

CHANGEABILITY OF MONTHLY MEAN VALUES OF PM_{2.5} AND PM₁₀ IN THREE POINTS OF TBILISI FROM JANUARY 2017 TO OCTOBER 2021. PANDEMIC OF CORONAVIRUS COVID-19 AND PM_{2.5}/10 IN TBILISI FROM MARCH 2020 TO AUGUST 2021

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Summary: *The statistical characteristics of the weight concentrations of aerosols (particulate matter PM_{2.5} and PM₁₀) in three points of Tbilisi city (A. Kazbegi av., A. Tsereteli av. and Varketili) from January 2017 to October 2021 are represented. The data of National Environmental Agency of Georgia about the mean monthly values of PM_{2.5} and PM₁₀ are used. In particular, it is obtained that the greatest average values of PM_{2.5} during entire period of observations on the A. Tsereteli av. were observed (20.1 mcg/m³), smallest - on A. Kazbegi av. (15.0 mcg/m³). The greatest average values of PM₁₀ during entire period of observations also on A. Tsereteli av. were observed (44.8 mcg/m³), smallest - in Varketili (34.0 mcg/m³).*

It is obtained, that the value of the linear correlation coefficient between the mean monthly values of PM_{2.5} and PM₁₀ on all points changes from 0.70 to 0.96. The annual mean of PM_{2.5} and PM₁₀ for all of measurements points are higher, that maximum permissible concentration according to the standards of the World Health Organization. The influence of limitation on the movement of public transport in Georgia in different time periods from March 2020 to August 2021 in connection with the pandemic of coronavirus COVID-19 to the changeability of the level of aerosol pollution of atmosphere is studied.

Key words: *Atmospheric aerosols, particulate matter, PM_{2.5}, PM₁₀.*

Introduction

In Georgia for many decades has been conducting research on atmospheric aerosols (including radioactive ones) and their properties [1-7]. In recent years, in Georgia, the Environmental Agency, in accordance with international standards, began monitoring particulate matter with a diameter of ≤ 2.5 mcm (PM_{2.5}) and ≤ 10 mcm (PM₁₀). Some results of this monitoring in [8-11] are presented.

The PM_{2.5} and PM₁₀ contents in atmosphere directly depends on industrial and transport emissions.

In particular limitation on the movement of public transport in Georgia in connection with the pandemic of coronavirus COVID-19 influenced on PM_{2.5} and PM₁₀ contents in the air in Tbilisi, causing them to decrease [10,11].

This paper is a continuation of previous studies and in it the results of a statistical analysis of mean monthly data about PM_{2.5} and PM₁₀ values at three points in the city of Tbilisi from January 2017 to October 2021, including period with limitation on the movement of public transport in Georgia in different time periods from March 2020 to August 2021 in connection with the pandemic of coronavirus COVID-19 is presented.

Study area, material and methods

Study area – three locations of Tbilisi (A. Kazbegi av. – KZBG, A. Tsereteli av. – TSRT, Varketili – VRKT). Coordinates of these locations of air pollution measurements points in [8] are presented.

The data of Georgian National Environmental Agency about the dust concentration (atmospheric particulate matter - PM_{2.5} and PM₁₀) in three points of Tbilisi city are used [http://air.gov.ge/reports_page]. Period of observation: January 1, 2017 - October 31, 2021.

The data analysis with the use of standard statistical methods was conducted. The following designations will be used below: Mean – average values; Min – minimal values; Max - maximal values;

Range = Max-Min; St Dev – standard deviation; Cv = $100 \cdot \text{St Dev} / \text{Mean}$, coefficient of variation (%); 99% Low and 99% Upp – 99% confidence interval of lower and upper calculated level accordingly; R – coefficient of linear correlation. Comparison of mean values of SOC in two periods of time was produced with the use of Student's criterion with the level of significance α not worse than 0.01.

In the correspondence with the standards of the World Health Organization maximum permissible concentration (MPC) composes: annual mean for PM2.5 - 10 mcg/m³ and for PM10 - 20 mcg/m³ [12].

