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Pandemic of Coronavirus COVID-19 and Air Pollution in Tbilisi in Spring 2020

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ABSTRACT

At the end of 2019, a novel coronavirus COVID-19 emerged in Wuhan, China and later spread throughout the world, including Georgia. To control the rapid dispersion of the virus, Georgia, as another countries has imposed national lockdown policies to praxise social distancing, restriction of automobile traffic, industrial enterprises, etc. This has led to reduced human activities and hence primary air pollutant emissions, which caused improvement of air quality.

In this work data about influence of these limitation in Georgia in connection with the pandemic of COVID-19 to the decrease of the level of air pollution in Tbilisi during spring 2020 compared to the same period in 2017-2019.

The data of Georgian National Environmental Agency about the daily mean values of dust concentration (atmospheric particulate matter - PM2.5 and PM10), NO_2, CO and O_3 and also data of the satellite monitoring of the aerosol optical thickness of atmosphere are used. In particular, there has been a significant increase in ozone in the air and a significant decrease in other atmospheric pollutants.

Key words: *Pandemic of Coronavirus COVID-19, air pollution.*

1. Introduction

At the M. Nodia Institute of Geophysics for many decades has been conducting research on atmospheric aerosols (including radioactive ones) [1-7] and ozone [3-5, 8, 9]. Some experimental and theoretical studies of the structure of atmospheric aerosols, their optical properties, distribution in the atmosphere, etc. are presented in [5, 10-20]. Data about experimental laboratory studies of the processes of washing out aerosols and ozone, their ice-forming properties, etc. are presented in [2, 5, 21].

Particular attention is paid to full-scale studies of ozone, mineral and secondary aerosols (stationary monitoring of ozone, solid particles and secondary aerosols in the surface atmosphere [2, 5, 8, 22-27], aircraft research of mineral aerosols and ozone in the lower troposphere [2, 7, 8, 28-30], mobile monitoring of aerosols and ozone in Tbilisi [5], data analysis of stationary ground-based remote and satellite monitoring of the aerosol optical depth of the atmosphere and ozone [4, 5, 31-42], radar monitoring of large dust formations in the atmosphere [43,44]).

In recent years, in Georgia, the Environmental Agency, in accordance with international standards [45], began monitoring particulate matter with a diameter of ≤ 2.5 μm (PM2.5) and ≤ 10 μm (PM10), and the gas pollution of the atmosphere: SO_2, NO_2, CO, O_3. [http://air.gov.ge/reports_page].

The statistical characteristics of the weight concentrations of aerosols (particulate matter PM2.5 and PM10) in three points of Tbilisi city (A. Kazbegi av., A. Tsereteli av. and Varketili) in 2017-2018 are represented in [46]. In particular, it is obtained that the greatest average annual values of PM2.5 on the A. Tsereteli av. were observed (24.9 μg/m³, the range of the change: 0-440 μg/m³), smallest - on A. Kazbegi av. (16.6 μg/m³, the range of the change: 0-494 μg/m³). The greatest average annual values PM10 also on. A. Tsereteli av. were observed (57.2 μg/m³, the range of the change: 0-553 μg/m³), smallest - in Varketili (37.4 μg/m³, the range of the change: 0-319 μg/m³).

It is obtained, that the value of the linear correlation coefficient between the hourly values PM2.5 and PM10 on all points sufficiently high and changes from 0.77 to 0.89. The value of the correlation coefficient between the hourly values of PM2.5 between the points changes from 0.64 to 0.73, and PM10 - from 0.49 to 0.60.

The statistical characteristics of surface ozone concentration (SOC) in three same points of Tbilisi city (A. Kazbegi av., A. Tsereteli av. and Varketili) in 2017-2018 are represented in [47].

In particular, it is obtained that the greatest average annual values of SOC in Varketili were observed (53.9 $\mu g/m^3$, the range of the change: 1-134 $\mu g/m^3$), smallest – at the A. Tsereteli av. (21.6 $\mu g/m^3$, the range of the change: 0-102 $\mu g/m^3$). The value of the correlation coefficient between the eight hour values SOC between the points sufficiently high and changes from 0.74 to 0.91.

At the end 2019 - to first half 2020, in connection with the pandemia of coronavirus COVID-19 in many countries of world, including Georgia, were introduced the limitations in the work of some industrial objects, the cancellation of aviation communication, movement of truck transport, etc. Those indicated limitation brought to the decrease of the level of the air pollution in many countries of the world [48-53].

In the work [48] it is noted that responding to the ongoing novel coronavirus (agent of COVID-19) outbreak, China implemented “the largest quarantine in human history” in Wuhan on 23 January 2020. Similar quarantine measures were imposed on other Chinese cities within days. Human mobility and relevant production and consumption activities have since decreased significantly. As a likely side effect of this decrease, many regions have recorded significant reductions in air pollution. Authors employed daily air pollution data and Intracity Migration Index (IMI) data form Baidu between 1 January and 21 March 2020 for 44 cities in northern China to examine whether, how, and to what extent travel restrictions affected air quality. On the basis of this quantitative analysis, they reached the following conclusions: (1) The reduction of air pollution was strongly associated with travel restrictions during this pandemic—on average, the air quality index (AQI) decreased by 7.80%, and five air pollutants (i.e., SO_2, PM2.5, PM10, NO_2, and CO) decreased by 6.76%, 5.93%, 13.66%, 24.67%, and 4.58%, respectively. (2) Mechanism analysis illustrated that the lockdowns of 44 cities reduced human movements by 69.85%, and a reduction in the AQI, PM2.5, and CO was partially mediated by human mobility, and SO_2, PM10, and NO_2 were completely mediated.

On another work [49] it is shown, that industrial emission reduction has played a significant role in the improvement of air quality in Yangtze River Delta Region of China. Concentrations of PM2.5, NO_2 and SO_2 decreased by 31.8%, 45.1% and 20.4% during the Level I period; and 33.2%, 27.2% and 7.6% during the Level II period compared with 2019. However, ozone did not show any reduction and increased greatly. Results of [49] also show that even during the lockdown, with primary emissions reduction of 15%–61%, the daily average PM2.5 concentrations range between 15 and 79 $\mu g \cdot m^{-3}$, which shows that background and residual pollutions are still high. Source apportionment results indicate that the residual pollution of PM2.5 comes from industry (32.2–61.1%), mobile (3.9–8.1%), dust (2.6–7.7%), residential sources (2.1–28.5%) in YRD and 14.0–28.6% contribution from long-range transport coming from northern China. This indicates that in spite of the extreme reductions in primary emissions, it cannot fully tackle the current air pollution.

