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COMPARISON OF ANGSTROM FIRE INDEX FOR BAKU (AZERBAIJAN) AND TBILISI (GEORGIA)

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Abstract. *The results of a statistical analysis of the daily and mean monthly values of Angstrom Fire Index (AFI) for Baku (Azerbaijan) and Tbilisi (Georgia) in the period 2005-2024 are presented. AFI = (R/20) + (27-T)/10, where R is the minimum relative humidity, T is the maximum air temperature. The gradations of the values of I are as follows: I. AFI ≥ 4.1 – Low, II. AFI = 4.0 ÷ 3.0 – Moderate, III. AFI = 2.9 ÷ 2.5 – High, IY. AFI = 2.4 ÷ 2.0 – Very High, Y. AFI = <2.0 – Extreme. In particular, it was found that an extreme fire hazard in Baku and Tbilisi are observed on average within 75 days a year, but in general, the level of forest fire danger in Tbilisi is higher than in Baku. Between the daily and monthly mean values of AFI in Baku and Tbilisi direct linear correlation is observed.*

Key Words: *Angstrom Fire Index, temperature, fire.*

Introduction

The problem of fires, including forest fires, is relevant for many countries worldwide [http://www.sasquatchstation.com/Fire_Weather.php; http://www.forestservice.gr/meteo/fwi1.html], including Georgia [1].

This problem has become even more pressing in recent decades due to rapid global and local warming [2-4], which is increasing the fire danger [5].

Different countries use different indicators of forest fire danger [5-8]. These indices are mathematical formulas that formalize the influence of air temperature and humidity, precipitation, moisture content of forest combustible materials, thunderstorm activity, etc. In many cases, the simple Swedish Angstrom index [6,7] with a four-range [http://www.forestservice.gr/meteo/fwi1.html] or five-range [http://www.sasquatchstation.com/Fire_Weather.php] scale is used. Along with climatological and operational information on forest fire danger levels, a forecast is produced [https://www.weather.gov/fire].

In Georgia, work on assessing the fire danger of an area using the Angstrom Fire Index [6,7] began in 2019, using Tbilisi as an example [9]. Similar studies were continued for the cities of Telavi and Kutaisi, as well as the Russian cities of Nalchik and Kislovodsk [10-15].

This work is a continuation of previous studies. Below are the results of a statistical analysis of daily Angstrom Fire Danger Index (AFI) values for Baku (the capital of Azerbaijan) and Tbilisi (the capital of Georgia) using a five-range scale for the period 2005–2024.

Study area, material and methods

The study area is Baku (the capital of Azerbaijan) and Tbilisi (the capital of Georgia) cities. Data of the daily maximum of air temperature T and minimum relative humidity R in the period 2005-2024 are used [http://www.pogodaiklimat.ru/archive.php?id=ru&region=07]. The Swedish Angstrom Index calculated from the formula: AFI = (R/20) + (27-T)/10 [6,7]. The gradations of the values of AFI are as follows [http://www.sasquatchstation.com/Fire_Weather.php]: I. AFI ≥ 4.1 – Low, II. AFI = 4.0 ÷ 3.0 – Moderate, III. AFI = 2.9 ÷ 2.5 – High, IY. AFI = 2.4 ÷ 2.0 – Very High, Y. AFI = <2.0 – Extreme.

The standard statistical methods are used. The following designations will be used below: Min – minimal values; Max – maximal values; St Dev – standard deviation; C_v – coefficient of variation (%); R – coefficient

of linear correlation; AFI_Max_B and AFI_Max_T – Angstrom Fire Index with daily maximum temperatures in Baku and Tbilisi, respectively.

Results and discussion

Results in Table 1, 2 and Fig. 1,2 are presented.

