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Holiday Climate Index in Some Mountainous Regions of Georgia

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ABSTRACT

The long-term monthly average values of Holiday Climate Index (HCI) for 13 mountainous locations of Georgia (Bakhmaro, Bakuriani, Borjomi, Goderdzi, Gudauri, Khaishi, Khulo, Lentekhi, Mestia, Pasanauri, Shovi, Stepantsminda, Tianeti) are presented in the article. Detailed analysis of the monthly, seasonal and annual HCIs values over the 60-year period (1956-2015) are carried out. Comparison of HCI and Tourism Climate Index (TCI) monthly values for three locations (Goderdzi, Khulo and Mestia) based on data from 1961 to 2010 are carried out. The variability of the HCI in 1986-2015 compared to 1956-1985 was studied, and the trends of the HCI in 1956-2015 were also investigated. Using Mestia as an example, the expected changes in monthly, seasonal and annual HCI values for 2041-2070 and 2071-2100 year periods has neen assested.

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

Introduction

The formation and development of the resort and tourism industry is directly depended on the geographical location, relief, vegetation, weather and climate of the region. Weather and climate are two main factors that determine the bioclimatic resources of an area. Thus, the study of these resources, which are necessary for the organization and development of the resort and tourism industry, plays a major role and requires significant efforts. Past studies have used a lot of climate indices for tourism [1-7]. The most widely known index, used both in the past and in the present, is the Tourist Climate Index (TCI), proposed by Mechkovsky [9].

In the south Caucasus countries, monthly value of TCI was calculated in Georgia firstly for Tbilisi [10] and then for many other locations of Caucasus (Armenia, Azerbaijan, North Caucasus etc.) [11-18].

From the recent studies of TCI, in particular, the noteable are the works [19, 20]. The study [19] presents the first TCI calculations for Zimbabwe, a country relient on outdoor nature-based tourism for attracting tourists and foreign visitors. The mean annual TCI scores classify Zimbabwe as very good to excellent by climatic suitability for tourism, with scores spanning 75.5–83 (of a maximum 100) for the 1989–2014 period. Monthly TCI scores categorize four locations in the Lowveld region as having a winter-peak suitability; the remaining stations have either summer-peak or bimodal shoulder-peaks. This reveals entire year climatic suitability for tourism in Zimbabwe, and highlights the importance of understanding seasonal variability per destination to maximize tourist satisfaction. The paper [20] evaluates the climate comfortability of Argentina as an intangible resource for tourism. The analysis builds on spatial modelling of the Tourism Climate Index (TCI) calculated for 69 weather stations uniformly distributed throughout the country. The mean annual TCI in Argentina is 73 indicating “very good” climatic-tourist comfort conditions for tourism.

Despite the TCI's wide application, it has been subject to substantial critiques [21]. The four key deficiencies of the TCI include: (1) the subjective rating and weighting system of climatic variables; (2) it neglects the possibility of the overriding influence of physical climatic parameters (e.g., rain, wind); (3) the low temporal resolution of climatic 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 precisely assess the climatic suitability of tourism destinations. The word "holiday" was chosen to better reflect what the index was designed for (i.e., leisure tourism), as the 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") [21-25]. In the same works, comparisons between HCI and TCI were made.

Results of comparison of Holiday Climate Index and Tourism Climate Index at some locations of Georgia and North Caucasus in [26-28] are presented. The article [26] compares the values and categories of TCI and HCI in Tbilisi. The HCI long-term monthly average values for 12 locations of Kakheti (Akhmeta, Dedoplistskaro, Gombori, Gurjaani, Kvareli, Lagodekhi, Omalo, Sagarejo, Shiraki, Telavi, Tsnori and Udabno) are presented in [27]. For 6 stations of this region (Dedoplistskaro, Gurjaani, Kvareli, Lagodekhi, Sagarejo and Telavi) detailed analysis of the monthly, seasonal and annual HCIs values over the 60-year period (1956-2015) are carried out. Comparison of HCI and Tourism Climate Index (TCI) monthly values for four points of Kakheti region (Dedoplistskaro, Kvareli, Sagarejo and Telavi) based on data from 1961 to 2010 are carried out. The results of the comparative analysis of the Tourism Climate Index and the Holiday Climate Index, as well as the ratings of the components of these indices for six points in the North Caucasus (Kislovodsk, Pyatigorsk, Essentuki, Zheleznovodsk, Teberda and Nalchik) are presented in [28].

In particular, it was found out that there is a high degree of correlation between the values of HCI and TCI. However, consider 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, based on our estimation the HCI more adequately determines the bioclimatic state of the environment for the development of various types of tourism than the TCI [26-28].

Great importance gains the study of variability and prediction of the HCI in relation to the limate change [29-33].

Using the Holiday Climate Index (HCI: Urban) the research [29] examines the long-term tourism climate records in Tokyo between 1964 and 2019. Findings suggest greater climatic variability and the favorability declination of Tokyo's tourism climatic resources in all three summer months. According to these findings the adaptation and mitigation strategies are recommended and a Japanocentric tourism climate index proposed.

The work [30] notes that TCI and HCI are good indicators of the environmental conditions for leisure activities in the Canary Islands. Using the Regional Climate Model, it is shown that by 2030-2059 and 2070-2099, tourism performance is expected to improve significantly in winter and off-season, but deteriorate in the summer months, including October, in the southeast, which is where hotels are currently located.

The aim of study [31] is to assess the future HCI performances of urban and beach destinations in the greater Mediterranean region. For this purpose, HCI scores for the reference (1971-2000) and future (2021-2050, 2070-2099) periods were computed. HCI: Urban results showed that Canary Islands hold suitable conditions for tourism during almost all four seasons and all periods which will have certain implications when other core Mediterranean competitors lose their relative climatic attractiveness. HCI:Beach results for the summer season showed that Las Canteras, Alicate, Pampelonne, Myrtos, Golden Sands and Edremit all pose Very Good to Excellent conditions without any Humidex risks for the extreme future scenario (2070-2099).

The detailed information on the variability of the monthly values of the Holiday Climate Index in Tbilisi in 1956-2015 are presented in [32]. It also presents data on the interval forecast of HCI value variability in Tbilisi for the next few decades.

This study develops the detailed analysis of the monthly, seasonal and annual HCIs values during 60-year period (1956-2015) for 13 mountainous locations of Georgia (Bakhmaro, Bakuriani, Borjomi, Goderdzi, Gudauri, Khaishi, Khulo, Lentekhi, Mestia, Pasanauri, Shovi, Stepantsminda, Tianeti), and comparison HCI and TCI of monthly values for three points of Georgia (Goderdzi, Khulo and Mestia) based on the data from 1961 to 2010. The variability data of HCI in 1986-2015 compared to 1956-1985, and the trends of HCI in 1956-2015 are also presented. Using Mestia as the example the expected changes of monthly, seasonal and annual HCI values of 2041-2070 and 2071-2100 has been assesed. The some results of this work were used in [33]. A more detailed description of these results is given below.

Study Area, Material and Methods

The study area includes 13 mountainous locations in Georgia - Bakhmaro (Bakh): 42.32° N, 41.85° E, 1926 m, a.s.l.; Bakuriani (Bak): 43.52° N, 41.73° E, 1665 m; Borjomi (Borj): 43.40° N, 41.83° E, 789 m; Goderdzi (God): 42.52° N, 41.63° E, 2025 m; Gudauri (Gud): 44.48° N, 42.47° E, 2194 m; Khaishi (Kha): 42.18° N, 42.95° E, 730 m; Khulo (Khu): 42.32° N, 41.65° E, 914 m; Lentekhi (Lent): 42.73° N, 42.78° E, 760 m; Mestia (Mest): 42.75° N, 43.05° E, 1441 m; Pasanauri (Pas): 44.70° N, 42.35° E, 1070 m; Shovi (Sho): 43.68° N, 42.70° E, 1507 m; Stepantsminda (Step): 44.65° N, 42.67° E, 1744 m; Tianeti (Tian): 44.97° N, 42.12° E, 1099 m. The development of the resort and tourism industry takes place in these locations, in particular – the mountain and winter tourism. Fig. 1 depicts the map of the arrangement of the indicated locations.

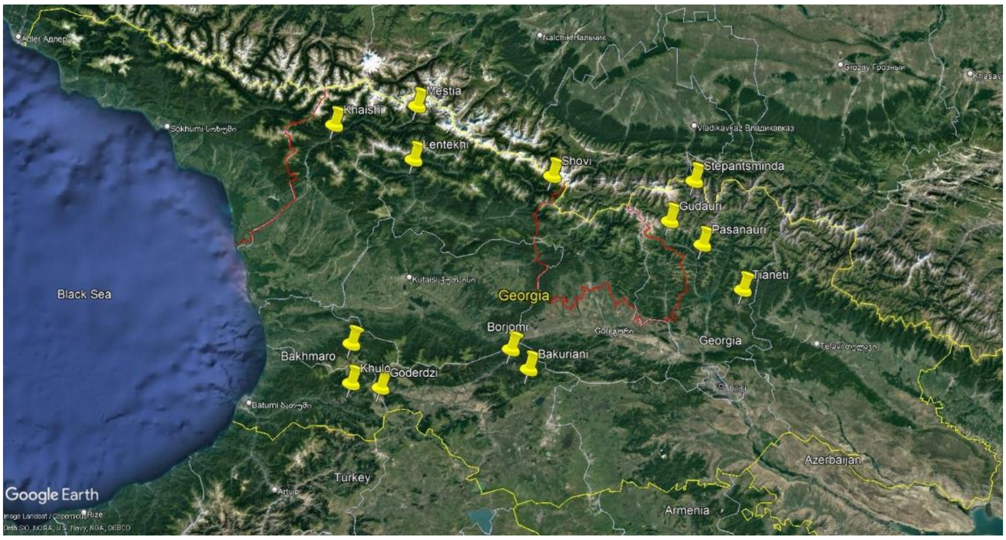


Fig.1. Locations of 13 mountainous meteorological stations in Georgia.

In this work the Holiday Climate Index (HCI) is used. The five climatic variables for the HCI identification are used: air temperature maximum, relative humidity, cloud cover, precipitation and wind [21].

In the Table 1 rating scheme and HCI's category are presented.

Table 1. 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 (Unf.)
70÷79	Very Good (V_Good)	**20÷29**	Very Unfavorable (V_Unf.)
60÷69	Good	**10÷19**	Extremely Unfavorable (Ext_Unf.)
50÷59	Acceptable (Accept.)	**9÷-9; -10÷-20**	Impossible (Impos.)

In this work the monthly mean data of Georgian National Environmental Agency of indicated meteorological parameters during the period from 1956 through 2015 are used [34]. Based on this data the HCI monthly average values were calculated. Comparison of monthly HCI and TCI values for three

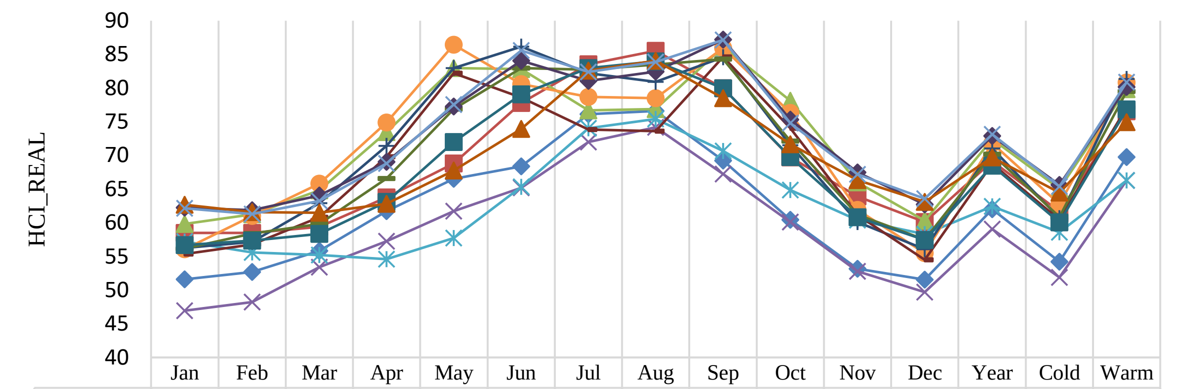
locations of Georgia (Goderdzi, Khulo and Mestia) based on the TCI data t from 1961-2010 is performed [12, 17].
Analysis of the HCI data using the standard statistical analysis methods is carried out [35]. The applied following designations are listed below: Mean – average values; Min – minimal values; 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; α - level of significance; ΔHCI - the difference between the HCI mean values in 1986-2015 (II period of time) and 1956-1985 (I period of time) using Student's criterion was determined (level of significance not worse than 0.15). Calculation of expected changes in monthly, seasonal and annual HCI values in Mestia by 2041-2070 and 2071-2100 conducted in accordance with the model of expected climate change in Georgia. The expected climate change has been forecast using Representative Concentration Pathway (RCP) 4.5 scenario that stabilizes radiative forcing at 4.5 W/m2 in the year 2100 without ever exceeding that value. Compared to the A1B scenario used in the Third National Communication, the RCP4.5 scenario is less severe. Version 4.6.0 of the RegCM Regional Climate Model has been used to improve the global forecast scale [33].