The first COVID-19 case in Brazil was confirmed on February 25, 2020 [50]. On March 16, the state's governor declared public health emergency in the city of Rio de Janeiro and partial lockdown measures came into force a week later. The main goal of work [50] is to discuss the impact of the measures on the air quality of the city by comparing the particulate matter, carbon monoxide, nitrogen dioxide and ozone concentrations determined during the partial lockdown with values obtained in the same period of 2019 and also with the weeks prior to the virus outbreak. Concentrations varied with substantial differences among pollutants and also among the three studied monitoring stations. CO levels showed the most significant reductions (30.3–48.5%) since they were related to light-duty vehicular emissions. NO_2 also showed reductions while PM10 levels were only reduced in the first lockdown week. In April, an increase in vehicular flux and movement of people was observed mainly as a consequence of the lack of consensus about the importance and need of social distancing and lockdown. Ozone concentrations increased probably due to the decrease in nitrogen oxides level. When comparing with the same period of 2019, NO_2 and CO median values were 24.1–32.9 and 37.0–43.6% lower.

In Almaty, a city-scale quarantine came into force on March 19, 2020, which was a week after the first COVID-19 case was registered in Kazakhstan [51]. In study [51] analyze the effect of the lockdown from March 19 to April 14, 2020 (27 days), on the concentrations of air pollutants in Almaty is conducted. Daily concentrations of PM2.5, NO_2, SO_2, CO, O_3, and BTEX were compared between the periods before and during the lockdown. During the lockdown, the PM2.5 concentration was reduced by 21% with spatial variations of 6–34% compared to the average on the same days in 2018–2019, and still, it exceeded WHO daily limit values for 18 days. There were also substantial reductions in CO and NO_2 concentrations by 49%

and 35%, respectively, but an increase in O_3 levels by 15% compared to the prior 17 days before the lockdown. The concentrations of benzene and toluene were 2–3 times higher than those during in the same seasons of 2015–2019. It is noted, that temporal reductions may not be directly attributed to the lockdown due to favorable meteorological variations during the period, but the spatial effects of the quarantine on the pollution levels are evidenced. The results demonstrate the impact of traffic on the complex nature of air pollution in Almaty, which is substantially contributed by various nontraffic related sources, mainly coal-fired combined heat and power plants and household heating systems, as well as possible small irregular sources such as garbage burning and bathhouses.

In the work [52] was a substantial reduction in many countries in the level of nitrogen dioxide (NO_2: 0.00002 $mol \cdot m^{-2}$), a low reduction in CO (<0.03 $mol \cdot m^{-2}$), and a low - to moderate reduction in Aerosol Optical Thickness (AOT: ~0.1–0.2) in the major hotspots of COVID-19 out break during February–March 2020, which may be attributed to the mass lockdowns.

In the work [53] authors assessed air quality during the COVID-19 pandemic for fine particulate matter (PM2.5) and nitrogen dioxide (NO_2) in the continental United States from January 8th-April 21st in 2017–2020. They considered pollution during the COVID-19 period (March 13–April 21st) and the pre-COVID-19 period (January 8th-March 12th) with 2020 representing 'current' data and 2017–2019 representing 'historical' data. County-level pollution concentrations were compared between historical versus current periods, and counties were stratified by institution of early or late non-essential business closures. Statistically significant NO_2 declines were observed during the current COVID-19 period compared to historical data: a 25.5% reduction with absolute decrease of 4.8 ppb. PM2.5 also showed decreases during the COVID-19 period, and the reduction is statistically significant in urban counties and counties from states instituting early non-essential business closures.

In Georgia the following limitations were introduced: from March 21 to May 22, 2020 - state of emergency and curfew, from 17 to 27 April 2020 - complete ban of the movement of automobiles, from 28 April through 28 May 2020 - the permission of the movement of passenger automobiles, from 29 May 2020 - the permission of the movement of buses [https://ren.tv/news/v-mire/687151-vlasti-gruzii-zapreshchaiut-dvizhenie-avtomobilei-iz-za-koronavirusa, ttps://www.ekhokavkaza.com/a/30578567.html, https://yandex.ru/turbo/s/vz.ru/news/2020/5/22/ 1040797.html].

Data about influence of these limitations in Georgia in connection with the pandemic of coronavirus COVID-19 to the decrease of the level of air pollution in Tbilisi during spring 2020 compared to the same period in 2017-2019 are presented below.

2. Study area, material and methods

Study area – three locations of Tbilisi (A. Kazbegi av., A. Tsereteli av., Varketili). Coordinates of these locations of air pollution measurements points in [46,47] are presented.

The data of Georgian National Environmental Agency about the daily mean values of dust concentration (atmospheric particulate matter - PM2.5 and PM10), NO_2, CO and O_3 [http://air.gov.ge/reports_page] that averaged on three indicated stations are used. Period of observation: January 1- May 31, 2017 - 2020.

Data of the satellite monitoring of the aerosol optical thickness of atmosphere (AOT) are used also [https://neo.sci.gsfc.nasa.gov/view.php?datasetId=MODAL2_M_AER_OD]). Period of observation: April 2019, January 1 - June 1, 2020.

In the proposed work the analysis of data is carried out with the use of the standard statistical analysis methods of random events and methods of mathematical statistics for the non accidental time-series of observations [54, 55]. Missed data of time-series of observations were restored in the correspondence with the standard methods [54].

The following designations will be used below: Min – minimal values, Max - maximal values, St Dev - standard deviation, R^2 – coefficient of determination, K_{DW} – Durbin-Watson Statistic, Res – residual component, Real - measured data, Calc – calculated data. The curve of trend is equation of the regression of the connection of the investigated parameter with the time at the significant value of the determination coefficient and such values of K_{DW}, where the residual values are accidental. If the residual values are not accidental the connection of the investigated parameter with the time we will consider simply regression.

3.Results and discussion

Results in table 1-3 and fig. 1-16 are presented.

In table 1-2 statistical characteristics of PM2.5, PM10, NO_2, CO and O_3 in air of Tbilisi in spring 2017-2020 are presented. In table 3 form of the equations of the regression of the time changeability of the daily values of five air pollutants in Tbilisi from 1 March through 31 May 2017-2020 are presented. In fig. 1,3,5,7 and 9 data about changeability of the measured values of five air pollutants in Tbilisi from 1 March through 31 May 2017-2020 are represented. In fig. 2,4,6,8 and 10 data about changeability of the calculated according to table 3 values of five air pollutants in Tbilisi from 1 March through 31 May 2017-2020 are represented.

Table 1. Statistical characteristics of PM2.5 and PM10 in air of Tbilisi in spring 2017-2020.