Results and discussion

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

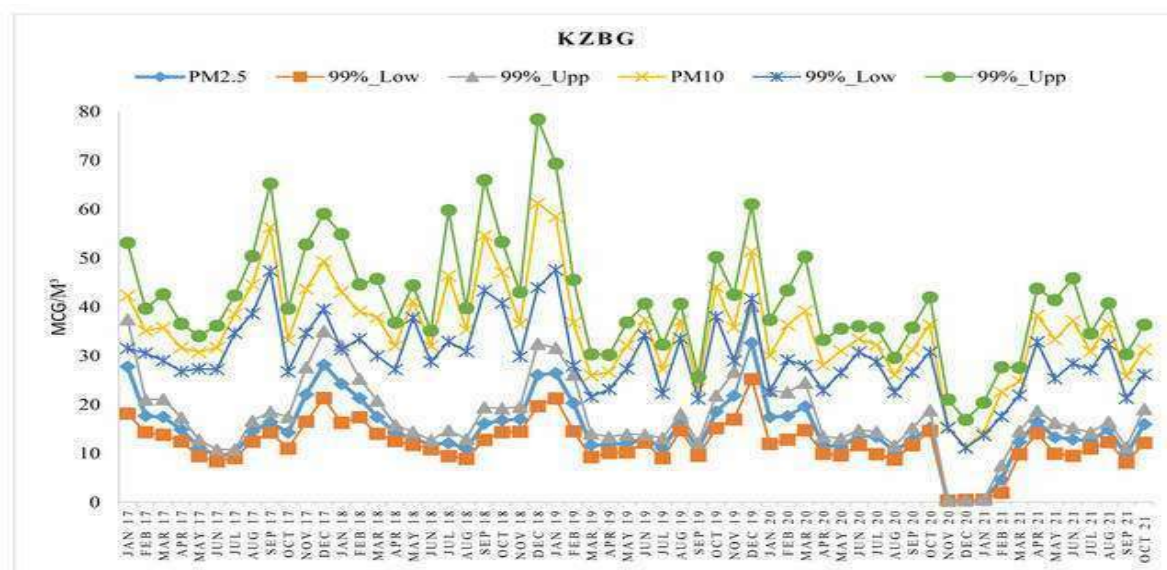


Fig. 1. Monthly mean values of PM2.5 and PM10 and their 99% confidence intervals on the A. Kazbegi av. from January 2017 to October 2021.

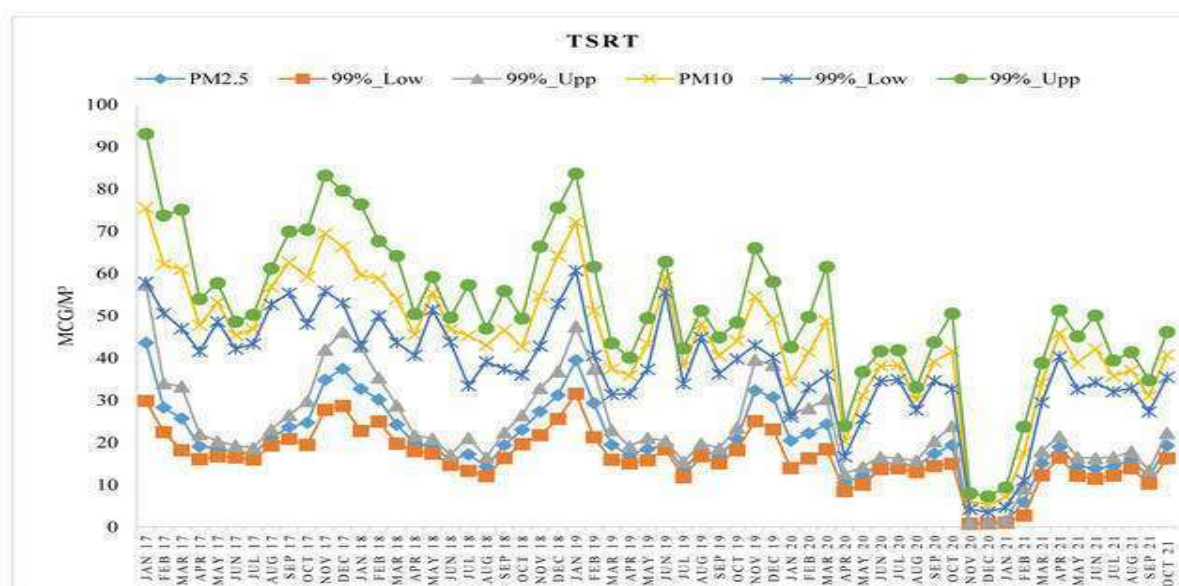


Fig. 2. Monthly mean values of PM2.5 and PM10 and their 99% confidence intervals on the A. Tsereteli av. from January 2017 to October 2021.