Results and discussion

Results in Fig. 2-12 and Tables 2-12 and Annexes 1-8 are presented.

1. Basic Information about HCI for 13 Mountainous Regions of Georgia.

The long-term mean HCI real values at 13 locations of Georgia are presented on the Fig. 2.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Bakh	52	53	56	62	67	68	76	77	69	60	53	52	62	54	70
Bak	58	58	59	64	69	78	84	86	80	70	64	60	69	62	77
Borj	60	61	65	73	83	83	77	77	86	78	66	60	72	65	80
God	47	48	53	57	62	65	72	74	67	60	53	50	59	52	66
Gud	57	56	55	55	58	65	74	75	71	65	60	58	62	59	66
Kha	56	61	66	75	86	81	79	78	86	76	62	56	72	63	81
Khu	56	57	63	71	83	86	82	81	85	71	60	56	71	61	81
Lent	55	57	61	70	82	79	74	74	85	74	61	54	69	60	77
Mest	56	58	60	67	77	83	83	84	84	72	61	58	70	61	79
Pas	62	62	64	69	77	84	81	82	87	75	67	63	73	66	80
Sho	57	57	58	63	72	79	83	84	80	70	61	57	68	60	77
Step	63	62	61	63	68	74	83	84	78	72	66	63	70	64	75
Tian	62	61	63	69	78	86	82	84	87	75	67	64	73	65	81

Fig. 2. Mean HCI real values at 13 locations of Georgia.

As it follows from Fig. 2 the HCI mean monthly values change from 47 (Goderdzi, January, Acceptable) to 87 (Pasanauri, Tianeti September, Excellent). The variability of HCI values for individual items is as follows: Bakhmato (52, January, December – 77, August), Bakuriani (58, January, February – 86, August), Borjomi (60, January, December – 86, September), Gooderdzi (47, January – 74, August), Gudauri (55, March, April – 75, August), Khaishi (56, January, December – 86, September), Khulo (56, January, December – 86, June), Lentekhi (54, December – 85, September), Mestia (56, January – 84, August, September), Pasanauri (62, January, February – 87, September), Shovi (57, January, February, December – 84, August), Stepantsminda (61, March – 84, August), Tianeti (61, February – 87, September).

Table 2. Linear correlation coefficient between separated stations of HCI monthly mean values (R min = 0.58, α = 0.04; R max = 1, α = <0.001).

Location	Bakh	Bak	Borj	God	Gud	Kha	Khu	Lent	Mest	Pas	Sho	Step	Tian
Bakh	1	0.95	0.81	0.98	0.83	0.84	0.92	0.81	0.95	0.89	0.96	0.90	0.90
Bak	0.95	1	0.79	0.98	0.94	0.77	0.87	0.78	0.96	0.94	0.99	0.98	0.95
Borj	0.81	0.79	1	0.83	0.62	0.98	0.96	1.00	0.93	0.94	0.86	0.70	0.93
God	0.98	0.98	0.83	1	0.88	0.84	0.91	0.82	0.96	0.93	0.98	0.94	0.93
Gud	0.83	0.94	0.62	0.88	1	0.58	0.69	0.60	0.83	0.82	0.90	0.99	0.83
Kha	0.84	0.77	0.98	0.84	0.58	1	0.97	0.99	0.91	0.90	0.85	0.68	0.89
Khu	0.92	0.87	0.96	0.91	0.69	0.97	1	0.96	0.97	0.96	0.93	0.78	0.96
Lent	0.81	0.78	1.00	0.82	0.60	0.99	0.96	1	0.92	0.93	0.85	0.69	0.91
Mest	0.95	0.96	0.93	0.96	0.83	0.91	0.97	0.92	1	0.99	0.99	0.90	0.99
Pas	0.89	0.94	0.94	0.93	0.82	0.90	0.96	0.93	0.99	1	0.97	0.88	1.00
Sho	0.96	0.99	0.86	0.98	0.90	0.85	0.93	0.85	0.99	0.97	1	0.96	0.97
Step	0.90	0.98	0.70	0.94	0.99	0.68	0.78	0.69	0.90	0.88	0.96	1	0.89
Tian	0.90	0.95	0.93	1	0.83	0.89	0.96	0.91	0.99	1.00	0.97	0.89	1

Linear correlation coefficient between separated station of HCI monthly mean values changes as follows (Table 2) - Bakhmaro: 0.81 (Borjomi, Lentekhi) ÷ 0.98 (Goderdzi); Bakuriani: 0.77 (Khaishi) ÷ 0.99 (Shovi); Borjomi: 0.62 (Gudauri) ÷ 1.00 (Lentekhi); Goderdzi: 0.82 (Lentekhi) ÷ 0.98 (Bakhmaro, Bakuriani, Shovi); Gudauri: 0.58 (Khaishi) ÷ 0.99 (Stepantsminda); Khaishi: 0.58 (Gudauri) ÷ 0.99 (Lentekhi); Khulo: 0.69 (Gudauri) ÷ 0.97 (Khaishi, Mestia); Lentekhi: 0.60 (Gudauri) ÷ 1.00 (Borjomi); Mestia: 0.83 (Gudauri) ÷ 0.99 (Pasanauri, Shovi, Tianeti); Pasanauri: 0.82 (Gudauri) ÷ 1.00 (Tianeti); Shovi: 0.85 (Khaishi, Lentekhi) ÷ 0.99 (Mestia); Stepantsminda: 0.68 (Khaishi) ÷ 0.99 (Gudauri); Tianeti: 0.83 (Gudauri) ÷ 1.00 (Pasanauri).

The intra-annual distribution of TCI monthly mean values for 13 locations of Georgia by the ninth power of polynomial ($R^2 \geq 0.990$) is described. Coefficients of the regression equation of the intra-annual motion of TCI monthly mean values for these points are presented in Table 3.

Table 3. Coefficients of regression equation of the intra-annual motion of TCI monthly mean values for 13 points of Georgia.

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
Bakh	9.76E-05	-0.00591	0.152068	-2.17025	18.76576	-100.966	333.9624	-644.542	648.6272	-201.833	0.994
Bak	1.25E-05	-0.00083	0.022622	-0.33703	2.99689	-16.4553	55.53566	-108.942	110.5176	14.66667	0.999
Borj	-0.00021	0.012368	-0.30315	4.098518	-33.4105	168.8146	-524.14	956.8664	-919.932	408	0.997
God	5.85E-05	-0.00348	0.087734	-1.22078	10.23453	-53.0477	167.8676	-307.733	294.3048	-63.5	0.996
Gud	4.86E-05	-0.00279	0.067503	-0.89662	7.144545	-35.1709	106.5046	-190.103	178.4566	-9	0.999
Kha	-1.56E-04	0.008875	-0.21273	2.797211	-22.0306	106.7157	-315.115	543.5795	-489.079	229.3333	0.990
Khu	-2.43E-04	0.014074	-0.34541	4.688892	-38.5037	196.6584	-619.155	1148.475	-1121.66	485.8333	0.998
Lent	-2.48E-04	0.014261	-0.34608	4.627231	-37.256	185.657	-567.677	1019.447	-963.629	414.1667	0.994
Mest	-1.27E-04	0.007268	-0.17676	2.371367	-19.1728	95.8908	-293.471	525.3931	-492.671	237.8333	0.999
Pas	-0.00023	0.013184	-0.32497	4.435359	-36.6564	188.5303	-597.32	1112.285	-1088.78	479.8333	0.992
Bakh	9.76E-05	-0.00591	0.152068	-2.17025	18.76576	-100.966	333.9624	-644.542	648.6272	-201.833	0.994
Bak	1.25E-05	-0.00083	0.022622	-0.33703	2.99689	-16.4553	55.53566	-108.942	110.5176	14.66667	0.999
Borj	-0.00021	0.012368	-0.30315	4.098518	-33.4105	168.8146	-524.14	956.8664	-919.932	408	0.997

In Table 4the information on the intra-annual distribution types of HCI monthly mean values at 13 locations of Georgia are provided.

As follows from this Table the HCI bimodal distribution type for 6 locations is detected (Borjomi, Khaishi, Khulo, Lentekhi, Pasanauri, Tianeti). At the same time, the first extremum is observed in May (Khaishi, Lentekhi), in May-June (Borjomi) and in June (Khulo, Pasanauri, Tianeti). The second extremum for all points is observed in September. It is notable that all these points are located at the altitude of less than 1100 m above sea level.

For the remaining seven locations, there is the unimodal (or smooth unimodal) type of intra-annual distribution of HCI values with a maximum in the following months: July-August (Bakhmaro, Gudauri, Stepantsminda), August (Bakuriani, Goderdzi), June-September (Mestia), July- September (Shovi). Regarding height, these points are located at an altitude of ≥ 1441 m above sea level.

Table 4. Intra-annual distribution types of HCI monthly mean values at 13 locations of Georgia.

Location	Distribution type	First extremum (Max)	Second extremum
Bakhmaro	Unimodal, flat	Jul, Aug	
Bakuriani	Unimodal	Aug	
Borjomi	Bimodal	May, Jun	Sep
Goderdzi	Unimodal	Aug	
Gudauri	Unimodal, flat	Jul, Aug	
Khaishi	Bimodal	May	Sep
Khulo	Bimodal	Jun	Sep
Lentekhi	Bimodal	May	Sep
Mestia	Unimodal, flat	Jun-Sep	
Pasanauri	Bimodal	Jun	Sep
Shovi	Unimodal, flat	Jul-Sep	
Stepantsminda	Unimodal, flat	Jul, Aug	
Tianeti	Bimodal	Jun	Sep

In Table 5, 6 the categories of HCI monthly mean and seasonal values at 13 locations of Georgia in cold and warm period are presented.

Table 5. Categories of HCI monthly mean and seasonal values at 13 locations of Georgia in cold period.

Location	Jan	Feb	Mar	Oct	Nov	Dec	Cold	Year
Bakhmaro	Accept.	Accept.	Accept.	Good	Accept.	Accept.	Accept.	Good
Bakuriani	Accept.	Accept.	Accept.	V_Good	Good	Good	Good	Good
Borjomi	Good	Good	Good	V_Good	Good	Good	Good	V_Good
Goderdzi	Marg.	Marg.	Accept.	Good	Accept.	Accept.	Accept.	Accept.
Gudauri	Accept.	Accept.	Accept.	Good	Good	Accept.	Accept.	Good
Khaishi	Accept.	Good	Good	V_Good	Good	Accept.	Good	V_Good
Khulo	Accept.	Accept.	Good	V_Good	Good	Accept.	Good	V_Good
Lentekhi	Accept.	Accept.	Good	V_Good	Good	Accept.	Good	Good
Mestia	Accept.	Accept.	Good	V_Good	Good	Accept.	Good	V_Good
Pasanauri	Good	Good	Good	V_Good	Good	Good	Good	V_Good
Shovi	Accept.	Accept.	Accept.	V_Good	Good	Accept.	Good	Good
Stepantsminda	Good	Good	Good	V_Good	Good	Good	Good	V_Good
Tianeti	Good	Good	Good	V_Good	Good	Good	Good	V_Good

As follows from the Table 5 categories of HCI monthly mean and seasonal values at 13 locations of Georgia in year cold period changes from Marginal to Very Good. In warm period of year categories of HCI monthly mean and seasonal values changes from Acceptable to Excellent (Table 6).

Table 6. Categories of HCI monthly mean and seasonal values at 13 locations of Georgia in warm period.

Location	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Warm**
Bakhmaro	Good	Good	Good	V_Good	V_Good	Good	V_Good
Bakuriani	Good	Good	V_Good	Excell.	Excell.	Excell.	V_Good
Borjomi	V_Good	Excell.	Excell.	V_Good	V_Good	Excell.	Excell.
Goderdzi	Accept.	Good	Good	V_Good	V_Good	Good	Good
Gudauri	Accept.	Accept.	Good	V_Good	V_Good	V_Good	Good
Khaishi	V_Good	Excell.	Excell.	V_Good	V_Good	Excell.	Excell.
Khulo	V_Good	Excell.	Excell.	Excell.	Excell.	Excell.	Excell.
Lentekhi	V_Good	Excell.	V_Good	V_Good	V_Good	Excell.	V_Good
Mestia	Good	V_Good	Excell.	Excell.	Excell.	Excell.	V_Good
Pasanauri	Good	V_Good	Excell.	Excell.	Excell.	Excell.	Excell.
Shovi	Good	V_Good	V_Good	Excell.	Excell.	Excell.	V_Good
Stepantsminda	Good	Good	V_Good	Excell.	Excell.	V_Good	V_Good
Tianeti	Good	V_Good	Excell.	Excell.	Excell.	Excell.	Excell.

So, as follows from Fig. 2 and Tables 5, 6 in the indicated 13 locations of Georgia there are favorable bioclimatic conditions for the development of tourism and resorts throughout the year in terms of climatic timescale.

In Annexes 1-3 the Min and Max values of HCI and these categories at 13 locations of Georgia in different months and seasons in 1956-2015 are presented. As follows from Annexes values of HCI and these categories in indicated locations changes from 20 (Goderdzi, January, “Very Unfavorable”) to 100 (Stepantsminda, September, “Ideal”; Khaishi, October, “Ideal”). For separated locations Min and Max monthly values of HCI and these categories changes as follows (Annexes 1-3).