Pollutant	PM2.5, (μg/m³)				PM10, (μg/m³)			
Year	2017	2018	2019	2020	2017	2018	2019	2020
Month	March-May							
Max	44.2	40.7	26.7	52.1	81.8	92.5	62.6	117.7
Min	8.0	8.1	5.5	4.3	22.4	23.0	13.0	9.1
Mean	16.7	17.8	14.5	14.9	38.7	41.1	31.8	31.9
StDev	6.5	5.8	4.5	9.2	10.9	12.0	9.6	19.3
Month	March							
Max	44.2	40.7	26.7	52.1	81.8	92.5	51.5	117.7
Min	11.2	8.1	6.9	6.6	26.6	23.0	13.1	12.1
Mean	20.6	20.5	14.9	22.4	43.2	42.1	29.6	44.4
StDev	8.4	8.3	5.8	12.0	14.1	17.6	9.7	27.0
Month	April							
Max	27.9	21.4	20.5	18.0	56.6	50.3	44.8	34.8
Min	9.6	9.5	5.5	4.3	22.5	23.6	13.0	9.1
Mean	15.8	17.0	14.0	11.0	36.7	36.7	29.6	22.1
StDev	4.5	3.3	4.0	3.5	9.2	7.3	8.3	6.7
Month	May							
Max	21.5	20.7	22.6	19.1	52.6	52.2	62.6	50.9
Min	8.0	9.0	7.2	5.7	22.4	27.9	14.3	13.0
Mean	13.8	15.9	14.5	11.2	36.1	44.2	36.1	28.8
StDev	3.8	3.2	3.6	3.7	7.2	6.9	9.5	9.4

Table 2. Statistical characteristics of NO_2, CO and O_3 in air of Tbilisi in spring 2017-2020.

Pollutant	NO_2, (μg/m³)				CO, (mg/m³)				O_3, (μg/m³)			
Year	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020
Month	March-May											
Max	77.3	53.9	53.0	32.5	2.0	2.3	1.5	2.0	93.7	87.7	88.2	107.6
Min	25.2	17.7	20.3	9.3	0.4	0.6	0.5	0.3	37.3	22.4	32.0	21.1
Mean	41.3	31.0	33.5	15.9	1.0	1.0	0.9	0.7	69.5	62.0	62.7	76.3
StDev	10.2	6.3	6.5	4.6	0.3	0.3	0.2	0.3	12.1	14.1	11.6	14.8
Month	March											
Max	67.8	41.0	53.0	32.5	2.0	2.3	1.5	2.0	86.1	81.8	83.1	85.5
Min	25.2	17.7	21.2	12.2	0.7	0.6	0.5	0.4	40.8	22.4	32.0	21.1
Mean	42.5	31.0	32.7	19.8	1.1	1.2	0.9	0.9	67.5	52.8	60.0	64.9
StDev	10.7	6.2	7.2	5.3	0.3	0.4	0.3	0.4	10.0	15.2	10.8	12.1
Month	April											
Max	77.3	38.6	52.3	16.6	1.7	1.1	1.2	0.6	93.7	87.7	81.2	102.4
Min	26.6	20.1	25.8	9.3	0.4	0.6	0.6	0.3	42.9	53.7	35.5	58.3
Mean	41.8	28.9	34.4	12.7	0.9	0.8	0.8	0.5	74.0	70.2	61.1	82.9
StDev	12.6	5.0	5.7	2.2	0.3	0.2	0.2	0.1	12.6	8.6	13.5	11.5
Month	May											
Max	50.1	53.9	46.9	22.5	1.4	1.3	1.3	1.1	83.5	87.4	88.2	107.6
Min	25.6	23.2	20.3	11.2	0.6	0.6	0.5	0.4	37.3	34.7	54.8	40.8
Mean	39.6	33.1	33.5	15.1	0.9	0.9	0.8	0.6	67.2	63.3	67.1	81.4
StDev	6.8	7.0	6.5	2.4	0.2	0.2	0.2	0.2	12.6	11.9	9.2	13.6

As follows from tables 1-2 in 2020, compared with 2017-2019, the average monthly measured level of air pollution in Tbilisi changes as follows:

PM2.5.
- March-May: 2017 – decrease by 10.9% , 2018 – decrease by 16.4%, 2019 – slight increase on 3% ;
- March: 2017 – increase on 8.9% , 2018 – increase on 9.3% , 2019 – increase on 50.5%;
- April: 2017 – decrease by 30.7%, 2018 – decrease by 35.7%, 2019 decrease by 22%;
- May: 2017 – decrease by 18.4%, 2018 – decrease by 29.6%, 2019 – decrease by 22.4%

PM10.
- March-May: 2017 – decrease by 17.6%, 2018 – decrease by 22.4%, 2019 – virtually unchanged;
- March: 2017 – weak growth on 2.9%, 2018 - weak growth on 5.4%, 2019 – growth by 50.2%;
- April: 2017 – decrease by 39.8%, 2018 - decrease by 39.6% , 2019 - decrease by 25.4%;
- May: 2017 - decrease by 20.2%, 2018 - decrease by 34.9%, 2019 - decrease by 20.3%.

NO_2. For all time periods, a decrease.
- March-May: 2017 – 61.5% , 2018 – 48.8%, 2019 – 52.6%;
- March: 2017 – 53.4%, 2018 – 36.2% , 2019 – 39.5%;
- April: 2017 – 69.6%, 2018 – 56.1%, 2019 – 63.1%;
- May: 2017 – 62.0%, 2018 – 54.5%, 2019 – 55.1%.

CO. For all time periods except March 2019, a decrease.
- March-May: 2017 – 29.3%, 2018 – 28.3%, 2019 – 19.4%;
- March: 2017 – 13.8%, 2018 – 19.9%, 2019 – slight increase on 5.8% ;
- April: 2017 – 49.4%, 2018 – 43.6%, 2019 – 45.6%;
- May: 2017 – 29.0%, 2018 – 26.1%, 2019 – 21.1%.

O_3. For all time periods except March 2017, growth.
- March-May: 2017 – 9.8%, 2018 -23.1 %, 2019 -21.7 %;
- March: 2017 – slight decrease by 3.8%, 2018 – 23.0%, 2019 – 8.2%;
- April: 2017 – 12.1%, 2018 – 18.1%, 2019 – 35.8%;
- May: 2017 – 21.0%, 2018 – 28.5%, 2019 – 21.3%.

The time dependence of all measured components of air pollution in Tbilisi have fairly complicated behavior. For PM2.5, PM10, NO_2 and CO are satisfactorily described by the tenth order polynomial and for O_3 - by the fifth order polynomial (fig. 2,4,6,8,10, table 3).