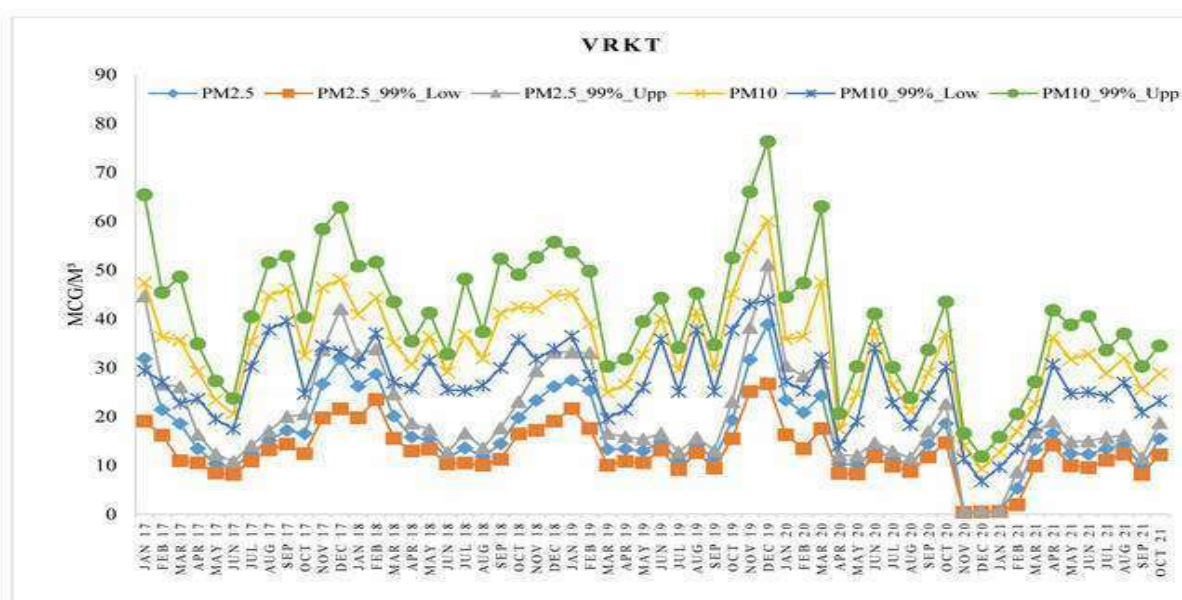


Fig. 3. Monthly mean values of PM2.5 and PM10 and their 99% confidence intervals in Varketili from January 2017 to October 2021.

In fig. 1-3 data about monthly mean values of PM2.5 and PM10 and their 99% confidence intervals on the three points of measurements in Tbilisi city from January 2017 to October 2021 are presented.

As follows from these figures, the intra-annual distribution of aerosol pollution of the atmosphere in Tbilisi as a whole is wave-like - an increase in the cold half-year, a decrease in the warm season of the year.

Table 1. Statistical characteristics of the monthly mean values of PM2.5 and PM10 at three points of Tbilisi from January 2017 to October 2021 (mcg/m³).

| Location | KZBG | KZBG | TSRT | TSRT | VRKT | VRKT |
|-------------------------------|-------|------|-------|------|-------|------|
| Parameter | PM2.5 | PM10 | PM2.5 | PM10 | PM2.5 | PM10 |
| Max | 32.7 | 61.2 | 43.6 | 75.5 | 38.9 | 60.1 |
| Min | 0.3 | 11.3 | 0.8 | 5.4 | 0.5 | 9.3 |
| Range | 32.4 | 49.9 | 42.8 | 70.1 | 38.4 | 50.8 |
| Mean | 15.0 | 35.5 | 20.1 | 44.8 | 16.5 | 34.0 |
| St Dev | 6.3 | 10.0 | 8.7 | 15.0 | 7.8 | 10.4 |
| Cv, % | 42.1 | 28.1 | 43.3 | 33.4 | 47.6 | 30.5 |
| Correlation Matrix (R) | | | | | | |
| KZBG, PM2.5 | 1 | 0.78 | 0.92 | 0.79 | 0.96 | 0.87 |
| KZBG, PM10 | 0.78 | 1 | 0.73 | 0.77 | 0.70 | 0.83 |
| TSRT, PM2.5 | 0.92 | 0.73 | 1 | 0.90 | 0.93 | 0.82 |
| TSRT, PM10 | 0.79 | 0.77 | 0.90 | 1 | 0.76 | 0.79 |
| VRKT, PM2.5 | 0.96 | 0.70 | 0.93 | 0.76 | 1 | 0.88 |
| VRKT, PM10 | 0.87 | 0.83 | 0.82 | 0.79 | 0.88 | 1 |

The statistical characteristics of the monthly mean values of PM2.5 and PM10 for three points of Tbilisi from January 2017 to October 2021 in table 1 are presented. As it follows from this table and fig. 1-3 the monthly mean values of PM2.5 changes from 0.3 mcg/m³ (KZBG) to 43.6 mcg/m³ (TSRT); the monthly mean values of PM10 changes from 5.4 mcg/m³ (TSRT) to 75.5 mcg/m³ (TSRT).