Table 1. Statistical characteristics of daily values of Angstrom Fire Index in Baku and Tbilisi for different months in 2005-2024.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Param	Baku											
Min	2.0	1.6	1.4	0.7	-0.1	-0.7	-1.0	-0.8	-0.5	0.9	1.8	1.7
Max	7.9	7.8	7.0	6.8	6.1	5.4	5.4	4.7	5.5	6.1	7.0	7.6
Mean	5.6	5.5	5.0	3.9	2.9	1.8	1.7	1.5	2.6	3.9	4.7	5.3
St Dev	0.94	0.99	0.97	1.16	1.15	1.01	1.03	0.98	0.96	0.92	0.78	0.82
Cv,%	16.9	18.0	19.5	29.9	40.1	56.0	61.7	64.4	37.5	23.8	16.4	15.5
	Tbilisi											
Min	2.6	1.5	1.0	0.6	0.6	-0.4	-0.2	-0.3	0.0	0.9	1.4	1.6
Max	7.3	7.6	7.3	7.2	6.2	5.5	4.4	4.8	6.0	7.0	7.2	7.3
Mean	4.9	4.6	4.0	3.3	2.8	2.1	1.8	1.6	2.5	3.5	4.3	4.9
St Dev	0.90	1.09	1.01	1.10	0.98	0.88	0.80	0.91	0.92	1.02	0.99	0.82
Cv,%	18.5	23.9	25.6	33.4	34.7	42.0	45.2	57.2	37.2	29.2	23.1	16.7
	The values of the correlation coefficient (**R**) between the AFI values in Baku and Tbilisi											
R	0.40	0.35	0.22	0.47	0.45	0.58	0.49	0.49	0.41	0.44	0.37	0.23

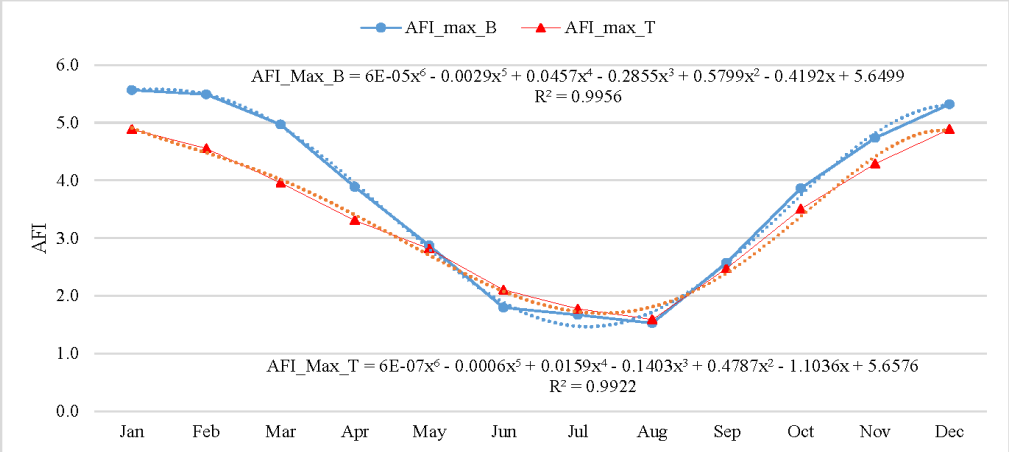

Fig. 1. The intra-annual distributions of mean monthly values of AFI in Baku and Tbilisi in 2005-2024.

In Table 1 and Fig. 1 the statistical characteristics of daily and mean monthly values of AFI in Baku and Tbilisi for different months in 2005-2024 are presented.

In particular, as follows from Table 1 in Baku values of AFI changes from -0.8 (August, fire occurrence is extreme) to 7.9 (January, fire occurrence is low). The mean monthly values of AFI) changes from 1.5 (August, fire occurrence is extreme) to 5.6 (January, fire occurrence is low).

In Tbilisi values of AFI changes from -0.4 (June, fire occurrence is extreme) to 7.6 (February, fire occurrence is low). The mean monthly values of AFI changes from 1.6 (August, fire occurrence is extreme) to 4.9 (January, December, fire occurrence is low).

The coefficient of linear correlation between daily values of AIF in Baku and Tbilisi changes from 0.22 (March, negligible correlation) to 0.58 (June, moderate correlation). Note that the coefficient of linear correlation between daily values of AIF in Baku and Tbilisi is ≈ 1.0 (very high correlation).

The intra-annual distributions of mean monthly values of AFI in Baku and Tbilisi have the form of a sixth-degree polynomial (Fig. 1).

Table 2. Repetition of AFI in Baku and Tbilisi in different months for five gradations in 2005-2024.