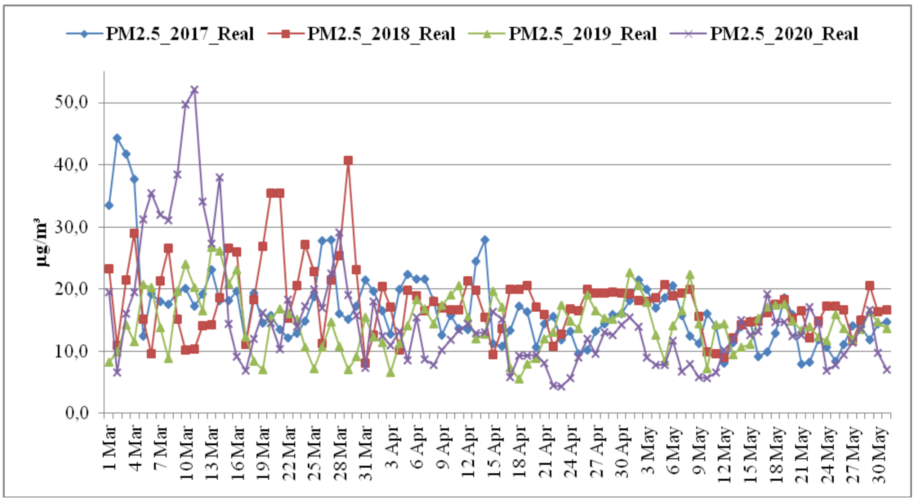

Fig. 1. Changeability of the measured values of PM2.5 in Tbilisi from 1 March through 31 May 2017-2020.

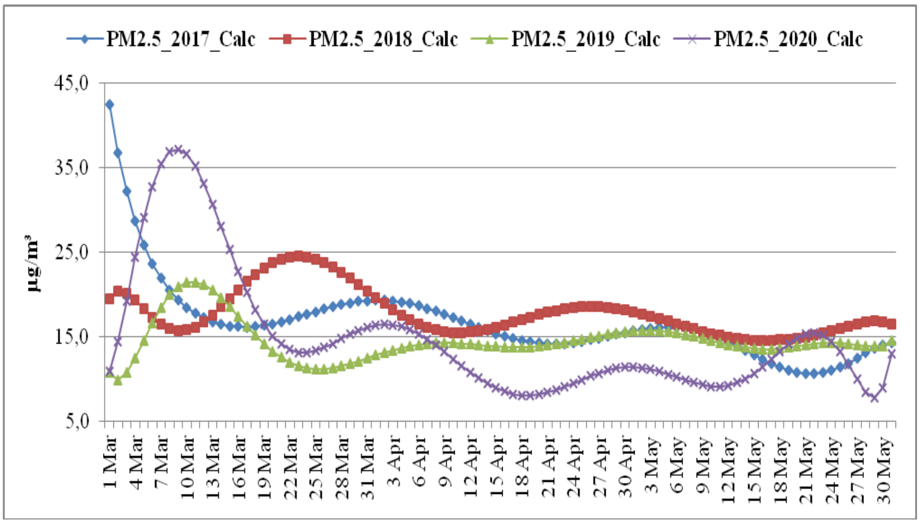

Fig. 2. Changeability of the calculated values of PM2.5 in Tbilisi from 1 March through 31 May 2017-2020.

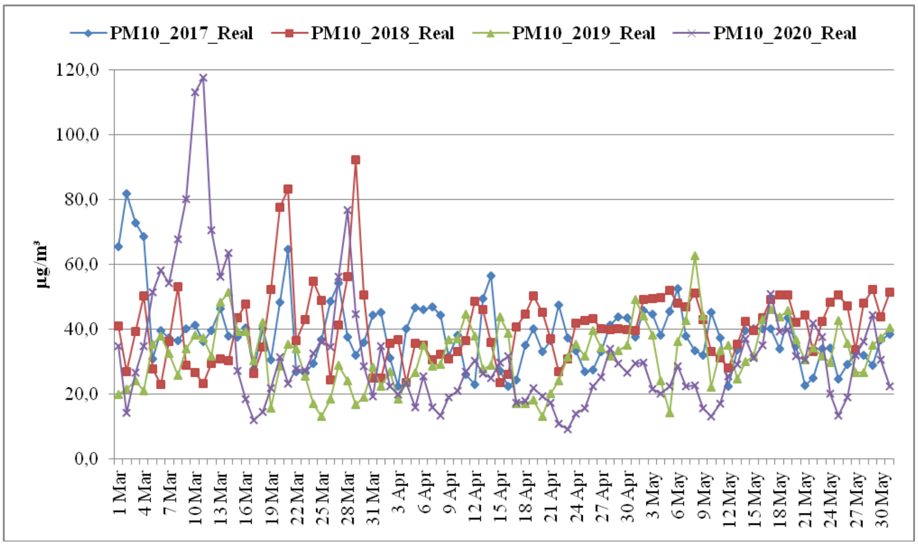

Fig. 3. Changeability of the measured values of PM10 in Tbilisi from 1 March through 31 May 2017-2020.

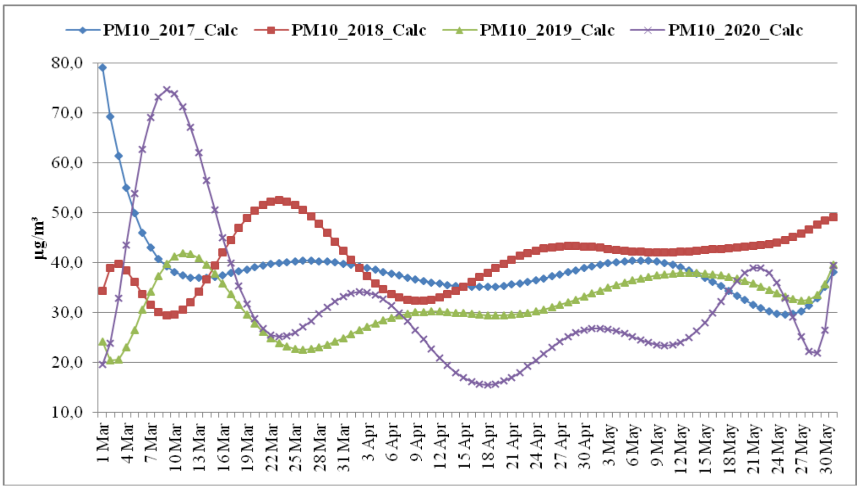

Fig. 4. Changeability of the calculated values of PM10 in Tbilisi from 1 March through 31 May 2017-2020.

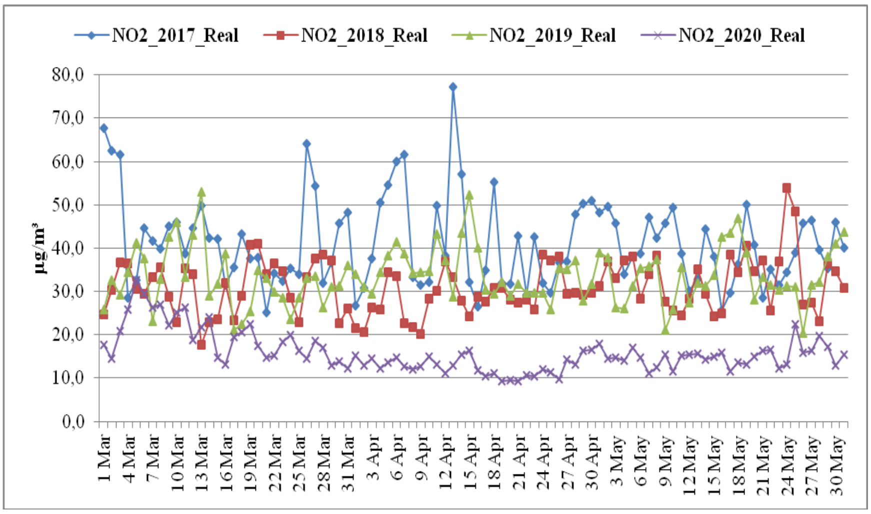

Fig. 5. Changeability of the measured values of NO_2 in Tbilisi from 1 March through 31 May 2017-2020.