The greatest average values of PM_{2.5} during entire period of observations on the A. Tsereteli av. were observed (20.1mcg/m³), smallest - on A. Kazbegi av. (15.0 mcg/m³). The greatest average values of PM₁₀ during entire period of observations also on. A. Tsereteli av. were observed (44.8 mcg/m³), smallest - in Varketili (34.0mcg/m³).

The annual mean of PM_{2.5} and PM₁₀ for all of measurements points are higher, that maximum permissible concentration according to the standards of the World Health Organization.

The values of the linear correlation coefficient between the mean monthly values of PM_{2.5} and PM₁₀ on all points changes from 0.70 to 0.96 (table 1).

In connection with the pandemic of coronavirus COVID-19 in Georgia were introduced the limitations in the movement of different type of transport in different time periods from March 2020 to August 2021.

The preliminary studies of the influence of these limitations on the daily and monthly content of PM_{2.5} and PM₁₀ in Tbilisi in the spring 2020 are given to [10,11].

Data about influence of the various limitation on the movement of transport in Georgia from March 2020 to August 2021 in connection with the pandemic of coronavirus COVID-19 to the mean values of PM_{2.5} and PM₁₀ in this period of time are presented below.

Table 2 presents the data about changeability of mean values of PM_{2.5} and PM₁₀ at three points of Tbilisi city in three periods of time. I. March 2017-August 2018, first pre-pandemic period; II. March 2018 - August 2019, second pre-pandemic period; III. March 2020 - August 2021, period with pandemic.

Table 2. Changeability of mean values of PM_{2.5} and PM₁₀ at three points of Tbilisi city in three periods of time, mcg/m³

| Location | KZBG | KZBG | TSRT | TSRT | VRKT | VRKT |
|--|--------------|-------------|--------------|-------------|--------------|-------------|
| Parameter | PM2.5 | PM10 | PM2.5 | PM10 | PM2.5 | PM10 |
| I. Mean (Mar 2017-Aug 2018) | 15.8 | 39.0 | 23.0 | 54.3 | 17.5 | 35.9 |
| II. Mean (Mar 2018 - Aug 2019) | 15.5 | 39.2 | 21.5 | 49.0 | 16.9 | 36.1 |
| III. Mean (Mar 2020 - Aug 2021) | 10.9 | 29.0 | 12.8 | 30.9 | 11.2 | 26.5 |
| Differ. (II-I) | No sign | | | | | |
| Differ. (III-II), $\alpha \leq 0.01$ | -4.6 | -10.2 | -8.7 | -18.1 | -5.7 | -9.6 |
| Differ. (III-I), $\alpha \leq 0.01$ | -4.8 | -10.0 | -10.2 | -23.3 | -6.3 | -9.4 |

As it follows from table 2, in the second period of time, as compared with the first, the average values of PM_{2.5} and PM₁₀ did not change at any of the measurement points. In the third time period (the period of the pandemic), as compared to the first and the second, a decrease in the mean values of PM_{2.5} and PM₁₀ at the all measurement points are noted.

In particular, it comprises this decrease: PM_{2.5} - from 4.6÷4.6 mcg/m³ (KZBG) to 8.7÷10.2 mcg/m³ (TSRT); PM₁₀ - from 9.4÷9.6 mcg/m³ (VRKT) to 18.1÷23.3 mcg/m³ (TSRT).

Conclusion

Over the long term is planned the more detailed study of the aerosol pollution of the atmosphere, in particular, conducting the statistical analysis of monthly, daily, day and night variations in the values of PM_{2.5} and PM₁₀ for Tbilisi and other cities of Georgia.

Acknowledgement.

The author is grateful to the chief of the atmospheric physics department of M. Nodia of Institute of Geophysics A. Amiranashvili for the idea and assistance in the fulfillment of this work.

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