Bakhmaro: 21 (January, “Very Unfavorable”) ÷ 91 (July-September, “Ideal”); Bakuriani: 46 (May, “Marginal”) ÷ 95 (August-September, “Ideal”); Borjomi: 48 (February, “Marginal”) ÷ 98 (October, “Ideal”); Goderdzi: 20 (January, “Very Unfavorable”) ÷ 92 (August, “Ideal”); Gudauri: 26 (January and February, “Very Unfavorable”) ÷ 98 (July, “Ideal”); Khaishi: 26 (January, “Very Unfavorable”) ÷ 100 (October, “Ideal”); Khulo: 28 (February, “Very Unfavorable”) ÷ 97 (October, “Ideal”); Lentekhi: 28 (January, “Very Unfavorable”) ÷ 95 (October, “Ideal”); Mestia: 34 (January, “Unfavorable”) ÷ 95 (September-October, “Ideal”); Pasanauri: 44 (April, “Marginal”) ÷ 95 (September, “Ideal”); Shovi: 28 (January, “Very Unfavorable”) ÷ 95 (September, “Ideal”); Stepantsminda: 49 (February and April, “Marginal”) ÷ 100 (September, “Ideal”); Tianeti: 53 (January and April, “Acceptable”) ÷ 95 (September, “Ideal”).

In Annexes 4-6 information about 99%_Low and 99%_Upp levels of mean values of HCI and these categories at 13 locations of Georgia in different months and season in 1956-2015 are presented. As follows from Annexes 4-6 Lower and Upper levels of 99% confidence interval of mean values of HCI changes from 44 (Marginal) to 89 (Excellent). For separated locations 99%_Low and 99%_Upp confidence interval of mean values of HCI and these categories changes as follows (Annexes 4-6).

Bakhmaro: 48 (January, “Marginal”) ÷79 (July-August, “Very Good”); Bakuriani: 57 (January-February, “Acceptable”) ÷ 87 (August, “Excellent”); Borjomi: 59 (January and December, “Acceptable”) ÷ 88 (September, “Excellent”); Goderdzi: 44 (January, “Marginal”) ÷ 77 (August, “Very Good”); Gudauri: 52 (April, “Acceptable”) ÷ 79 (August, “Very Good”); Khaishi: 53 (December, “Acceptable”) ÷ 88 (May and September, “Excellent”); Khulo: 53 (January and December, “Acceptable”) ÷ 87 (June and September, “Excellent”); Lentekhi: 52 (December, “Acceptable”) ÷ 86 (September, “Excellent”); Mestia: 54 (January, “Acceptable”) ÷ 86 (September, “Excellent”); Pasanauri: 60 (February, “Good”) ÷ 89 (September, “Excellent”); Shovi: 55 (January, “Acceptable”) ÷ 86 (August, “Excellent”); Stepantsminda: 60 (February and March, “Good”) ÷ 87 (August, “Excellent”); Tianeti: 60 (February, “Good”) ÷ 89 (September, “Excellent”).

2. Vertical Distribution of HCI in the Mountainous Regions of Georgia.

The vertical distribution of the Tourism Climat Index was studied for 21 points in Georgia and 6 points in the North Caucasus within the height range from 3 m (Anaklia) to 2194 m (Gudauri) above sea level in our early work [14]. Results of the study of the HCI vertical distribution for thirteen mountain locations in Georgia within the height range from 730 m (Khaishi) to 2194 m (Gudauri) above sea level are presented below (Table 7 and Fig. 3-5).

Table 7. Regression equations for the relationship between HCI and terrain height.

Month/Season	Regression equation	R^2	α
Jan	$HCI=19.03 \cdot H^3 - 91.056 \cdot H^2 + 132.83 \cdot H - 0.1852$	0.3596	0.030
Feb	$HCI = -6.362 \cdot H^2 + 13.302 \cdot H + 53.093$	0.4543	0.011
Mar	$HCI = -6.624 \cdot H + 69.492$	0.7689	<0.001
Apr	$HCI= -11.451 \cdot H + 81.671$	0.9334	<0.001
May	$HCI= -16.99 \cdot H + 97.245$	0.957	<0.001
Jun	$HCI = 22.77 \cdot H^3 - 116.94 \cdot H^2 + 173.17 \cdot H + 6.6863$	0.9624	<0.001
Jul	$HCI = -17.581 \cdot H^2 + 47.966 \cdot H + 50.684$	0.7385	<0.001
Aug	$HCI = -18.958 \cdot H^2 + 53.137 \cdot H+ 47.33$	0.7607	<0.001
Sep	$HCI = 16.765 \cdot H^3 - 84.553 \cdot H^2 + 119.68 \cdot H + 35.573$	0.9181	<0.001
Oct	$HCI = -9.5626 \cdot H + 83.802$	0.7359	<0.001
Nov	$HCI = 17.61 \cdot H^3 - 84.639 \cdot H^2 + 122.3 \cdot H + 10.412$	0.4244	0.016
Dec	$HCI = 22.014 \cdot H^3 - 105.32 \cdot H^2 + 155.27x \cdot H- 10.724$	0.3763	0.026
Year	$HCI= 9.3544 \cdot H^3 - 50.088 \cdot H^2 + 74.751 \cdot H + 38.759$	0.8247	<0.001
Cold	$HCI= 12.704 \cdot H^3 - 61.958 \cdot H^2 + 88.966 \cdot H + 24.778$	0.53	0.005
Warm	$HCI = -12.002 \cdot H^2 + 24.754 \cdot H + 67.736$	0.9324	<0.001

For different month the form of this distribution is as follows. Inverse linear regression (decrease of HCI values with increasing altitude H): March, April, May and October; second order polynomial – February, July, August, and warm season mean; third order polynomial – January, June, September, November, December, mean annual and cold season mean.

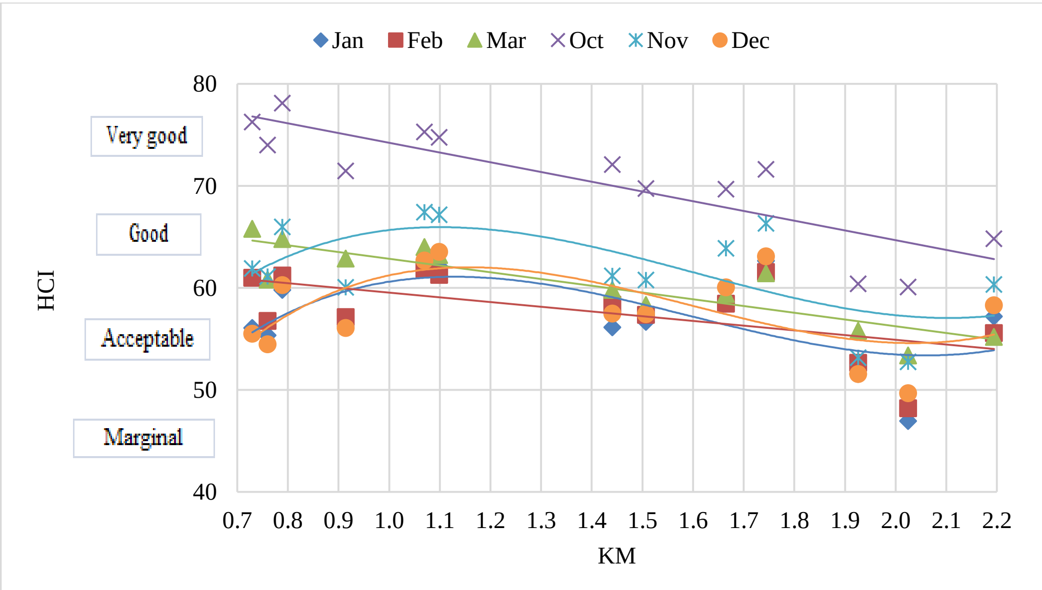


Fig. 3. Vertical distribution of HCI monthly mean values from October to March.

As it follows from Fig. 3 in January and February at level of 1500 m HCI values are weakly dependent on altitude, then there is a slight decrease in their values. In November and December, up to an altitude of 1100 m, HCI values grow, and then slowly decreases.

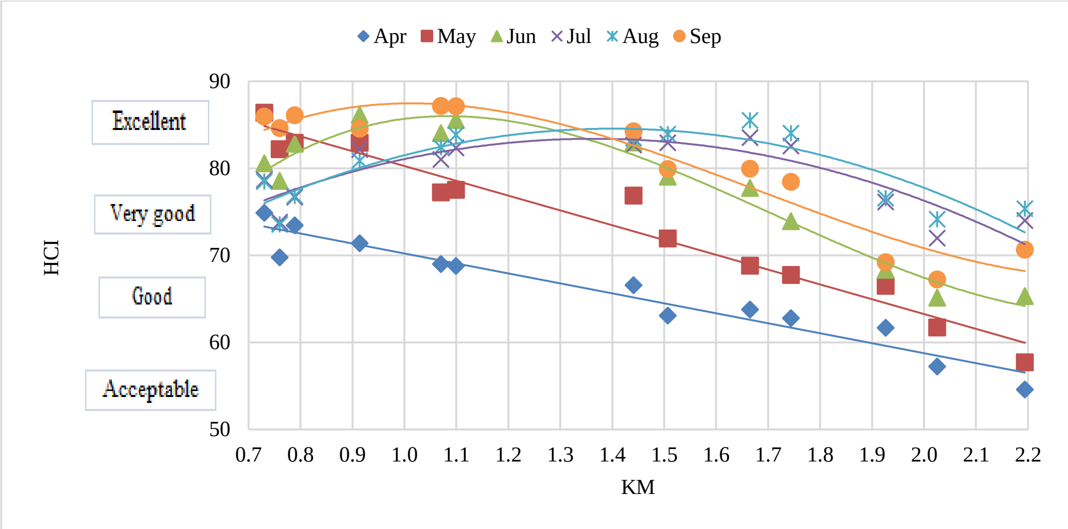


Fig. 4. Vertical distribution of HCI monthly mean from April to September.

In June and September, an increase in HCI values is observed up to an altitude of 1100 m, then a decrease. In July and August, HCI values grow to an altitude of 1400-1500 m with a further decrease (Fig. 4).

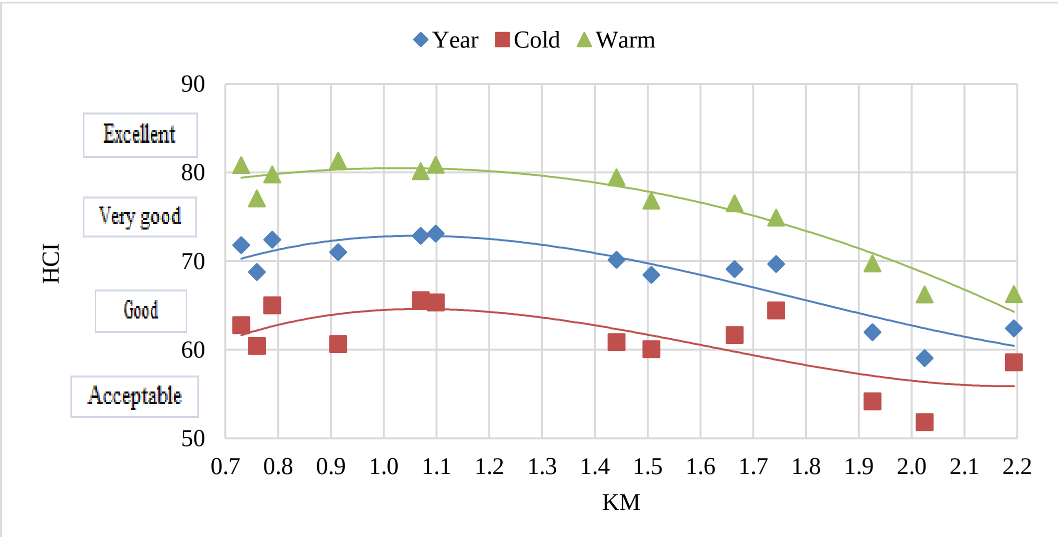


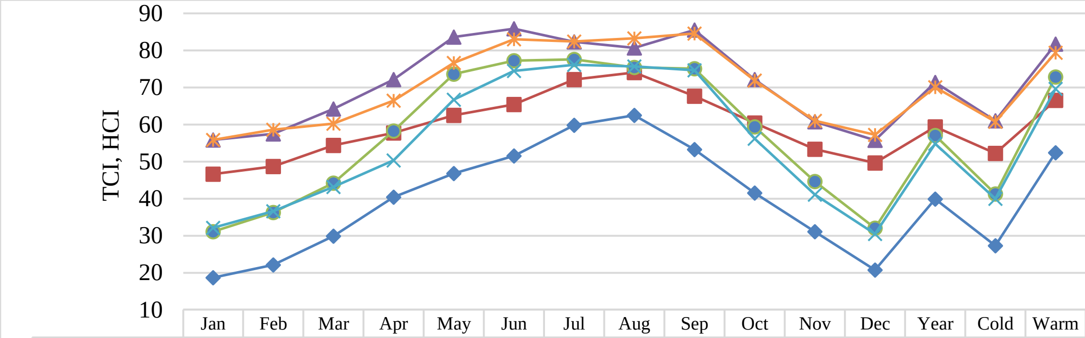
Fig. 5. Vertical distribution of HCI monthly mean and half-year values.

