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COMPARISON OF ANGSTROM FIRE INDEX FOR NALCHIK (KABARDINO-BALKARIA, RUSSIAN FEDERATION) AND TELAVI (GEORGIA)

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Summary: The results of a statistical analysis of the daily values of Angstrom Fire Index (AFI) for Nalchik (Kabardino-Balkaria, Russian Federation) in comparison with values of AFI for Telavi (Georgia) in the period 2010, 2012-2015 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> 4.0 - Fire occurrence unlikely, II.AFI = 4.0 ÷ 2.5 - Fire conditions unfavorable, III. AFI = 2.5 ÷ 2.0 - Fire conditions favorable, IY. AFI = <2.0 - Fire occurrence very likely. In particular, it was found that a high fire hazard in Nalchik is observed on average within 53 days a year (in Telavi - within 67 days a year), and increased - within 39 days a year (in Telavi - within 43 days a year). Between the daily and monthly mean values of AFI in Telavi and Nalchik direct correlation is observed.

Key Words: Angstrom Fire Index, temperature, fire.

Introduction

The problem of fires, including forest fires, is actual for many countries of world [http://www.sasquatchstation.com/Fire_Weather.php; http://www.forestservice.gr/meteo/fwi1.html]. This problem is also important for Russia and Georgia, where forest fires are frequent [1-3].

In recent decades this problem is aggravated in connection with global and local climate warming [4-6] which influences an increase in the fire hazard [7, 8].

In different countries of world different (including their own) indices of forest fire hazard are used [1-3, 7-11]. These indices are the mathematical formulas, which formalize the effect of air temperature and humidity, atmospheric precipitations, the moisture content of forest fuels, thunderstorm activity, etc. In terms of the numerical value of these indices with the aid of the appropriate scale the class and the degree of fire hazard is determined. Together with the climatological and operational information about the levels of the forests fire hazard, also their short term and long-term prognostication is accomplished [1-3, 8-12].

Russia possesses enormous forests. Accordingly, to such questions as the division into districts of the territories of forests on their fire hazard, the publication of operational information about their fire hazard, the prognostication of this danger, etc. is given great value. The all-Russian scale has five classes of fire hazard in the forest on the weather conditions. For the separate regions the values of complex index in the classes can differ from the values of the all-Russian scale, which consider the local special features of these regions [1, 10-12]. In particular, the forest stock for Kabardino-Balkaria republic is characterized by the low degree of the fire hazard (mean class of natural fire hazard is equal to 3.9) [12].

In Georgia the works regarding the forests fire index hazard based on the example to Tbilisi began in 2019 year [2]. In this case was used simple Swedish Angstrom Index [7,8]. In this year analogous studies are continued for Telavi city [3].

The results of a statistical analysis of the daily values of Angstrom Fire Index (AFI) for Nalchik (Kabardino-Balkaria, Russian Federation) in comparison with values of AFI for Telavi (Georgia) in the period 2010, 2012-2015 are presented below.

Study area, material and methods

Study area is Nalchik city and Telavi. Data of the about daily maximum of air temperature T and minimum relative humidity R in the period 2010, 2012-2015 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 [7,8]. The gradations of the values of AFI are as follows: I. AFI> 4.0 - Fire occurrence unlikely, II. AFI = 4.0 ÷ 2.5 - Fire conditions unfavorable, III. AFI = 2.5 ÷ 2.0 - Fire conditions favorable, IY. AFI = <2.0 - Fire occurrence very likely.

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 (%); σ_m – standard error; 99%(+/-) - 99% upper and lower levels of the confidence interval of average; R^2 – coefficient of determination.

Results and discussion

Results in table 1-2 and fig. 1-3 are presented.

Table 1. Statistical Characteristics of Monthly Values of Angstrom Fire Index in Nalchik in 2010, 2012-2015.

Param.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	2.5	1.9	1.1	0.9	0.8	0.5	0.3	-0.1	0.4	1.4	1.6	2.2
Max	8.3	8.1	7.4	7.0	6.0	4.7	5.4	5.4	6.2	7.9	7.8	8.0
Mean	6.3	6.4	4.7	3.5	3.1	2.6	2.3	2.0	3.0	4.4	4.9	5.6
St Dev	1.4	1.2	1.5	1.4	0.9	0.8	0.9	0.9	1.2	1.3	1.6	1.5
C_v,%	21.6	18.8	32.9	38.5	29.8	30.8	37.1	48.6	39.2	30.1	32.8	27.3
σ_m	0.12	0.10	0.12	0.11	0.07	0.07	0.07	0.08	0.10	0.11	0.13	0.12
99%(+/-	0.30	0.26	0.32	0.28	0.19	0.17	0.18	0.20	0.24	0.27	0.34	0.31

In table 1 the statistical characteristics of monthly values of Angstrom Fire Index in Nalchik is presented. In particular, as follows from this table values of AFI changes from -0.1 (August, fire occurrence very likely) to 8.3 (February, fire occurrence unlikely). The greatest variations in the values of AFI are observed during August (C_v = 48.6 %), smallest - in February (C_v = 18.8 %). The mean values of Angstrom Fire Index changes from 2.0 (August, fire occurrence very likely) to 6.4 (February, fire occurrence unlikely).

