro and Kvareli; in July, August and Warm season, for Kvareli; TCI_Very Good → HCI_ Excellent in May for all stations, in June for Dedoplistskaro and Sagarejo; in September, for Telavi, Sagarejo and Kvareli; in Warm season, for Sagarejo.

The same categories: Very Good, in June, for Telavi and Kvareli; in July and August, for Dedoplistskaro, Telavi and Sagarejo; in Warm season, for Dedoplistskaro and Telavi. Excellent, in September, for Dedoplistskaro.

Table 18. Comparison of Min and Max values of TCI and HCI and its category for four location of Kakheti in 1961-2010.

Parameter		Value	Location/Month/Category
TCI	Min	44	Dedoplistskaro, January, February, Marginal
	Max	81	Dedoplistskaro, September, Excellent
	Mean on Station	62	Good
HCI	Min	61	Good, Dedoplistskaro, January,February; Telavi, January
	Max	88	Sagarejo, September, Excellent
	Mean on Station	73	Very Good

In Table 18 comparison of Min and Max values of TCI and HCI and its category for four location of Kakheti is provided. As follows from this Table TCI value change from 44 (Dedoplistskaro, January, February, Marginal) to 81 (Dedoplistskaro, September, Excellent) and HCI value – from 61 (Good, Dedoplistskaro, January, February; Telavi, January) to 88 (Sagarejo, September, Excellent). Mean on the one station for TCI is 62 (Good) and for HCI - 73 (Very Good).

However, given that the TCI is calculated for the so-called “average tourist” (regardless of gender, age, physical condition), the value and category of this index is lower than the HCI values and categories. In general, HCI more adequately determines the bioclimatic state of the environment for the development of certain types of tourism (winter tourism, extreme tourism, etc.) than TCI.

Conclusion

In the future, we are planning a more detailed study of the climatic resources of this and other regions of Georgia for tourism, recreation and treatment (mapping the territory on HCI and TCI, long-term forecasting of HCI and TCI, determining other modern climatic and bioclimatic indicators for tourism, recreation and treatment, assessing the adequacy of bioclimatic indicators scales to human health, etc.).

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დასვენების კლიმატური ინდექსი კახეთში

ა.ამირანაშვილი, ლ.ქართველიშვილი

რეზიუმე

წარმოდგენილია მონაცემები დასვენების კლიმატური ინდექსის (დკი) მრავალწლიური საშუალო თვიური მნიშვნელობების შესახებ კახეთის 12 ადგილისთვის (ახმეტა, დედოფლისწყარო, გომბორი, გურჯაანი, ყვარელი, ლაგოდეხი, ომალო, საგარეჯო, შირაქი, თელავი, წნორი და უდაბნო). ამ რეგიონის 6 სადგურისთვის (დედოფლისწყარო, გურჯაანი, ყვარელი, ლაგოდეხი, საგარეჯო და თელავი) ჩატარებულია ყოველთვიური, სეზონური და წლიური დკი-ს მნიშვნელობების დეტალური ანალიზი 60 წლიანი პერიოდის განმავლობაში (1956-2015 წწ.). ჩატარებულია დკი-ს და ტურიზმის კლიმატური ინდექსის ყოველთვიური მნიშვნელობების შედარება კახეთის ოთხ პუნქტზე (დედოფლისწყარო, ყვარელი, საგარეჯო და თელავი) 1961-2010 წწ. მონაცემების საფუძველზე.

Климатический Индекс Отдыха в Кахетии (Грузия)

А.Г. Амиранашвили, Л. Г. Картвелишвили

Резюме

Представлены данные о многолетних среднемесячных значениях Климата Индекса Отдыха (КИО) для 12 населенных пунктов Кахетии (Ахмета, Дедоплисцкаро, Гомбори, Гурджаани, Кварели, Лагодехи, Омало, Сагареджо, Шираки, Телави, Цнори и Удабно). Для 6 станций этого региона (Дедоплисцкаро, Гурджаани, Кварели, Лагодехи, Сагареджо и Телави) проведен детальный анализ месячных, сезонных и годовых значений КИО за 60-летний период времени (1956-2015 гг.). Проведено сравнение месячных значений КИО и Климатического Индекса Туризма для четырех пунктов Кахетии (Дедоплисцкаро, Кварели, Сагареджо и Телави) по данным с 1961 по 2010 гг.