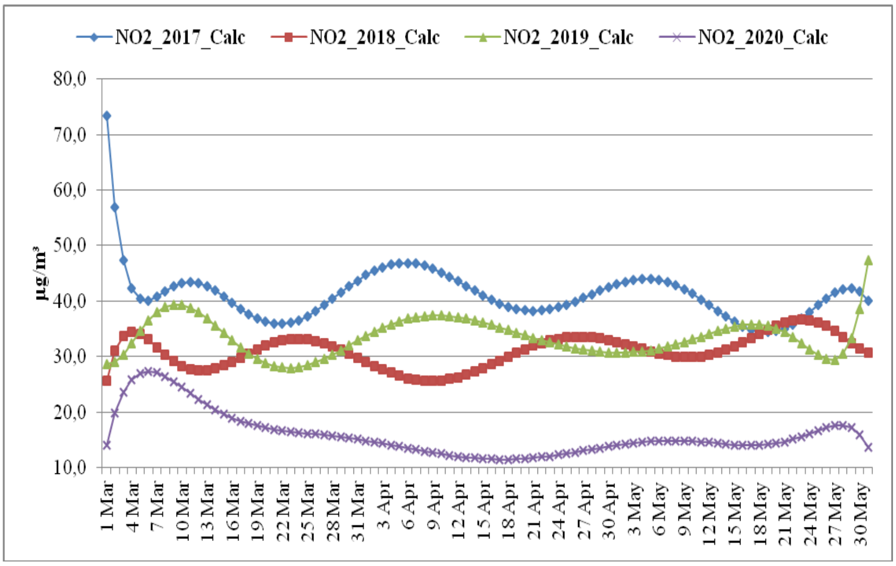

Fig. 6. Changeability of the calculated values of NO_2 in Tbilisi from 1 March through 31 May 2017-2020.

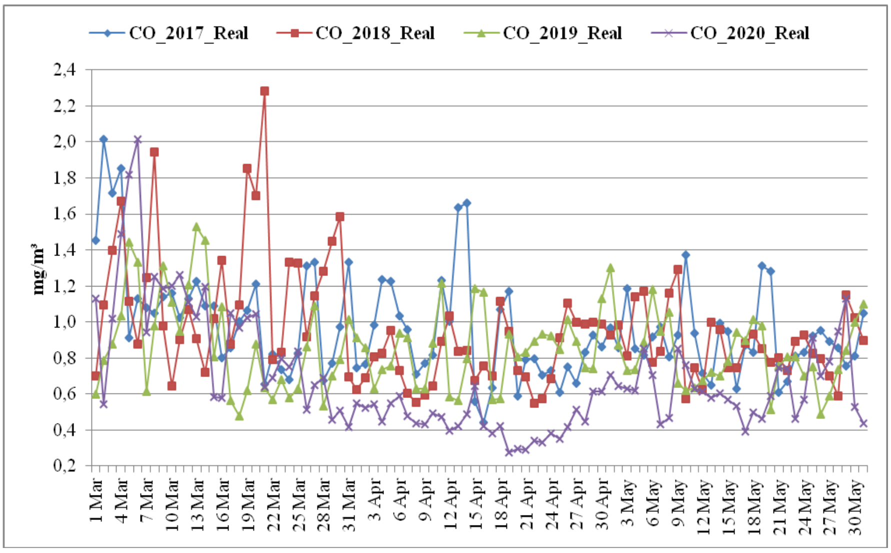

Fig. 7. Changeability of the measured values of CO in Tbilisi from 1 March through 31 May 2017-2020.

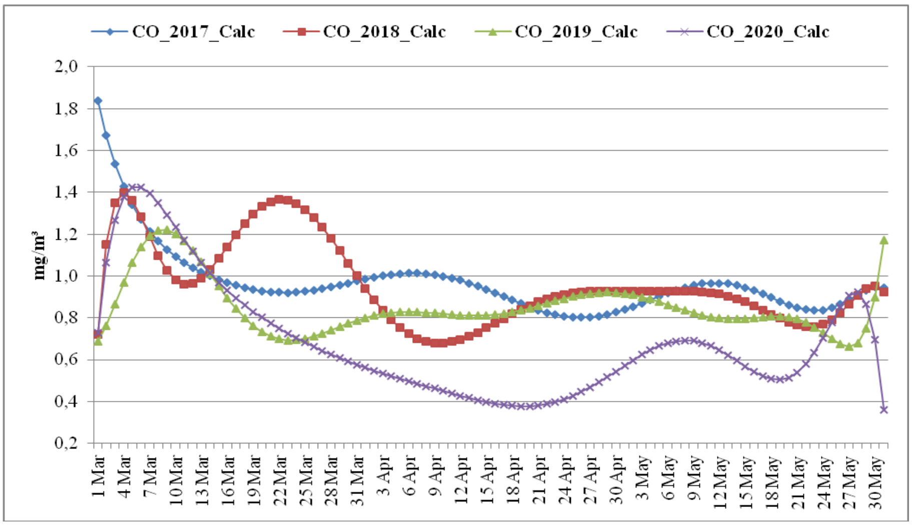

Fig. 8. Changeability of the calculated values of CO in Tbilisi from 1 March through 31 May 2017-2020.

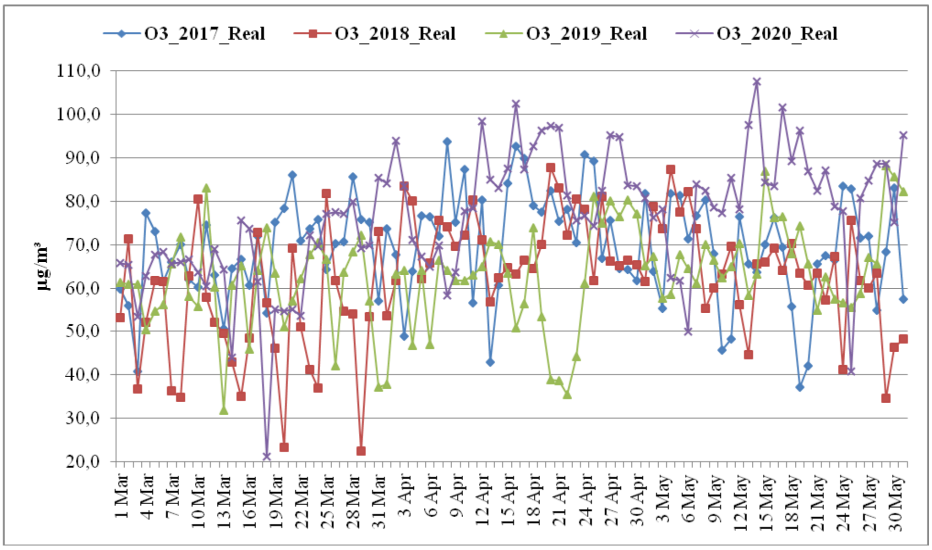

Fig. 9. Changeability of the measured values of O_3 in Tbilisi from 1 March through 31 May 2017-2020.