In the warm half of the year, there is a slight increase in the average HCI values up to an altitude of 1100-1200 m with a further decrease in their values. In the cold half of the year and on average over the year, the HCI values grow to an altitude of 1100-1200 m, and then they decrease (Fig. 5).

3. Comparison of TCI and HCI in Goderdzi, Khulo and Mestia in 1961-2010.

Comparison of TCI and HCI values are provided in many investigations [21-25]. In Georgia the analogous study was conducted for Tbilisi [26] and Kakheti region [27], in Russia – for some North Caucasus locations [28].

Comparison of TCI and HCI at three location of Georgia (Goderdzi, Khulo and Mestia) in 1961-2010 is provided below (Fig. 6-9, Table 8).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
God, TCI	19	22	30	40	47	52	60	63	53	41	31	21	40	27	52
God, HCI	47	49	54	58	62	65	72	74	68	60	53	50	59	52	67
Khu, TCI	31	36	44	58	74	77	78	75	75	59	45	32	57	41	73
Khu, HCI	56	58	64	72	84	86	82	81	86	72	61	56	71	61	82
Mest, TCI	32	37	43	50	67	75	76	76	75	56	41	31	55	40	70
Mest, HCI	56	59	60	66	77	83	82	83	85	72	61	57	70	61	79

Fig. 6. Monthly and seasonal values of HCI and TCI in Goderdzi, Khulo and Mestia.

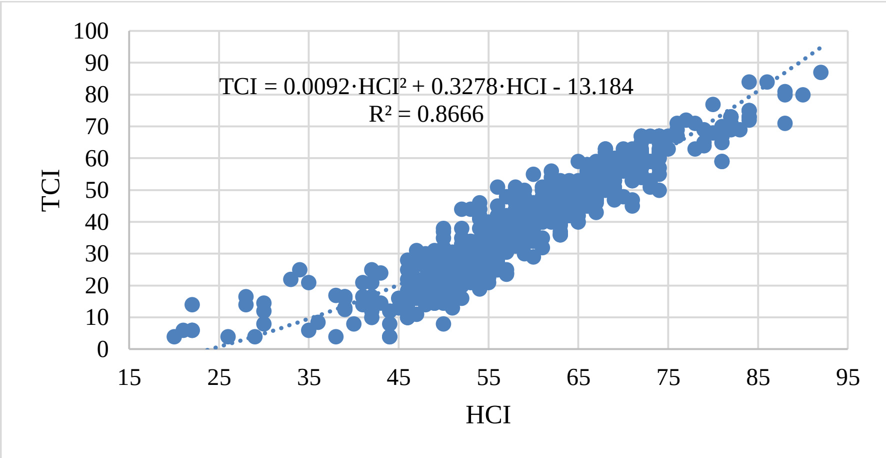


Fig. 7. Correlation and regression between monthly values of HCI and TCI in Goderdzi.

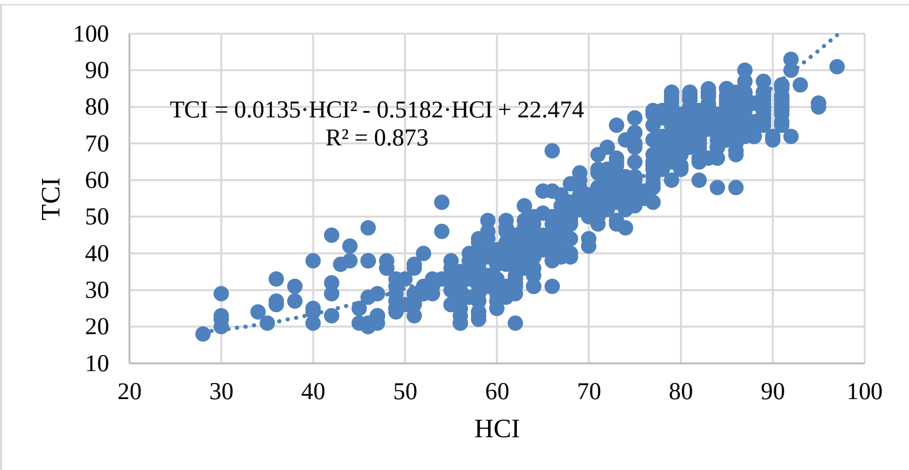


Fig. 8. Correlation and regression between monthly values of HCI and TCI in Khulo.

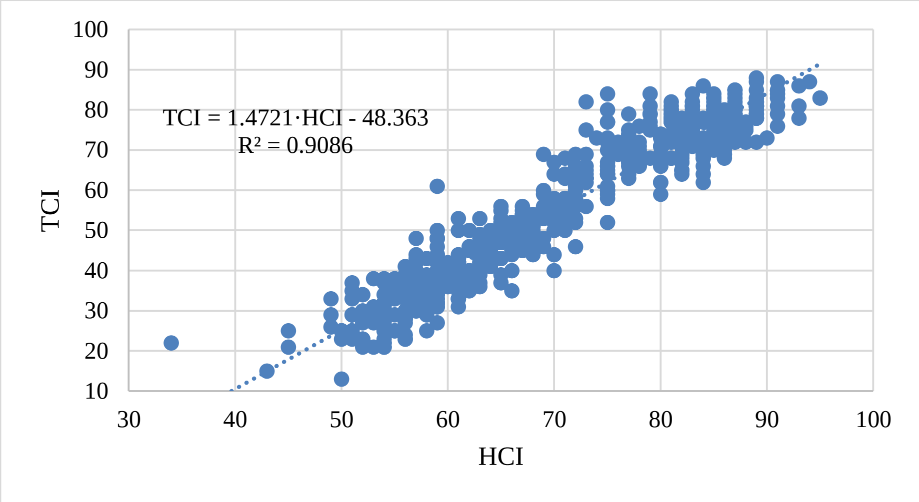


Fig. 9. Linear correlation and regression between HCI and TCI in Mestia.

Table 8. Categories of HCI and TCI monthly mean and seasonal values in Goderdzi, Khulo and Mestia.

Location	**Goderdzi**		**Khulo**		**Mestia**	
Month/Season	**TCI**	**HCI**	**TCI**	**HCI**	**TCI**	**TCI**
Jan	Ext_Unf.	Marg.	Unf.	Accept.	Unf.	Accept.
Feb	V_Unf.	Marg.	Unf.	Accept.	Unf.	Accept.
Mar	Unf.	Accept.	Marg.	Good	Marg.	Good
Apr	Marg.	Accept.	Accept.	V_Good	Accept.	Good
May	Marg.	Good	V_Good	Excell.	Good	V_Good
Jun	Accept.	Good	V_Good	Excell.	V_Good	Excell.
Jul	Good	V_ Good	V_Good	Excell.	V_Good	Excell.
Aug	Good	V_ Good	V_Good	Excell.	V_Good	Excell.
Sep	Accept.	Good	V_Good	Excell.	V_Good	Excell.
Oct	Marg.	Good	Accept.	V_Good	Accept.	V_Good
Nov	Unf.	Accept.	Marg.	Good	Marg.	Good
Dec	V_Unf.	Accept.	Unf.	Accept.	Unf.	Accept.
Year	Marg.	Accept.	Accept.	V_Good	Accept.	V_Good
Cold	V_Unf.	Accept.	Marg.	Good	Marg.	Good
Warm	Accept.	Good	V_Good	Excell.	V_Good	V_Good

In Fig. 6 the HCI and TCI monthly mean and seasonal values of in these locations are presented.

The comparison of the values and categories of the Tourism Climate Index and Holiday Climate Index (Fig. 6, Table 8) shows that the intra-annual distributions of both indices in Goderdzi and Mestia is similar and has a unimodal and flat unimodal forms respectively. In Khulo, this distribution is flat unimodal, for TCI and bimodal for HCI.

The relationship between monthly HCI and TCI values in Goderdzi and Khulo has a second order polynomial form (Figures 7 and 8). In Khulo, this connection is linear (Fig. 9).

Comparison of TCI and HCI categories shows, that in cold months, season and year HCI categories on 0-3 step higher than TCI categories (Table 8).

Difference on 3 step in the following cases are observed: TCI_ Ext_Unf. → HCI_ Marg., in January (Goderdzi); TCI_ V_Unf. → HCI_ Accept., in December and cold season (Goderdzi).

Difference on 2 step: TCI_ V_Unf. → HCI_ Marg., in February (Goderdzi); TCI_ Unf. → HCI_ Accept., in January, February and December (Khulo, Mestia); in March and November (Goderdzi); TCI_Marg. → HCI_Good, in March (Khulo, Mestia); in May and October (Goderdzi); in November and cold season (Khulo, Mestia); TCI_ Accept. → HCI_V_Good, in April, October and mean annual (Khulo, Mestia)

Difference on 1 step: TCI_Marg. → HCI_ Accept., in April and mean annual (Goderdzi); TCI_ Accept. → HCI_Good, in June, September and warm season (Goderdzi); TCI_ Good→HCI_V_Good, in May (Mestia), in July and August (Goderdzi); TCI_ V_Good→ HCI_ Excell., in May (Khulo), from June to September (Khulo, Mestia), warm season (Khulo).

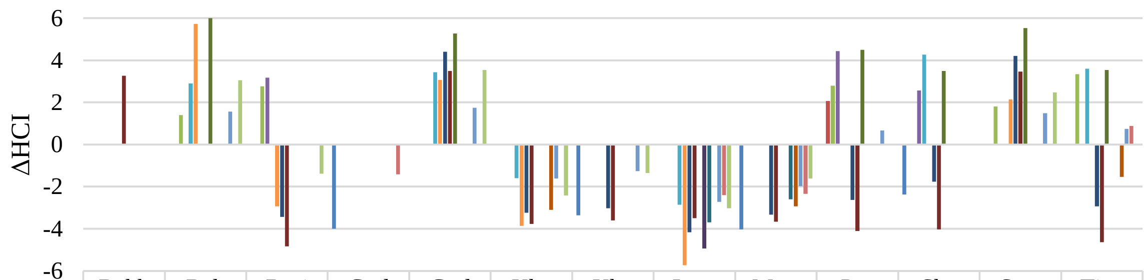
The same category ”Very Good” for TCI and HCI only in warm season mean in Mestia is observed.

So the valuee and categories of TCI is lower than the HCI ones. In general, on our opinions, at least in Georgia HCI more adequately determines the bioclimatic state of the environment for the development of certain types of tourism (mountain tourism, winter tourism, extreme tourism, etc.) than TCI.

4. Changeability of HCI in the Mountainous Regions of Georgia in 1956-2015.

Data on changeability of HCI and its category are presented in Fig. 10-11, Tables 9-11 and Annexes 7-8at the 13 mountainous regions of Georgia in 1956-2015.

On Fig. 10 the information about difference between HCI monthly mean and seasonal values in 1986-2015 and 1956-1985 (ΔHCI) in 13 locations of Georgia are presented.



	Bakh	Bak	Borj	God	Gud	Kha	Khu	Lent	Mest	Pas	Sho	Step	Tian
Jan				-4.0			-3.4		-4.0		-2.4		
Feb										2.1			
Mar		1.4	2.8							2.8		1.8	3.3
Apr			3.2							4.4	2.6		
May		2.9			3.4	-1.6		-2.9			4.3		3.6
Jun		5.7	-2.9		3.1	-3.9		-5.7				2.1	
Jul			-3.4		4.4	-3.2	-3.0	-4.2	-3.3	-2.6	-1.8	4.2	-2.9
Aug	3.3		-4.8		3.5	-3.8	-3.6	-3.5	-3.7	-4.1	-4.0	3.5	-4.6
Sep		6.0			5.3					4.5	3.5	5.5	3.5
Oct								-4.9					
Nov								-3.7	-2.6				
Dec						-3.1			-2.9				-1.5
Year		1.6			1.7	-1.6	-1.3	-2.7	-2.0	0.7		1.5	0.7
Cold				-1.4				-2.4	-2.3				0.9
Warm		3.1	-1.4		3.5	-2.4	-1.4	-3.0	-1.6			2.5	

Fig. 10. Difference between HCI monthly mean and seasonal values in 1986-2015 and 1956-1985 in 13 locations of Georgia.

For individual locations, significant values of ΔHCI and their tendencies ($\alpha \leq 0.15$) are observed in the following months and seasons of the year.

Bakhmaro - increase in August. Bakuriani - increase in March, May, June, September, for mean annual and warm season mean. Borjomi - increase in March and April, decrease from June to August and for warm season mean. Goderdzi – decrease in January and for cold season mean. Gudauri – increase from May to September and for mean annual and warm season mean. Khaishi - decrease from May to August, in December and for mean annual and warm season mean. Khulo – decrease in January, July, August, for mean annual and warm season mean. Lentekhi – decrease from May to August, in October, November and for mean annual, cold and warm seasons mean. Mestia - decrease in January, July, August, November, December and for mean annual, cold and warm seasons mean. Pasanauri - increase from February to April, in September and for mean annual; decrease in July and August. Shovi - decrease in January, July and August; increase in April May and September. Stepantsminda – increase in March, from June to September and for mean annual and warm season mean; Tianeti - increase in March, May, September and for for mean annual and cold season mean; decrease in July, August and December.