In Telavi values of AFI changes from 0.3 (August, fire occurrence very likely) to 7.5 (February, fire occurrence unlikely). The greatest variations in the values of AFI are observed during August (C_v = 48.4 %), smallest - in December (C_v = 24.3 %). The mean values of Angstrom Fire Index changes from 1.6 (August, fire occurrence very likely) to 5.0 (February, fire occurrence unlikely) [3].

In table 2 data about repetition of AFI in Nalchik in different months for four gradations is presented. As follows from table 1 on average in Nalchik high fire hazard from June to August is observed (repetition are 21.3, 38.1 and 57.4 % respectively). Sufficiently fire dangerous month is also September (repetition of AFI<2.0 - 20.7 %). In December and January the values of AFI<2.0 is not observed. From October through March in the majority of the cases fire hazard is absent (repetition of AFI> 4.0 changes from 59.4 to 94.3 %).

As follows from table 2 and fig. 1 a high fire hazard in Nalchik is observed on average within 53 days a year (repetition – 14.5 %), and increased - within 39 days a year (repetition – 10.7 %).

Table 2. Repetition of AFI in Nalchik in different months for four gradations in 2010, 2012-2015.

Month	> 4.0	4.0 – 2.5	2.5 – 2.0	< 2.0
	Fire occurrence unlikely	Fire conditions unfavorable	Fire conditions favorable	Fire occurrence very likely
Jan	93.9	6.1	0.0	0.0
Feb	94.3	4.3	0.7	0.7
Mar	67.1	21.9	7.1	3.9
Apr	34.0	40.0	12.7	13.3
May	17.4	56.1	18.1	8.4
Jun	3.3	50.7	24.7	21.3
Jul	3.9	37.4	20.6	38.1
Aug	4.5	20.0	18.1	57.4
Sep	20.7	46.0	12.7	20.7
Oct	59.4	34.8	4.5	1.3
Nov	72.7	17.3	4.7	5.3
Dec	81.3	16.1	2.6	0.0
Jan- Dec	45.2	29.6	10.7	14.5

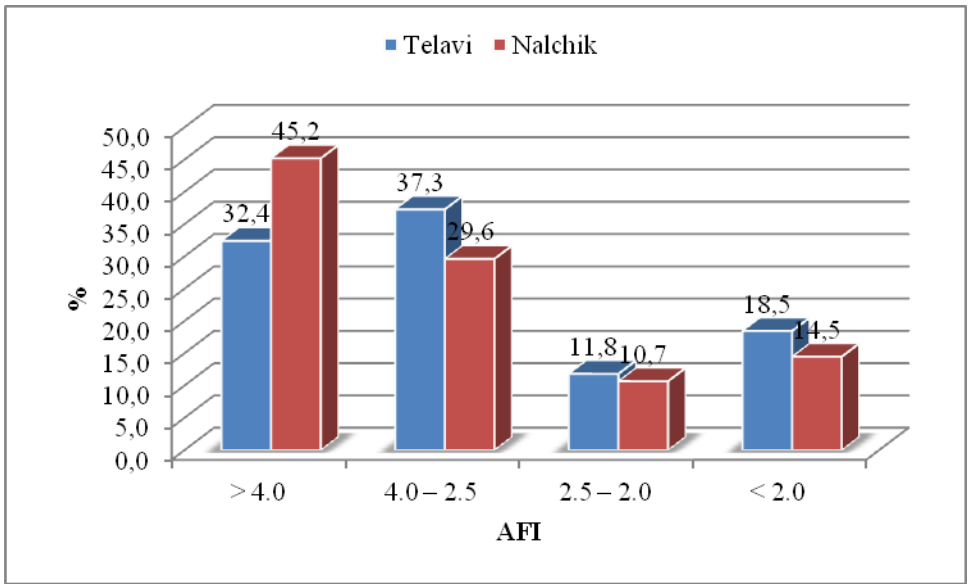

Fig.1. Repetition of AFI in Telavi and Nalchik.

A high fire hazard in Telavi (fig. 1) is observed on average within 67 days a year (repetition – 18.5 %), and increased - within 43 days a year (repetition – 11.8 %). Thus, the level of the forests fire hazard under the conditions of Telavi is somewhat higher than under the conditions of Nalchik.