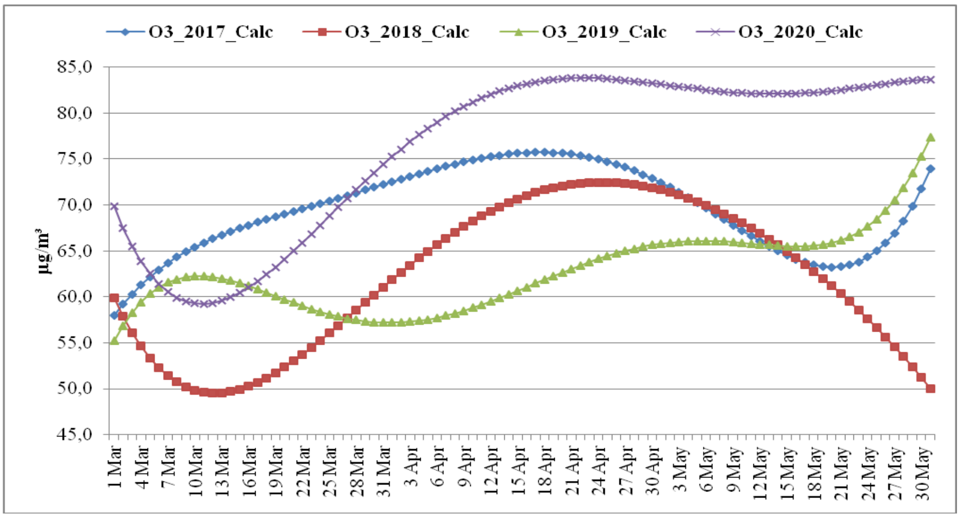

Fig. 10. Changeability of the calculated values of O_3 in Tbilisi from 1 March through 31 May 2017-2020.

Table 3. Form of the equations of the regression of the time changeability of the daily values of five air pollutants in Tbilisi from 1 March through 31 May 2017-2020. The level of significance of R^2 is not worse than 0.001.

Pollutant / Regression	PM2.5 / Tenth order polynomial			
Year	2017	2018	2019	2020
R^2	0.571	0.225	0.266	0.657
K_{DW}	1.41	1.54	1.19	1.07
	Positive autocorrelation of Res.	The autocorrelation of Res. is absent	Positive autocorrelation of Res.	Positive autocorrelation of Res.
Pollutant / Regression	PM10 / Tenth order polynomial			
R^2	0.412	0.228	0.307	0.535
K_{DW}	1.58	1.37	1.23	0.75
	The autocorrelation of Res. is absent	Positive autocorrelation of Res.	Positive autocorrelation of Res.	Positive autocorrelation of Res.
Pollutant / Regression	NO_2 / Tenth order polynomial			
R^2	0.240	0.207	0.271	0.732
K_{DW}	1.58	1.40	1.60	1.74
	The autocorrelation of Res. is absent	Positive autocorrelation of Res.	The autocorrelation of Res. is absent	The autocorrelation of Res. is absent
Pollutant / Regression	CO / Tenth order polynomial			
R^2	0.352	0.370	0.306	0.734
K_{DW}	1.63	1.63	1.61	1.92
	The autocorrelation of Res. is absent	The autocorrelation of Res. is absent	The autocorrelation of Res. is absent	The autocorrelation of Res. is absent
Pollutant / Regression	O_3 / Fifth order polynomial			
R^2	0.148	0.323	0.140	0.358
K_{DW}	1.60	1.77	1.19	1.17
	The autocorrelation of Res. is absent	The autocorrelation of Res. is absent	Positive autocorrelation of Res.	Positive autocorrelation of Res.

In particular, during the period of a complete stop of automobile traffic in Georgia from April 17 to 27, 2020, compared with the same period of 2017-2019, the average measured and calculated level of air pollution in Tbilisi changed as follows (fig. 1-10):

PM2.5. Decrease.
Measured values: 2017 – 40.5%, 2018 – 54.3%, 2019 – 36.4%. Calculated values: 2017 – 37.5%, 2018 – 49.7%, 2019 – 36.8%.

PM10. Decrease.
Measured values: 2017 – 49.1%, 2018 – 56.9%, 2019 -32.2 %. Calculated values: 2017 – 47.9%, 2018 -54.1 %, 2019 – 35.7%.

NO_2. Decrease.
Measured values: 2017 – 70.7%, 2018 – 65.4%, 2019 – 65.0%. Calculated values: 2017 – 69.2%, 2018 – 62.4%, 2019 – 63.6%.

CO. Decrease.
Measured values: 2017 – 53.1%, 2018 -55.8 %, 2019 -56.7 %. Calculated values: 2017 – 51.8%, 2018 – 54.1%, 2019 – 53.6%.

O_3. Increase.
Measured values: 2017 – 9.3%, 2018 – 17.8%, 2019 – 49.8%. Calculated values: 2017 – 11.3%, 2018 – 16.0%, 2019 – 32.1%.

As is known, the comparison of ground-based observational data of the air pollution with satellite data is of significant interest. Previously similar studies we have carried out into [36-39]. The comparative analysis of satellite observations of the aerosol optical thickness of the atmosphere (AOT) with the data of ground-based measurements PM2.5 and PM10 in Tbilisi in the period of pandemic is given below.

From table 1 follows that in 2017-2019 the lowest content of PM2.5 and PM10 in Tbilisi was observed in 2019. Therefore, in this stage of studies we compared the average monthly data about AOT during April 2019 and 2020 years (fig. 11,12).