In Tables 9 and 10 data on the coefficients of the linear trend (α for $R \le 0.15$) of monthly and seasonal HCI values for 13 points of Georgia in 1956-2015 are presented.

Table 9. Coefficients of the linear trend of monthly and seasonal HCI values for 13 points of Georgia in 1956-2015 (October-March, average for the year, average in the cold half-year). HCI=a·X+b, (X – year).

Location	Parameter	Jan	Feb	Mar	Oct	Nov	Dec	Year	Cold
Bakh	**a**								
Bakh	**b**								
Bak	**a**			0.0546				0.0474	
Bak	**b**			-49.0				-25.0	
Borj	**a**			0.1029	0.0812				0.0425
Borj	**b**			-139.6	-83.0				-19.4
God	**a**								
God	**b**								
Gud	**a**		0.0867					0.0636	
Gud	**b**		-116.5					-63.9	
Kha	**a**							-0.0273	
Kha	**b**							125.9	
Khu	**a**				-0.1295			-0.0478	
Khu	**b**				328.6			166.0	
Lent	**a**				-0.1314			-0.0669	-0.0409
Lent	**b**				335.0			201.5	141.6
Mest	**a**	-0.0846					-0.0446	-0.0487	-0.0508
Mest	**b**	224.1					146.1	166.9	161.7
Pas	**a**		0.0851	0.091				0.0244	0.0383
Pas	**b**		-107.1	-116.6				24.5	-10.5
Sho	**a**								
Sho	**b**								
Step	**a**			0.0485				0.0366	
Step	**b**			-34.7				-2.9	
Tian	**a**			0.0803					0.0275
Tian	**b**			-96.2					10.8

Table 10. Coefficients of the linear trend of monthly and seasonal HCI values for 13 points of Georgia in 1956-2015 (April-September, average in the warm half-year). HCI=a·X+b, (X – year).

Location	Parameter	Apr	May	Jun	Jul	Aug	Sep	Warm
Bakh	**a**					0.089		
Bakh	**b**					-100.2		
Bak	**a**		0.0785	0.1868			0.1847	0.0815
Bak	**b**		-87.0	-293.1			-286.8	-85.3
Borj	**a**	0.0911		-0.1033	-0.1303	-0.1522	-0.0495	-0.0527
Borj	**b**	-107.3		287.8	335.4	379.0	184.4	184.4
God	**a**							
God	**b**							
Gud	**a**		0.1058	0.1155	0.1178	0.1119	0.1372	0.0978
Gud	**b**		-152.4	-164.0	-159.9	-146.9	-201.8	-127.9
Kha	**a**			-0.1194	-0.0769	-0.0828		-0.0616
Kha	**b**			317.7	231.3	242.9		203.2
Khu	**a**				-0.0954	-0.0995		-0.054
Khu	**b**				271.6	278.5		188.5
Lent	**a**		-0.0627	-0.1671	-0.1291	-0.1097		-0.0928
Lent	**b**		206.8	410.4	330.2	291.4		261.4
Mest	**a**				-0.0958	-0.12		-0.0467
Mest	**b**				272.9	321.8		172.1
Pas	**a**	0.0965			-0.0844	-0.1006	0.1205	
Pas	**b**	-122.6			248.6	282.2	-152.1	
Sho	**a**	0.0732	0.1916		-0.1178	-0.1628	0.0947	
Sho	**b**	-82.2	-308.5		316.9	407.2	-108.1	
Step	**a**				0.0994	0.0896	0.1542	0.0542
Step	**b**				-114.8	-93.8	-227.7	-32.7
Tian	**a**		0.0905		-0.1355	-0.1571	0.0912	
Tian	**b**		-102.2		351.5	395.8	-94.0	

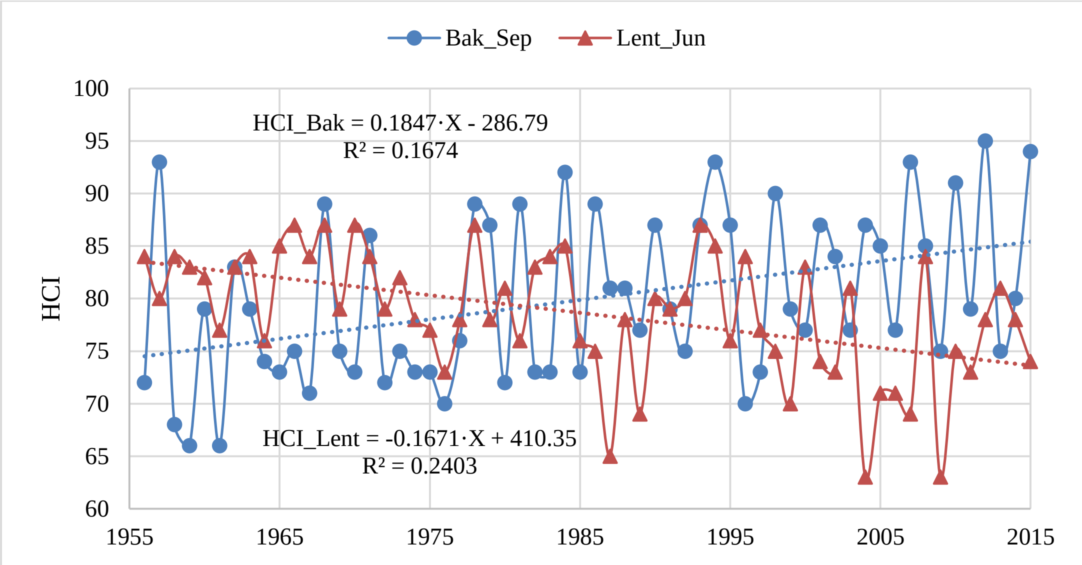


Fig. 11. Example of linear trend of HCI monthly values in Bakuriani (September) and Lentekhi (June) in 1956-2015

Example of linear trend of HCI monthly values in Bakuriani (September) and Lentekhi (June) in 1956-2015 is presented on Fig 11.

In Table 11 data about changeability of monthly mean and seasonal HCI categories in some research locations in 1986-2015 compared with 1956-1985 are presented.

Table 11. Changeability of monthly mean and seasonal HCI categories in some investigation locations in 1986-2015 compared with 1956-1985.

Location	**Month**	**HCI Category, 1956-1985**	**HCI Category, 1986-2015**	**Location**	**Month**	**HCI Category, 1956-1985**	**HCI Category, 1986-2015**
Bakh	Sep	Good	V_Good	**Khu**	Nov	Good	Accept.
Bak	Mar	Accept.	Good	**Lent**	Apr	V_Good	Good
Bak	May	Good	V_Good	**Lent**	Jun	Excell.	V_Good
Bak	Jun	V_Good	Excell.	**Lent**	Nov	Good	Accept.
Bak	Sep	V_Good	Excell.	**Lent**	Cold	Good	Accept.
Bak	Oct	V_Good	Good	**Lent**	Year	V_Good	Good
Bak	Year	Good	V_Good	**Mest**	Mar	Good	Accept.
Borj	Warm	Excell.	V_Good	**Mest**	Year	V_Good	Good
God	Dec	Accept.	Marg.	**Mest**	Warm	Excell.	V_Good
Gud	Sep	Good	V_Good	**Pas**	Apr	Good	V_Good
Kha	Jun	Excell.	V_Good	**Sho**	Sep	V_Good	Excell.
Kha	Jul	Excell.	V_Good	**Step**	Sep	V_Good	Excell.
Kha	Aug	Excell.	V_Good	**Step**	Year	Good	V_Good
Khu	Aug	Excell.	V_Good	**Tian**	Apr	Good	V_Good

As follows from Table 11, changes in HCI categories occur only by one step downward or an improvement in its rating. However, these changes do not fall outside the 99% confidence interval of mean HCI values (Annexes 4-6).

In Annex 7 information about repetition (%) of monthly values of HCI categories at 13 locations of Georgia in 1956-1985, 1956-2015 and 1986-2015 are presented. In Annex 8 data about number of days in year of various categories of HCI at 13 locations of Georgia in 1956-1985, 1956-2015 and 1986-2015 are presented. As follows from Table 11 and Annexes 7-8 changeability of monthly values of HCI categories and number of days per year of various categories of HCI for separated locations is as follows.

Bakhmaro

In the period from 1956 to 2015 the highest repeatability of HCI values was in the “Good” category (29.7% of cases), the lowest - in the “Ideal” category (0.8% of cases). In the second period, compared to the first in Bakhmaro, there was an increase in the HCI category by one notch in September (“Good” → “Very Good”).

Repeatability of HCI category “Very Unfavorable” did not change - 1.1% of cases (respectively, 4 days a year), category “Unfavorable” increased from 2.5% to 4.2% of cases (respectively, 9 and 15 days a year), category “Marginal” decreased from 10.0% to 8.6% of cases (37 and 31 days a year, respectively), category “Acceptable” decreased from 29.7% to 28.1% of cases (109 and 102 days a year, respectively), category “Good” increased from 29.4% to 30.0% of cases (108 and 110 days, respectively) per year), category “Very Good” decreased from 22.5% to 19.2% of cases (82 and 70 days per year, respectively), category “Excellent” increased from 4.2% to 7.8% of cases (15 and 28 days per year, respectively), category “ Ideal “grew from 0.6% to 1.1% of cases (2 and 4 days a year, respectively).

Bakuriani

In the period from 1956 to 2015 the highest repeatability of HCI values was in the “Good” category (34.3% of cases), the lowest - in the “Marginal” category (0.8% of cases). In the second period of time, compared to the first in Bakuriani, climate change led to an increase in HCI categories by one level in March (“Acceptable” → “Good”), May and on average per year (“Good” → “Very Good”), June and September (“Very Good” → “Excellent”), decreasing by one notch - in October (“Very Good” → “Good”).

Repeatability of HCI category “Marginal” decreased from 1.1% to 0.6% of cases (4 and 2 days per year, respectively), category “Acceptable” remained practically unchanged ≈23.2% of cases (respectively, 85 days per year), category “Good” decreased from 35.6% to 33.1% of cases (respectively 130 and 121 days a year), category “Very Good” decreased from 21.7% to 17.2% (respectively 79 and 63 days a year), category “Excellent” increased from 15.8% to 21.4% of cases (respectively 58 and 78 days a year), the “Ideal” category increased from 2.8% to 4.4% of cases (10 and 16 days a year, respectively).

Borjomi

Over the entire observation period, the highest repeatability of HCI values was in the “Good” category (31.0% of cases), the lowest - in the “Marginal” category (0.1% of cases). In the second period of time, compared to the first in Borjomi, climate change led to an increase in the HCI category by one level only in the warm half of the year (“Excellent” → “Very Good”).

The repeatability of the HCI category “Marginal” decreased from 0.3% to 0.0% of cases(respectively 1 and 0 days a year), category “Acceptable” increased from 11.4% to 13.3% of cases(respectively 42 and 49 days a year), category “Good” decreased from 32.8% to 29.2% of cases (respectively 120 and 107 days a year), the “Very Good” category increased from 23.9% to 32.2% of cases (87 and 118 days a year, respectively), the “Excellent” category decreased from 29.7% to 21.9% of cases (109 and 80 days a year respectively), category “Ideal” increased from 1.9% to 3.3% of cases (7 and 12 days a year, respectively).

Goderdzi

In the period from 1956 to 2015 the highest repeatability of HCI values was in the “Acceptable” category (38.2% of cases), the lowest - in the “Ideal” category (0.3% of cases). In the second time period, compared to the first in Goderdzi, climate change led to a decrease in HCI categories by one level only in December (“Acceptable” → “Marginal”).

The repeatability of HCI category “Very Unfavorable” increased from 0.8% to 1.9% of cases (3 and 7 days per year, respectively), category “Unfavorable” increased from 2.2% to 2.8% of cases (respectively, 8 and 10 days a year), category “Marginal” increased from 11.7% to 12.8% of cases (43 and 47 days a year, respectively), the “Acceptable” category decreased from 39.4% to 37.2% of cases (144 and 136 days a year, respectively), the “Good” category decreased from 30.3% to 27.8% of cases (respectively 111 and 101 days a year), the “Very Good” category decreased from 12.2% to 11.1% of cases (45 and 41 days a year, respectively), the “Excellent” category increased from 3.3% to 5.8% of cases (12 and 21 days a year, respectively.), the “Ideal” category increased from 0.0% to 0.6% of cases (0 and 2 days a year, respectively).

Gudauri

Over the entire observation period, the highest repeatability of HCI values was in the “Good” category (35.8% of cases), the lowest - in the “Ideal” category (0.1% of cases). In the second period of time, compared to the first in Gudauri, climate change led to an increase in HCI categories by one level only in September (“Good” → “Very Good”).