Location	Baku					Tbilisi				
AFI	**≥ 4.1**	**4.0 – 3.0**	**2.9 – 2.5**	**2.4 – 2.0**	**< 2.0**	**≥ 4.1**	**4.0 – 3.0**	**2.9 – 2.5**	**2.4 – 2.0**	**< 2.0**
Jan	93.7	5.3	0.2	0.6	0.2	81.9	16.6	1.5	0.0	0.0
Feb	92.0	5.3	1.4	0.5	0.7	65.1	27.6	5.1	1.8	0.4
Mar	84.7	10.5	2.6	1.5	0.8	44.0	39.2	9.2	5.3	2.3
Apr	43.3	33.3	9.5	8.0	5.8	22.7	35.5	17.2	14.2	10.5
May	12.9	31.3	20.0	13.9	21.9	10.3	27.4	22.1	19.5	20.6
Jun	2.2	9.2	10.0	17.3	61.3	1.7	14.2	15.0	25.3	43.8
Jul	2.1	6.5	12.1	17.9	61.5	0.6	6.6	9.7	19.7	63.4
Aug	1.1	4.8	9.4	18.7	66.0	0.5	6.6	9.2	14.5	69.2
Sep	6.0	25.2	20.8	22.5	25.5	5.5	20.0	21.5	23.7	29.3
Oct	38.2	45.8	9.7	3.7	2.6	26.0	41.1	18.2	10.6	4.0
Nov	80.8	17.2	1.3	0.5	0.2	54.2	38.3	5.7	1.5	0.3
Dec	92.7	5.6	0.5	0.8	0.3	86.3	12.3	1.0	0.3	0.2

In Table 2 data about repetition of AFI in Baku and Tbilisi for different months is presented. Specifically, as Table 2 shows, on average, for most days of the month extreme fire danger in Baku is observed from June to August (repetition are 61.3, 61.5, and 66.0%, respectively), while in Tbilisi it is observed in July and August (repetition are 63.4 and 69.2%, respectively).

In Baku, for most days of the month low fire danger is observed from January to March, in November and in December (repetition is over 80%), while in Tbilisi it is observed in January, February, November, and December (repetition is over 54%).

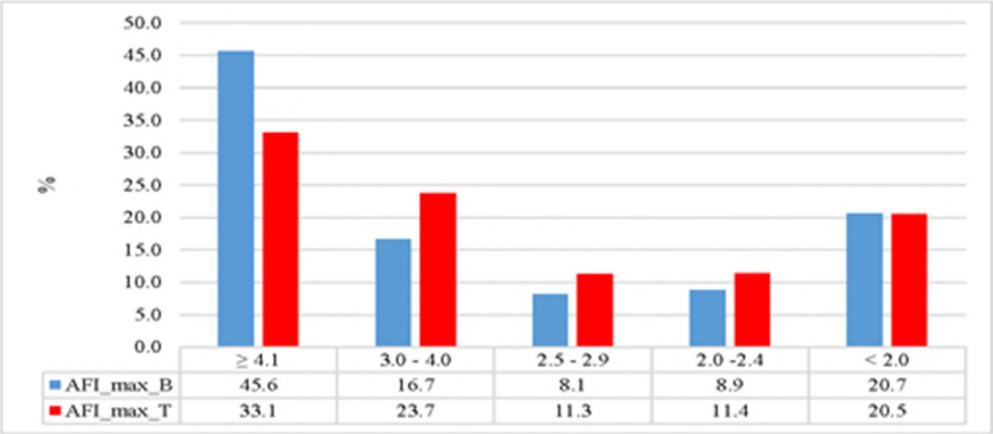

Fig. 2. Repetition of AFI in Baku and Tbilisi (full data).

A low fire hazard in Baku and Tbilisi (Fig. 2) are observed on average within 166 and 121 days a year (repetition – 45.6 and 33.1 % respectively), moderate – within 61 and 87 days a year (repetition – 16.7 and 23.7 % respectively), high – within 30 and 41 days a year (repetition – 8.1 and 11.3 % respectively), very high – within 32 and 42 days a year (repetition – 8.9 and 11.4 % respectively) and extreme – 75 days a year

in both cities (repetition – 20.5 and 20.5%, respectively). Thus, in general, the level of forest fire danger in Tbilisi is higher than in Baku.

Conclusion

It is planned to continue this research in the near future, taking into account the rapid warming of the climate in recent years.

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