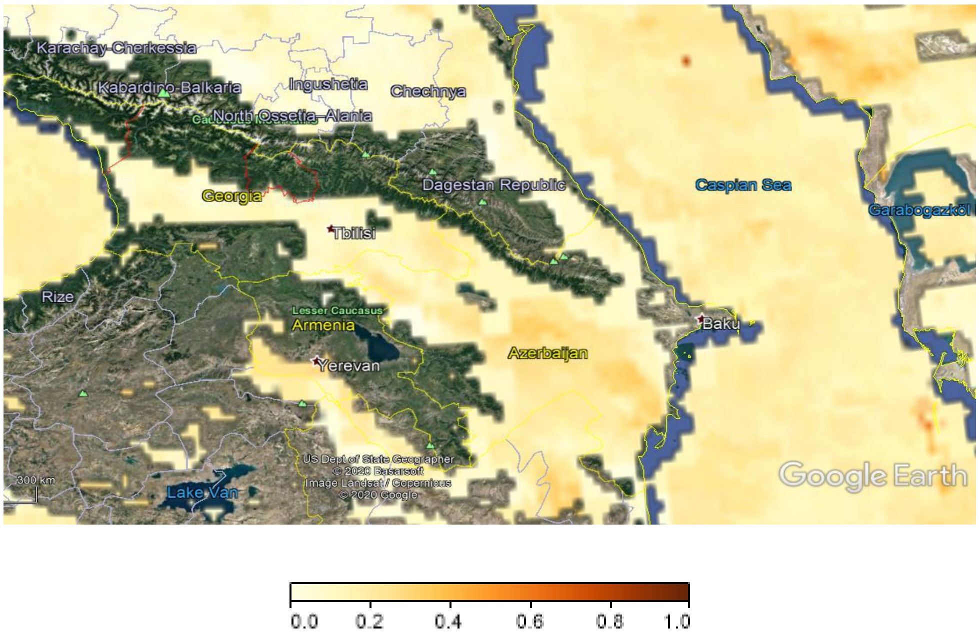

Fig. 11. Monthly mean values of AOT over the South Caucasus in April 2019.

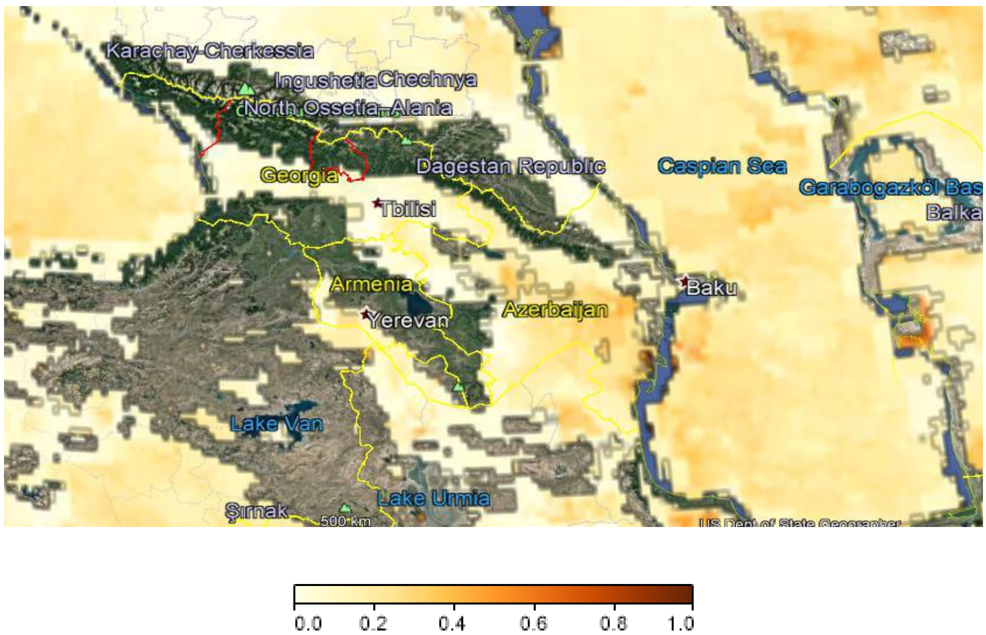

Fig. 12. Monthly mean values of AOT over the South Caucasus in April 2020.

As follows from these figures in April 2020 monthly mean values of AOT over Tbilisi is considerably lower than into 2019 (0.1 and 0.067 accordingly, decrease by 33%). Thus, the decrease of the level of the aerosol pollution of the atmosphere in Tbilisi in the period of pandemic as in [52] was fixed with satellite observations.

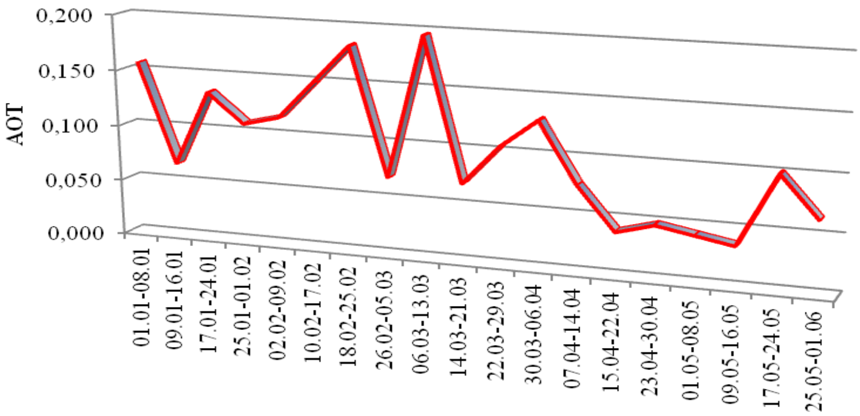

Fig. 13. Changeability of mean eight day values of AOT over Tbilisi from 1 January through 1 June 2020.

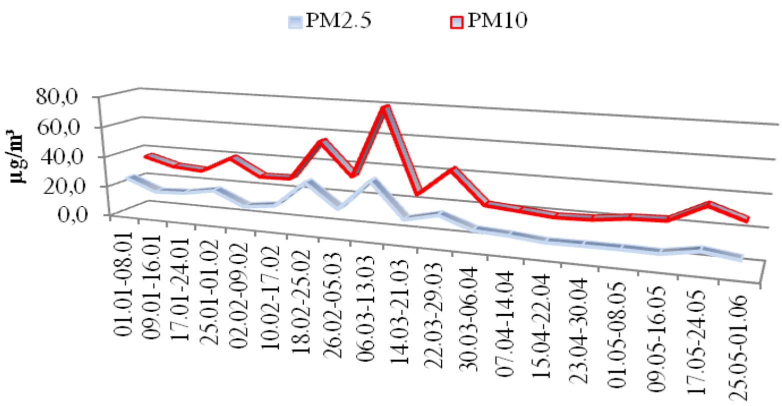

Fig. 14. Changeability of mean eight day values of PM2.5 and PM10 in Tbilisi from 1 January through 1 June 2020.

Let us finally estimate the correspondence of data of AOT satellite observations with the data of ground-based measurements of PM2.5 of and PM10 in Tbilisi. In fig. 13 and 14 data about changeability of mean eight day values of AOT over Tbilisi and PM2.5 and PM10 in Tbilisi from 1 January through 1 June 2020 are presented. As follows from these figures in the time dependence of the indicated parameters of atmosphere it is observed similarity.