The repeatability of the HCI category "Very Unfavorable" did not change - 0.3% of cases (respectively, 1 day per year), category "Unfavorable" decreased from 1.9% to 0.8% of cases (respectively, 7 and 3 days a year), category "Marginal" increased from 6.9% to 8.6% of cases (25 and 31 days per year, respectively), the "Acceptable" category decreased from 33.3% to 27.8% of cases (122 and 101 days a year, respectively), category "Good" decreased from 37.2% to 34.4% of cases (136 and 126 days per year), category "Very Good" increased from 16.9% to 20.0% of cases (respectively 62 and 73 days per year), category "Excellent" increased from 3.3% to 7.8% of cases (respectively 12 and 28 days per year), category "Ideal" increased from 0.0% to 0.3% of cases (0 and 1 day per year, respectively).

Khaishi

In the period from 1956 to 2015 the highest repeatability of HCI values was in the "Excellent" category (29.3% of cases), the lowest - in the "Very Unfavorable" category (0.1% of cases). In the second period compared to the first in Khaishi, climate change led to a decrease in the HCI category by one notch only in the summer months, from June to August ("Excellent" → "Very Good").

The repeatability of the HCI category "Very Unfavorable" increased from 0.0% to 0.3% of cases (0 and 1 day per year, respectively), category "Unfavorable" decreased from 1.1% to 0.6% of cases (respectively, 4 and 2 days per year), category "Marginal" decreased from 4.2% to 3.1% of cases (15 and 11 days a year, respectively), the "Acceptable" category increased from 8.9% to 18.3% of cases (32 and 67 days a year, respectively), the "Good " category decreased from 27.5% to 22.5% of cases (100 and 82 days a year), the "Very Good" category increased from 22.8% to 24.7% of cases (83 and 90 days a year, respectively), the "Excellent" category decreased from 30.8% to 27.8% of cases (113 and 101 days a year, respectively) , category "Ideal" decreased from 4.7% to 2.8% of cases (17 and 10 days per year, respectively).

Khulo

In the period from 1956 to 2015 the highest repeatability of HCI values was in the "Excellent" category (32.1% of cases), the lowest - in the "Very Unfavorable" category (0.3% of cases). In the second time period compared to the first in Khulo, climate change led to a decrease in the HCI category by one notch in August ("Excellent" → "Very Good") and November ("Good" → "Acceptable").

The repeatability of HCI category "Very Unfavorable" did not change - 0.3% of cases (respectively, 1 day per year), category "Unfavorable" increased from 1.4% to 2.5% of cases (respectively, 5 and 9 days per year), category "Marginal" increased from 5.3% to 6.9% of cases (19 and 25 days a year, respectively), the "Acceptable" category decreased from 13.6% to 11.1% of cases (50 and 41 days a year, respectively), the "Good" category increased from 23.6% to 25.0% of cases (86 and 91 days per year respectively), category "Very Good" increased from 17.5% to 19.7% of cases (respectively 64 and 72 days a year), the category "Excellent" decreased from 34.7% to 29.4% of cases (respectively 127 and 108 days a year), the category " Ideal "grew from 3.6% to 5.0% of cases (13 and 18 days a year, respectively).

Lentekhi

Over the entire observation period, the highest repeatability of HCI values was in the "Very Good" category (26.5% of cases), the lowest - in the "Very Unfavorable" category (0.1% of cases). In the second period of time, compared to the first in Lentekhi, climate change led to a decrease in the HCI category by one level in April and on average per year ("Very Good" → "Good"), June ("Excellent" → "Very Good"), November and in the cold half of the year ("Good" → "Acceptable").

The repeatability of the HCI category "Very Unfavorable" increased from 0.0% to 0.3% of cases (0 and 1 day per year, respectively), category "Unfavorable" decreased from 1.9% to 0.8% of cases (respectively, 7 and 3 days per year), category "Marginal" did not changed - 4.4% of cases (16 days a year, respectively), the "Acceptable" category increased from 13.3% to 26.1% of cases (49 and 95 days a year, respectively), the "Good" category decreased from 26.9% to 22.2% of cases (98 and 81 days, respectively per year), category "Very Good" increased from 25.8% to 27.2% of cases (respectively, 94 and 99 days per year), category "Excellent" decreased from 25.8% to 18.6% of cases (respectively, 94 and 68 days per year), category " Ideal "decreased from 1.7% to 0.3% of cases (6 and 1 days per year, respectively).

Mestia

In the period from 1956 to 2015 the highest repeatability of HCI values was in the "Excellent" category (29.3% of cases), the lowest - in the "Unfavorable" category (0.1% of cases). In the second period of time compared to the first in Mestia, climate change led to a decrease in the HCI category by one level in March ("Good" → "Acceptable"), on average per year ("Very Good" → "Good") and in the warm half of the year ("Excellent" → "Very Good).

The repeatability of the HCI category “Unfavorable” increased from 0.0% to 0.3% of cases (0 and 1 day per year, respectively), category “Marginal” increased from 0.6% to 1.4% of cases (respectively, 2 and 5 days per year), category “Acceptable” increased from 21.7% to 30.0% of cases (79 and 110 days a year, respectively), the “Good” category decreased from 29.4% to 19.7% of cases (108 and 72 days a year, respectively), the “Very Good” category increased from 13.9% to 19.2% of cases (respectively 51 and 70 days a year), the “Excellent” category decreased from 30.3% to 28.3% of cases (111 and 103 days a year, respectively), the “Ideal” category decreased from 4.2% to 1.1% of cases (15 and 4 days per year, respectively).

Pasanauri

In the period from 1956 to 2015 the highest repeatability of HCI values was in the “Good” category (36.9% of cases), the lowest - in the “Marginal” category (0.7% of cases). In the second time period compared to the first in Pasanauri, climate change led to an increase in the HCI category by one notch only in April (“Good” → “Very Good”).

The repeatability of the HCI “Marginal” category decreased from 0.8% to 0.6% of cases (3 and 2 days per year, respectively), the “Acceptable” category decreased from 8.9% to 6.4% of cases (32 and 23 days per year, respectively), the “Good” category did not change - 36.9% of cases (135 days a year), category “Very Good” increased from 17.2% to 23.6% of cases (respectively 63 and 86 days a year), category “Excellent” decreased from 31.4% to 25.3% of cases (respectively 115 and 92 days a year), the “Ideal” category increased from 4.7% to 7.2% of cases (17 and 26 days a year, respectively).

Shovi

Over the entire observation period, the highest repeatability of HCI values was in the “Acceptable” category (27.1% of cases), the lowest - in the “Very Unfavorable” and “Unfavorable” categories (0.1% of cases). In the second period of time, compared to the first in Shovi, climate change led to an increase in the HCI category by one notch only in September (“Very Good” → “Excellent”).

The repeatability of HCI categories “Very Unfavorable” and “Unfavorable” increased from 0.0% to 0.3% of cases (0 and 1 day per year, respectively), category “Marginal” decreased from 2.8% to 1.7% of cases (10 and 6 days per year, respectively), category “Acceptable” increased from 24.2% to 30.0% of cases (respectively 88 and 110 days a year), category “Good” decreased from 31.4% to 22.5% of cases (respectively 115 and 82 days a year), category “Very Good” increased from 16.1 % to 18.3% of cases (59 and 67 days a year, respectively), the “Excellent” category increased from 23.3% to 26.7% of cases (85 and 97 days a year, respectively), the “Ideal” category decreased from 2.2% to 0.3% of cases (respectively 8 and 1 days a year).

Stepantsminda

In the period from 1956 to 2015 the highest repeatability of HCI values was in the “Good” category (48.2% of cases), the lowest - in the “Marginal” category (0.3% of cases). In the second period of time, as compared to the first in Stepantsminda, climate change led to an increase in the HCI category by one notch in September (“Very Good” → “Excellent”) and for the whole year (“Good” → “Very Good”).

The repeatability of the HCI category “Marginal” decreased from 0.6% to 0.0% of cases (respectively 2 and 0 days per year), category “Acceptable” increased from 9.2% to 10.3% of cases (respectively, 33 and 38 days per year), category “Good” decreased from 50.6% to 45.8% of cases (185 and 167 days a year, respectively), the “Very Good” category decreased from 24.4% to 23.1% of cases (89 and 84 days a year, respectively), the “Excellent” category increased from 12.8% to 16.4% of cases (47 and 60 days a year, respectively), the “Ideal” category increased from 2.5% to 4.4% of cases (9 and 16 days a year, respectively).

Tianeti

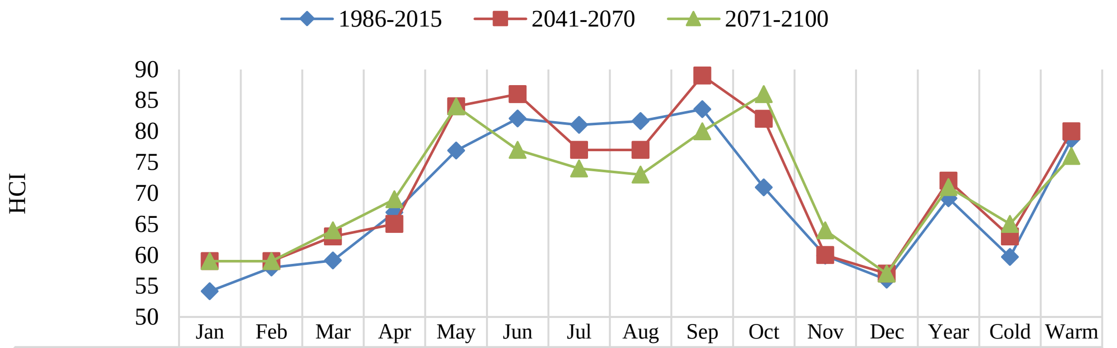
In the period from 1956 to 2015 the highest repeatability of HCI values was in the “Good” category (34.3% of cases), the lowest - in the “Ideal” category (5.8% of cases). In the second time period compared to the first in Tianeti, climate change led to an increase in HCI categories by one notch in April (“Good” → “Very Good”).

The repeatability of the HCI category “Acceptable” decreased from 11.7% to 8.6% of cases (43 and 31 days per year, respectively), category “Good” practically did not change - ≈ 34.3 of cases (respectively, 125 days per year), category “Very Good” increased from 19.7 % to 24.4% of cases (72 and 89 days a year, respectively), the “Excellent” category decreased from 29.2% to 26.1% of cases (107 and 95 days a year, respectively), the “Ideal” category increased from 5.0% to 6.7% of cases(18 and 24 days a year).

In 1956-1985, 1956-2015 and 1986-2015, the number of days in the range of HCI categories “Marginal” - “Ideal” for the studied locations, respectively, is the following: Bakhmaro (352-349-346), Goderdzi (354-351-348), Gudauri (357-359-361), Khaishi (361-362-362), Khulo (359-357-355), Lentekhi (358-360-361), Mestia (365-365-364), Shovi (365-345- 363); Bakuriani, Borjomi, Pasanauri, Stepantsminda and Tianeti (for all three time periods - by 365 days).

5. Expected Changes of HCI by 2041-2070 and 2071-2100 on the Example of Mestia.

Data about expected changes of HCI and its categories by 2041-2070 and 2071-2100 in Mestia according [33] in Fig. 12 and Table 12 are presented.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
1986-2015	54	58	59	67	77	82	81	82	84	71	60	56	69	60	79
2041-2070	59	59	63	65	84	86	77	77	89	82	60	57	72	63	80
2071-2100	59	59	64	69	84	77	74	73	80	86	64	57	71	65	76

Fig. 12. Average monthly, annual and seasonal values of HCI in Mestia (1986-2015, 2041-2070 and 2071-2100) [33].

Table 12. Average monthly, average annual and seasonal values of HCI category in Mestia (1986-2015, 2041-2070 and 2071-2100) [33].

Month / Period	99%_Low	99%_Upp	1986-2015	2041-2070	2071-2100
January	Accept.	Accept.	Acceptable	Acceptable	Acceptable
February	Accept.	Good	Acceptable	Acceptable	Acceptable
March	Accept.	Good	Acceptable	Good	Good
April	Good	Good	Good	Good	Good
May	V_Good	V_Good	Very Good	***Excellent***	***Excellent***
June	Excell.	Excell.	Excellent	Excellent	***Very Good***
July	Excell.	Excell.	Excellent	***Very Good***	***Very Good***
August	Excell.	Excell.	Excellent	***Very Good***	***Very Good***
September	Excell.	Excell.	Excellent	Excellent	Excellent
October	Good	V_Good	Very Good	***Excellent***	***Excellent***
November	Accept.	Good	Good	Good	Good
December	Accept.	Accept.	Acceptable	Acceptable	Acceptable
Year	Good	V_Good	Good	Very Good	Very Good
Cold period	Good	Good	Good	Good	Good
Warm period	V_Good	Excell.	Very Good	Excellent	Very Good

A significant change in HCI values and their categories in 2041-2070 and 2071-2100 compared to the 99% confidence interval of the average HCI values in 1956-2015 is expected in May and October (an increase in HCI values and a corresponding improvement in its category by one level, “Very Good” → “Excellent”), as well as in July and August (a decrease in HCI values and a corresponding deterioration in its category by one notch, “Excellent” → “Very Good”). In June 2071-2100, the HCI category will deteriorate by one notch, “Excellent” → “Very Good” (Fig. 12, Table 12).

Thus, in Mestia, at least until 2100, it is expected to maintain favorable bioclimatic conditions for tourism.