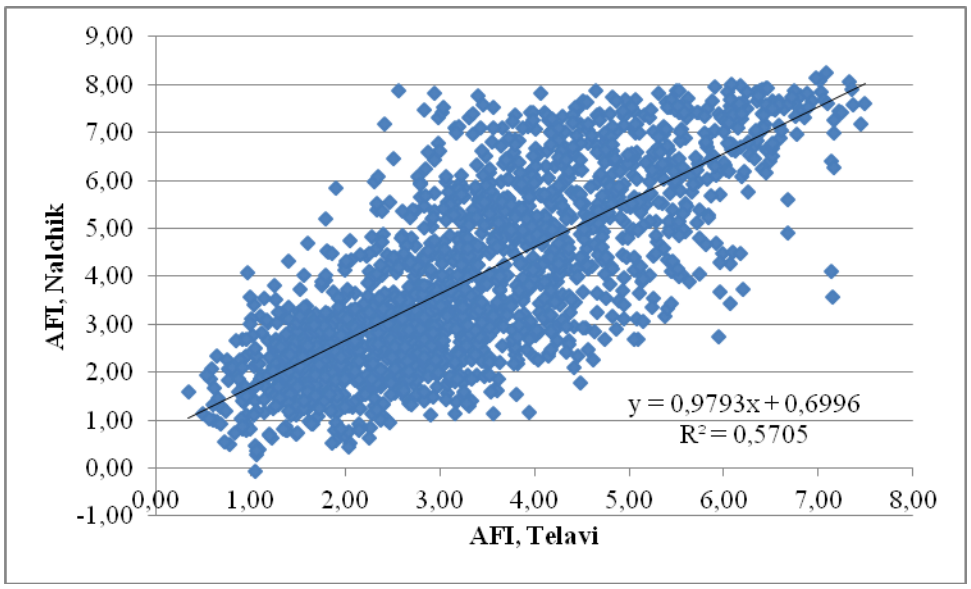

Fig.2. Correlation between daily values of AFI in Telavi and Nalchik.

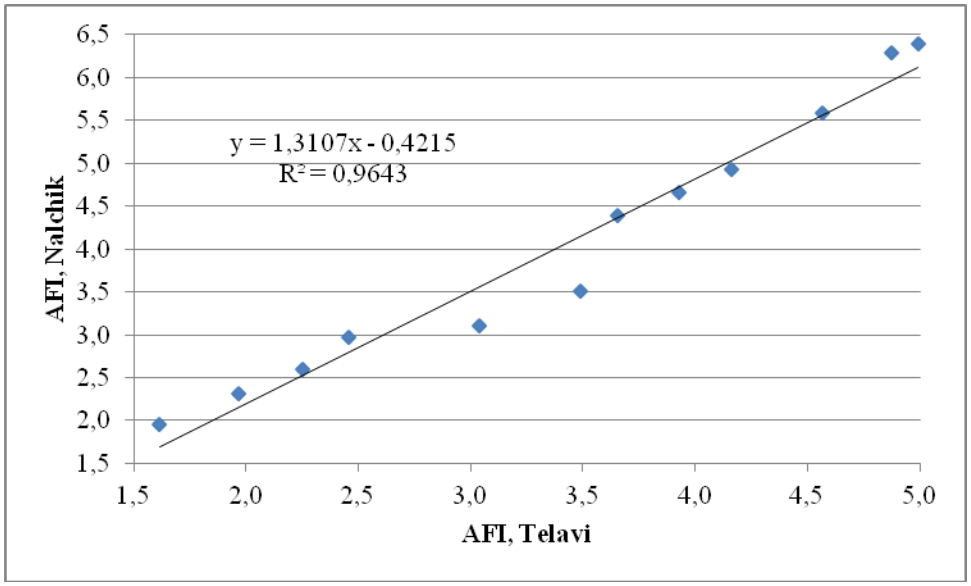

Fig.3. Correlation between monthly values of AFI in Telavi and Nalchik.

Let us finally note, that between the daily and monthly mean values of AFI in Telavi and Nalchik direct correlation is observed (fig. 2,3).

Conclusion

1. A high fire hazard in Nalchik is observed from June to August (the frequency of occurrence is 21.3, 38.1 and 57.4%, respectively). This degree of fire hazard in Nalchik is observed on average for 53 days a year (repeat - 14.5%) and increases - for 39 days a year (repeat - 10.7%).
2. A high fire hazard in Telavi is observed on average for 67 days a year (repeat - 18.5%) and increases - for 43 days a year (repeat - 11.8%). Thus, the level of forest fire hazard in Telavi is slightly higher than in Nalchik.

Further, it is planned to expand work on this issue (using other more complex fire hazard indices, studying their trends in connection with climate change, etc.).

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