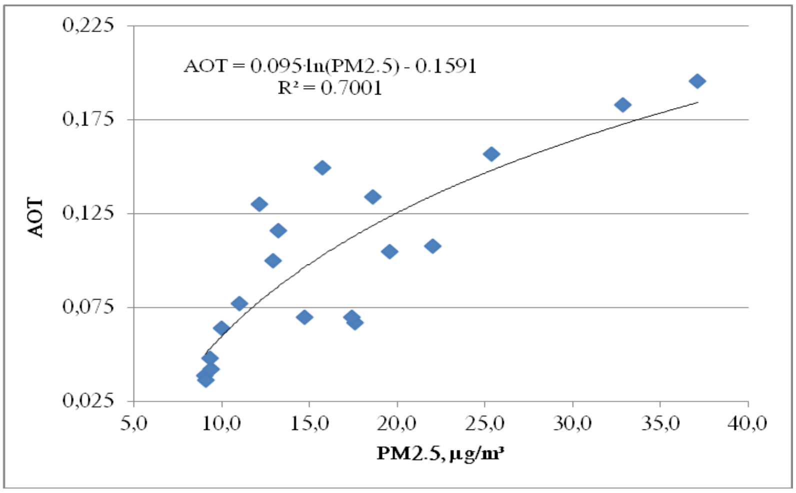

Fig. 15. Connection between mean eight day values of AOT and PM2.5 for Tbilisi from 1 January through 1 June 2020.

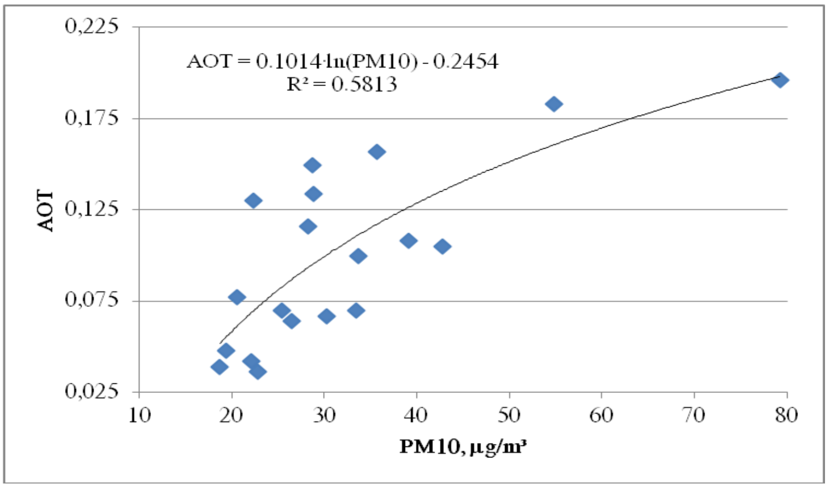

Fig. 16. Connection between mean eight day values of AOT and PM10 for Tbilisi from 1 January through 1 June 2020.

This is confirmed by fig. 15 and 16, in which curves of connection of mean eight day values of AOT with PM2.5 and PM10 for Tbilisi from 1 January through 1 June 2020 are presented. As follows from these figures the connection between AOT and PM2.5 and PM10 has logarithmic form and are sufficiently satisfactory (R^2 = 0.7 and 0.5813 accordingly).

Conclusion

In the near future we plan to continue analogous studies both for Tbilisi and other regions of Georgia, taking into account the new data about air pollution and different scales of averaging (hour, eight-hour, daily, eight day, monthly).

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COVID-19 კორონავირუსის პანდემია და ჰაერის დაბინძურება თბილისში 2020 წლის გაზაფხულზე

ა. ამირანაშვილი, დ. კირკიტაძე, ე. კეკენაძე

რეზიუმე

2019 წლის ბოლოს ჩინეთში, ქ. უხანში გაჩნდა კორონავირუსი COVID-19, ხოლო შემდეგ გავრცელდა მთელ მსოფლიოში და მათ შორის საქართველოშიც. ვირუსის გავრცელების სწრაფი გავრცელების კონტროლისთვის საქართველომ, ისევე როგორც სხვა ქვეყნებმა, შემოიღო შეზღუდვის ეროვნული პოლიტიკა, ჩათვალა საჭიროდ სოციალური დისტანცირება, საგზაო მოძრაობის შეზღუდვა, სამრეწველო წარმოების შეჩერება და სხვ. ამან გამოიწვია ადამიანთა საქმიანობის შემცირება, კერძოდ, ჰაერის პირველადი დამაბინძურებლების, გამონაბოლქვის შემცირება და ჰაერის ხარისხის გაუმჯობესება.

ნაშრომში მოცემულია მონაცემები საქართველოში პანდემია COVID-19 – თან დაკავშირებით შემოღებული შეზღუდვების გავლენის შესახებ თბილისში 2020 წლის გაზაფხულზე ჰაერის დაბინძურების დონის შემცირებაზე 2017 – 2019 წლების ანალოგიურ მონაცემებთან შედარებით.

ნაშრომში გამოყენებულია საქართველოში გარემოს დაცვის ეროვნული სააგენტოს მტვრის კონცენტრაციის მონაცემების საშუალო დღეღამური მნიშვნელობები (ატმოსფერული ნაწილაკები – PM2,5 და PM10), NO_2, CO და O_3, ასევე ატმოსფეროს აეროზოლების ოპტიკური სისქის თანამგზავრული მონიტორინგის მონაცემები. კერძოდ, შეინიშნება ჰაერში ოზონის შემცველობის არსებითი მატება და ჰაერის სხვა დამაბინძურებლების მნიშვნელოვანი შემცირება.

Пандемия коронавируса COVID-19 и загрязнение воздуха в Тбилиси весной 2020 года

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Резюме

В конце 2019 года новый коронавирус COVID-19 появился в Ухане, Китай, а затем распространился по всему миру, включая Грузию. Чтобы контролировать быстрое распространение вируса, Грузия, как и другие страны, ввела национальную политику сдерживания, с тем чтобы учесть социальное дистанцирование, ограничение автомобильного движения, работы промышленных предприятий и т. д. Это привело к сокращению человеческой деятельности и, следовательно, к выбросам первичных загрязнителей воздуха, что вызвало улучшение качества воздуха.

В работе приводятся данные о влиянии этих ограничений в Грузии в связи с пандемией COVID-19 на снижение уровня загрязнения воздуха в Тбилиси весной 2020 года по сравнению с аналогичным периодом в 2017-2019 годах.

В работе использованы данные Национального агентства по охране окружающей среды Грузии о среднесуточных значениях концентрации пыли (атмосферные частицы - PM2,5 и PM10), NO_2, CO и O_3, а также данные спутникового мониторинга аэрозольной оптической толщи атмосферы. В частности, отмечается существенный рост содержания озона в воздухе и значительное уменьшение остальных загрязнителей атмосферы.