Annexes

Annex 1. Min and Max values of HCI at 13 locations of Georgia in different months and season in 1956-2015.

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Bakh_Min	21	22	31	45	45	55	51	59	46	34	29	28	55	44	60
Bakh_Max	67	65	63	73	77	83	91	91	91	79	73	65	68	63	77
Bak_Min	50	48	54	49	46	62	70	70	66	60	47	52	65	57	69
Bak_Max	68	66	65	75	85	91	91	95	95	88	78	70	73	66	83
Borj_Min	55	48	56	60	68	70	68	60	78	64	56	52	68	59	74
Borj_Max	69	73	77	89	93	89	87	87	95	98	78	69	75	71	84
God_Min	20	22	37	43	48	52	50	52	48	46	28	21	54	44	59
God_Max	59	58	60	66	74	82	86	92	89	81	67	60	65	60	72
Gud_Min	26	26	30	30	38	46	42	56	55	42	38	34	56	43	57
Gud_Max	72	66	65	68	71	84	98	89	83	79	76	71	69	65	77
Kha_Min	26	47	45	54	72	62	61	69	65	54	42	30	64	55	70
Kha_Max	65	74	75	89	95	91	87	87	97	100	75	66	78	73	86
Khu_Min	30	28	39	44	66	78	66	68	61	42	36	30	63	50	74
Khu_Max	69	71	73	89	95	95	92	95	93	97	82	70	77	72	86
Lent_Min	28	36	32	48	70	63	59	59	71	57	38	34	62	52	71
Lent_Max	68	70	73	89	91	87	85	83	93	95	75	68	74	70	83
Mest_Min	34	45	45	51	66	59	69	74	68	53	49	51	64	55	73
Mest_Max	70	66	68	81	89	93	91	91	95	95	75	66	74	68	85
Pas_Min	45	45	49	44	57	69	62	71	73	65	58	49	68	58	76
Pas_Max	72	72	74	89	93	93	91	91	95	94	80	72	77	70	86
Sho_Min	28	43	43	49	53	61	71	72	62	48	43	36	63	52	72
Sho_Max	70	68	67	83	87	89	91	91	95	91	75	69	72	69	82
Step_Min	55	49	54	49	59	65	63	63	66	61	57	55	65	60	69
Step_Max	72	70	70	74	79	87	95	96	100	84	80	74	74	68	81
Tian_Min	53	54	54	53	57	68	72	69	73	59	54	56	69	60	77
Tian_Max	72	72	76	89	91	94	91	91	95	92	82	76	77	70	86

Annex 2. Categories of HCI Min and Max values at 13 locations of Georgia in cold period in 1956-2015.

Parameter	Jan	Feb	Mar	Oct	Nov	Dec	Year	Cold
Bakh_Min	V_Unf.	V_Unf.	Unf.	Unf.	V_Unf.	V_Unf.	Accept.	Marg.
Bakh_Max	Good	Good	Good	V_Good	V_Good	Good	Good	Good
Bak_Min	Accept.	Marg.	Accept.	Good	Marg.	Accept.	Good	Accept.
Bak_Max	Good	Good	Good	Excell.	V_Good	V_Good	V_Good	Good
Borj_Min	Accept.	Marg.	Accept.	Good	Accept.	Accept.	Good	Accept.
Borj_Max	Good	V_Good	V_Good	Ideal	V_Good	Good	V_Good	V_Good
God_Min	V_Unf.	V_Unf.	Unf.	Marg.	V_Unf.	V_Unf.	Accept.	Marg.
God_Max	Accept.	Accept.	Good	Excell.	Good	Good	Good	Good
Gud_Min	V_Unf.	V_Unf.	Unf.	Marg.	Unf.	Unf.	Accept.	Marg.
Gud_Max	V_Good	Good	Good	V_Good	V_Good	V_Good	Good	Good
Kha_Min	V_Unf.	Marg.	Marg.	Accept.	Marg.	Unf.	Good	Accept.
Kha_Max	Good	V_Good	V_Good	Ideal	V_Good	Good	V_Good	V_Good
Khu_Min	Unf.	V_Unf.	Unf.	Marg.	Unf.	Unf.	Good	Accept.
Khu_Max	Good	V_Good	V_Good	Ideal	Excell.	V_Good	V_Good	V_Good
Lent_Min	V_Unf.	Unf.	Unf.	Accept.	Unf.	Unf.	Good	Accept.
Lent_Max	Good	V_Good	V_Good	Ideal	V_Good	Good	V_Good	V_Good
Mest_Min	Unf.	Marg.	Marg.	Accept.	Marg.	Accept.	Good	Accept.
Mest_Max	V_Good	Good	Good	Ideal	V_Good	Good	V_Good	Good
Pas_Min	Marg.	Marg.	Marg.	Good	Accept.	Marg.	Good	Accept.
Pas_Max	V_Good	V_Good	V_Good	Ideal	Excell.	V_Good	V_Good	V_Good
Sho_Min	V_Unf.	Marg.	Marg.	Marg.	Marg.	Unf.	Good	Accept.
Sho_Max	V_Good	Good	Good	Ideal	V_Good	Good	V_Good	Good
Step_Min	Accept.	Marg.	Accept.	Good	Accept.	Accept.	Good	Good
Step_Max	V_Good	V_Good	V_Good	Excell.	Excell.	V_Good	V_Good	Good
Tian_Min	Accept.	Accept.	Accept.	Accept.	Accept.	Accept.	Good	Good
Tian_Max	V_Good	V_Good	V_Good	Ideal	Excell.	V_Good	V_Good	V_Good

Annex 3. Category of HCI Min and Max values at 13 locations of Georgia in warm period in 1956-2015.

Parameter	Apr	May	Jun	Jul	Aug	Sep	Warm
Bakh_Min	Marg.	Marg.	Accept.	Accept.	Accept.	Marg.	Good
Bakh_Max	V_Good	V_Good	Excell.	Ideal	Ideal	Ideal	V_Good
Bak_Min	Marg.	Marg.	Good	V_Good	V_Good	Good	Good
Bak_Max	V_Good	Excell.	Ideal	Ideal	Ideal	Ideal	Excell.
Borj_Min	Good	Good	V_Good	Good	Good	V_Good	V_Good
Borj_Max	Excell.	Ideal	Excell.	Excell.	Excell.	Ideal	Excell.
God_Min	Marg.	Marg.	Accept.	Accept.	Accept.	Marg.	Accept.
God_Max	Good	V_Good	Excell.	Excell.	Ideal	Excell.	V_Good
Gud_Min	Unf.	Unf.	Marg.	Marg.	Accept.	Accept.	Accept.
Gud_Max	Good	V_Good	Excell.	Ideal	Excell.	Excell.	V_Good
Kha_Min	Accept.	V_Good	Good	Good	Good	Good	V_Good
Kha_Max	Excell.	Ideal	Ideal	Excell.	Excell.	Ideal	Excell.
Khu_Min	Marg.	Good	V_Good	Good	Good	Good	V_Good
Khu_Max	Excell.	Ideal	Ideal	Ideal	Ideal	Ideal	Excell.
Lent_Min	Marg.	V_Good	Good	Accept.	Accept.	V_Good	V_Good
Lent_Max	Excell.	Ideal	Excell.	Excell.	Excell.	Ideal	Excell.
Mest_Min	Accept.	Good	Accept.	Good	V_Good	Good	V_Good
Mest_Max	Excell.	Excell.	Ideal	Ideal	Ideal	Ideal	Excell.
Pas_Min	Marg.	Accept.	Good	Good	V_Good	V_Good	V_Good
Pas_Max	Excell.	Ideal	Ideal	Ideal	Ideal	Ideal	Excell.
Sho_Min	Marg.	Accept.	Good	V_Good	V_Good	Good	V_Good
Sho_Max	Excell.	Excell.	Excell.	Ideal	Ideal	Ideal	Excell.
Step_Min	Marg.	Accept.	Good	Good	Good	Good	Good
Step_Max	V_Good	V_Good	Excell.	Ideal	Ideal	Ideal	Excell.
Tian_Min	Accept.	Accept.	Good	V_Good	Good	V_Good	V_Good
Tian_Max	Excell.	Ideal	Ideal	Ideal	Ideal	Ideal	Excell.

Annex 4. Low and Upper levels of 99% confidence interval of HCI mean values at 13 locations of Georgia in 1956-2015.

Parmeter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cold	Warm
Bakh_99%_Low	48	49	54	60	65	66	74	74	66	57	49	49	61	53	69
Bakh_99%_Upp	55	56	58	63	68	70	79	79	72	64	57	54	63	56	71
Bak_99%_Low	57	57	58	62	67	76	82	84	77	68	62	59	69	61	76
Bak_99%_Upp	60	60	60	65	71	80	85	87	83	71	66	61	70	62	78
Borj_99%_Low	59	60	63	71	81	81	75	75	85	76	64	59	72	64	79
Borj_99%_Upp	61	63	66	76	85	84	78	79	88	80	68	61	73	66	81
God_99%_Low	44	46	52	56	60	63	69	71	65	58	50	47	58	51	65
God_99%_Upp	50	51	55	59	64	67	75	77	70	63	56	52	60	53	67
Gud_99%_Low	55	53	53	52	55	63	71	72	68	63	58	56	61	57	65
Gud_99%_Upp	60	58	58	57	60	68	77	79	73	67	63	61	63	60	68
Kha_99%_Low	54	59	64	72	85	79	77	77	84	73	59	53	71	62	80
Kha_99%_Upp	59	63	68	78	88	83	80	80	88	79	65	58	73	64	82
Khu_99%_Low	53	54	61	69	81	85	81	79	83	68	56	53	70	59	81
Khu_99%_Upp	59	60	65	74	85	87	84	83	87	75	64	59	72	62	82
Lent_99%_Low	53	54	59	67	81	77	72	72	83	71	58	52	68	59	76
Lent_99%_Upp	58	59	63	73	84	81	76	75	86	77	64	57	70	62	78
Mest_99%_Low	54	57	58	65	75	81	81	82	82	69	59	56	69	60	79
Mest_99%_Upp	58	60	61	68	79	85	84	85	86	75	63	59	71	62	80
Pas_99%_Low	61	60	62	66	75	82	79	81	85	73	66	61	72	65	79
Pas_99%_Upp	64	63	66	72	80	86	83	84	89	77	69	64	73	66	81
Sho_99%_Low	55	56	57	61	69	77	81	82	78	67	59	56	68	59	76
Sho_99%_Upp	59	59	60	65	74	81	85	86	82	72	63	59	69	61	78
Step_99%_Low	61	60	60	61	66	72	80	82	76	70	65	62	69	64	74
Step_99%_Upp	64	63	63	64	69	76	85	87	81	73	68	64	70	65	76
Tian_99%_Low	61	60	62	67	75	84	81	82	85	73	65	62	73	65	80
Tian_99%_Upp	63	63	65	71	80	87	84	85	89	77	69	65	74	66	82

Annex 5. Category of Low and Upper levels of 99% confidence interval of HCI mean values at 13 locations of Georgia in cold period in 1956-2015.

Parameter	Jan	Feb	Mar	Oct	Nov	Dec	Year	Cold
Bakh_99%_Low	Marg.	Marg.	Accept.	Accept.	Marg.	Marg.	Good	Accept.
Bakh_99%_Upp	Accept.	Accept.	Accept.	Good	Accept.	Accept.	Good	Accept.
Bak_99%_Low	Accept.	Accept.	Accept.	Good	Good	Accept.	Good	Good
Bak_99%_Upp	Good	Good	Good	V_Good	Good	Good	V_Good	Good
Borj_99%_Low	Accept.	Good	Good	V_Good	Good	Accept.	V_Good	Good
Borj_99%_Upp	Good	Good	Good	Excell.	Good	Good	V_Good	Good
God_99%_Low	Marg.	Marg.	Accept.	Accept.	Accept.	Marg.	Accept.	Accept.
God_99%_Upp	Accept.	Accept.	Accept.	Good	Accept.	Accept.	Good	Accept.
Gud_99%_Low	Accept.	Accept.	Accept.	Good	Accept.	Accept.	Good	Accept.
Gud_99%_Upp	Good	Accept.	Accept.	Good	Good	Good	Good	Good
Kha_99%_Low	Accept.	Accept.	Good	V_Good	Accept.	Accept.	V_Good	Good
Kha_99%_Upp	Accept.	Good	Good	V_Good	Good	Accept.	V_Good	Good
Khu_99%_Low	Accept.	Accept.	Good	Good	Accept.	Accept.	V_Good	Accept.
Khu_99%_Upp	Accept.	Good	Good	V_Good	Good	Accept.	V_Good	Good
Lent_99%_Low	Accept.	Accept.	Accept.	V_Good	Accept.	Accept.	Good	Accept.
Lent_99%_Upp	Accept.	Accept.	Good	V_Good	Good	Accept.	V_Good	Good
Mest_99%_Low	Accept.	Accept.	Accept.	Good	Accept.	Accept.	Good	Good
Mest_99%_Upp	Accept.	Good	Good	V_Good	Good	Accept.	V_Good	Good
Pas_99%_Low	Good	Good	Good	V_Good	Good	Good	V_Good	Good
Pas_99%_Upp	Good	Good	Good	V_Good	Good	Good	V_Good	Good
Sho_99%_Low	Accept.	Accept.	Accept.	Good	Accept.	Accept.	Good	Accept.
Sho_99%_Upp	Accept.	Accept.	Good	V_Good	Good	Accept.	Good	Good
Step_99%_Low	Good	Good	Good	V_Good	Good	Good	Good	Good
Step_99%_Upp	Good	Good	Good	V_Good	Good	Good	V_Good	Good
Tian_99%_Low	Good	Good	Good	V_Good	Good	Good	V_Good	Good
Tian_99%_Upp	Good	Good	Good	V_Good	Good	Good	V_Good	Good

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

Parameter	Apr	May	Jun	Jul	Aug	Sep	Warm
Bakh_99%_Low	Good	Good	Good	V_Good	V_Good	Good	Good
Bakh_99%_Upp	Good	Good	V_Good	V_Good	V_Good	V_Good	V_Good
Bak_99%_Low	Good	Good	V_Good	Excell.	Excell.	V_Good	V_Good
Bak_99%_Upp	Good	V_Good	Excell.	Excell.	Excell.	Excell.	V_Good
Borj_99%_Low	V_Good	Excell.	Excell.	V_Good	V_Good	Excell.	V_Good
Borj_99%_Upp	V_Good	Excell.	Excell.	V_Good	V_Good	Excell.	Excell.
God_99%_Low	Accept.	Good	Good	Good	V_Good	Good	Good
God_99%_Upp	Accept.	Good	Good	V_Good	V_Good	V_Good	Good
Gud_99%_Low	Accept.	Accept.	Good	V_Good	V_Good	Good	Good
Gud_99%_Upp	Accept.	Good	Good	V_Good	V_Good	V_Good	Good
Kha_99%_Low	V_Good	Excell.	V_Good	V_Good	V_Good	Excell.	Excell.
Kha_99%_Upp	V_Good	Excell.	Excell.	Excell.	Excell.	Excell.	Excell.
Khu_99%_Low	Good	Excell.	Excell.	Excell.	V_Good	Excell.	Excell.
Khu_99%_Upp	V_Good	Excell.	Excell.	Excell.	Excell.	Excell.	Excell.
Lent_99%_Low	Good	Excell.	V_Good	V_Good	V_Good	Excell.	V_Good
Lent_99%_Upp	V_Good	Excell.	Excell.	V_Good	V_Good	Excell.	V_Good
Mest_99%_Low	Good	V_Good	Excell.	Excell.	Excell.	Excell.	V_Good
Mest_99%_Upp	Good	V_Good	Excell.	Excell.	Excell.	Excell.	Excell.
Pas_99%_Low	Good	V_Good	Excell.	V_Good	Excell.	Excell.	V_Good
Pas_99%_Upp	V_Good	Excell.	Excell.	Excell.	Excell.	Excell.	Excell.
Sho_99%_Low	Good	Good	V_Good	Excell.	Excell.	V_Good	V_Good
Sho_99%_Upp	Good	V_Good	Excell.	Excell.	Excell.	Excell.	V_Good
Step_99%_Low	Good	Good	V_Good	Excell.	Excell.	V_Good	V_Good
Step_99%_Upp	Good	Good	V_Good	Excell.	Excell.	Excell.	V_Good
Tian_99%_Low	Good	V_Good	Excell.	Excell.	Excell.	Excell.	Excell.
Tian_99%_Upp	V_Good	Excell.	Excell.	Excell.	Excell.	Excell.	Excell.

Annex 7. Repetition of categories of HCI monthly values at 13 locations of Georgia in 1956-1985, 1956-2015 and 1986-2915, (%).

Location	Year	V_Unf.	Unf.	Marg.	Accept.	Good	V_Good	Excell.	Ideal
Bakh	1956-1985	1.1	2.5	10.0	29.7	29.4	22.5	4.2	0.6
Bakh	1956-2015	1.1	3.3	9.3	28.9	29.7	20.8	6.0	0.8
Bakh	1986-2015	1.1	4.2	8.6	28.1	30.0	19.2	7.8	1.1
Bak	1956-1985	0.0	0.0	1.1	23.1	35.6	21.7	15.8	2.8
Bak	1956-2015	0.0	0.0	0.8	23.2	34.3	19.4	18.6	3.6
Bak	1986-2015	0.0	0.0	0.6	23.3	33.1	17.2	21.4	4.4
Borj	1956-1985	0.0	0.0	0.3	11.4	32.8	23.9	29.7	1.9
Borj	1956-2015	0.0	0.0	0.1	12.4	31.0	28.1	25.8	2.6
Borj	1986-2015	0.0	0.0	0.0	13.3	29.2	32.2	21.9	3.3
God	1956-1985	0.8	2.2	11.7	39.4	30.3	12.2	3.3	0.0
God	1956-2015	1.4	2.5	12.2	38.3	29.0	11.7	4.6	0.3
God	1986-2015	1.9	2.8	12.8	37.2	27.8	11.1	5.8	0.6
Gud	1956-1985	0.3	1.9	6.9	33.3	37.2	16.9	3.3	0.0
Gud	1956-2015	0.3	1.4	7.8	30.6	35.8	18.5	5.6	0.1
Gud	1986-2015	0.3	0.8	8.6	27.8	34.4	20.0	7.8	0.3
Kha	1956-1985	0.0	1.1	4.2	8.9	27.5	22.8	30.8	4.7
Kha	1956-2015	0.1	0.8	3.6	13.6	25.0	23.8	29.3	3.8
Kha	1986-2015	0.3	0.6	3.1	18.3	22.5	24.7	27.8	2.8
Khu	1956-1985	0.3	1.4	5.3	13.6	23.6	17.5	34.7	3.6
Khu	1956-2015	0.3	1.9	6.1	12.4	24.3	18.6	32.1	4.3
Khu	1986-2015	0.3	2.5	6.9	11.1	25.0	19.7	29.4	5.0
Lent	1956-1985	0.0	1.9	4.4	13.3	26.9	25.8	25.8	1.7
Lent	1956-2015	0.1	1.4	4.4	19.7	24.6	26.5	22.2	1.0
Lent	1986-2015	0.3	0.8	4.4	26.1	22.2	27.2	18.6	0.3
Mest	1956-1985	0.0	0.0	0.6	21.7	29.4	13.9	30.3	4.2
Mest	1956-2015	0.0	0.1	1.0	25.8	24.6	16.5	29.3	2.6
Mest	1986-2015	0.0	0.3	1.4	30.0	19.7	19.2	28.3	1.1
Pas	1956-1985	0.0	0.0	0.8	8.9	36.9	17.2	31.4	4.7
Pas	1956-2015	0.0	0.0	0.7	7.6	36.9	20.4	28.3	6.0
Pas	1986-2015	0.0	0.0	0.6	6.4	36.9	23.6	25.3	7.2
Sho	1956-1985	0.0	0.0	2.8	24.2	31.4	16.1	23.3	2.2
Sho	1956-2015	0.1	0.1	2.2	27.1	26.9	17.2	25.0	1.3
Sho	1986-2015	0.3	0.3	1.7	30.0	22.5	18.3	26.7	0.3
Step	1956-1985	0.0	0.0	0.6	9.2	50.6	24.4	12.8	2.5
Step	1956-2015	0.0	0.0	0.3	9.7	48.2	23.8	14.6	3.5
Step	1986-2015	0.0	0.0	0.0	10.3	45.8	23.1	16.4	4.4
Tian	1956-1985	0.0	0.0	0.0	11.7	34.4	19.7	29.2	5.0
Tian	1956-2015	0.0	0.0	0.0	10.1	34.3	22.1	27.6	5.8
Tian	1986-2015	0.0	0.0	0.0	8.6	34.2	24.4	26.1	6.7

Annex 8. Year day number of HCI various categories at 13 locations of Georgia in 1956-1985, 1956-2015 and 1986-2015.

Location	Year	V_Unf.	Unf.	Marg.	Accept.	Good	V_Good	Excell.	Ideal	Marg.-Ideal
Bakh	1956-1985	4	9	37	109	108	82	15	2	352
Bakh	1956-2015	4	12	34	106	109	76	22	3	349
Bakh	1986-2015	4	15	31	102	110	70	28	4	346
Bak	1956-1985	0	0	4	84	130	79	58	10	365
Bak	1956-2015	0	0	3	85	125	71	68	13	365
Bak	1986-2015	0	0	2	85	121	63	78	16	365
Borj	1956-1985	0	0	1	42	120	87	109	7	365
Borj	1956-2015	0	0	1	45	113	102	94	10	365
Borj	1986-2015	0	0	0	49	107	118	80	12	365
God	1956-1985	3	8	43	144	111	45	12	0	354
God	1956-2015	5	9	45	140	106	43	17	1	351
God	1986-2015	7	10	47	136	101	41	21	2	348
Gud	1956-1985	1	7	25	122	136	62	12	0	357
Gud	1956-2015	1	5	28	112	131	67	20	1	359
Gud	1986-2015	1	3	31	101	126	73	28	1	361
Kha	1956-1985	0	4	15	32	100	83	113	17	361
Kha	1956-2015	1	3	13	50	91	87	107	14	362
Kha	1986-2015	1	2	11	67	82	90	101	10	362
Khu	1956-1985	1	5	19	50	86	64	127	13	359
Khu	1956-2015	1	7	22	45	89	68	117	16	357
Khu	1986-2015	1	9	25	41	91	72	108	18	355
Lent	1956-1985	0	7	16	49	98	94	94	6	358
Lent	1956-2015	1	5	16	72	90	97	81	4	360
Lent	1986-2015	1	3	16	95	81	99	68	1	361
Mest	1956-1985	0	0	2	79	108	51	111	15	365
Mest	1956-2015	0	1	4	94	90	60	107	10	365
Mest	1986-2015	0	1	5	110	72	70	103	4	364
Pas	1956-1985	0	0	3	32	135	63	115	17	365
Pas	1956-2015	0	0	3	28	135	75	103	22	365
Pas	1986-2015	0	0	2	23	135	86	92	26	365
Sho	1956-1985	0	0	10	88	115	59	85	8	365
Sho	1956-2015	1	1	8	99	98	63	91	5	364
Sho	1986-2015	1	1	6	110	82	67	97	1	363
Step	1956-1985	0	0	2	33	185	89	47	9	365
Step	1956-2015	0	0	1	36	176	87	53	13	365
Step	1986-2015	0	0	0	38	167	84	60	16	365
Tian	1956-1985	0	0	0	43	126	72	107	18	365
Tian	1956-2015	0	0	0	37	125	81	101	21	365
Tian	1986-2015	0	0	0	31	125	89	95	24	365

Conclusion

It is planned in future to continue the climatic resources study of various 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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რეზიუმე

წინამდებარე ნაშრომში წარმოდგენილია მონაცემები დასვენების კლიმატური ინდექსის (დკი) მრავალწლიანი საშუალო თვიური მნიშვნელობების შესახებ საქართველოს 13 მთიანი რეგიონისთვის (ბახმარო, ბაკურიანი, ბორჯომი, გოდერძი, გუდაური, ხაიში, ხულო, ლენტეხი, მესტია, ფასანაური, შოვი, სტეფანწმინდა, თიანეთი). ჩატარდა დკი-ს ყოველთვიური, სეზონური და წლიური მნიშვნელობების დეტალური ანალიზი 60 წლიანი პერიოდისთვის (1956-2015 წწ.). საქართველოს სამი პუნქტისთვის (გოდერძი, ხულო და მესტია) 1961 წ. 2010 წ. მონაცემების მიხედვით, ჩატარდა დკი-ს და ტურიზმის კლიმატური ინდექსის ყოველთვიური მნიშვნელობების შედარება. შესწავლილი იქნა დკი-ს ცვალებადობა 1986-2015 წწ.-ში 1956-1985 წწ.-თან შედარებით და ასევე გამოკვლეულ იქნა დკი-ს ტრენდები 1956-2015 წწ.-ში. მესტიის მაგალითზე შეფასდა დკი-ს ყოველთვიური, სეზონური და წლიური მნიშვნელობების მოსალოდნელი ცვლილებები 2041-2070 და 2071-2100 წწ-ში.

Климатический индекс отдыха в некоторых горных районах Грузии

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Резюме

Представлены данные о многолетних среднемесячных значениях климатического индекса отдыха (КИО) для 13 горных районов Грузии (Бахмаро, Бакуриани, Боржоми, Годердзи, Гудаури, Хаиши, Хуло, Лентехи, Местия, Пасанаури, Шови, Степанцминда, Тианети). Проведен подробный анализ месячных, сезонных и годовых значений КИО за 60-летний период (1956-2015 гг.). Проведено сравнение месячных значений КИО и Климатического Индекса Туризма для трех пунктов Грузии (Годердзи, Хуло и Местия) по данным с 1961 по 2010 гг. Изучена изменчивость КИО в 1986-2015 гг. по сравнению с 1956-1985 гг., а также исследованы тренды значений КИО в 1956-2015 гг. На примере Местия сделана оценка ожидаемых изменений месячных, сезонных и годовых значений КИО к 2041-2070 и 2071-2100 гг.