ASSESSMENT OF THE STATE AIR QUALITY MONITORING IN GEORGIA

MGR. JÁCHYM BRZEZINA, PH.D. | PRAGUE – TBILISI, 2023

ARNIKA
Český hydrometeorologický ústav
MY CITY KILLS ME
TRANSITION
Ministry of Foreign Affairs of the Czech Republic

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Prague – Tbilisi

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INTRODUCTION

Air pollution is one of the main environmental concerns for Georgia, especially in large towns and industrial centres. The WHO has published data on pollution in 4300 cities in 108 countries of the world. The research shows that virtually all European metropolises suffer from overly high levels of pollution with suspended particles (PM), binding various toxic substances. The WHO labelled the situation in Ankara, Turkey, Skopje in North Macedonia, and Georgia's Tbilisi as the most critical. In Tbilisi, according to the same report, 3774 people die prematurely every year as a consequence of air pollution – the levels exceed the WHO safe levels threefold.

The heavily industrialised Czech Republic belonged among the most polluted countries of Europe in the 1980s. Because of acid rain, virtually all the forests in the mountainous border areas died. The first demonstrations in 1989 did not demand democracy, but clean air – however, they foreshadowed the Velvet Revolution. Since then, the Czech Republic has made significant progress in the protection of ambient air. One of the first and most important steps was robust state air quality monitoring, which belongs among the most advanced in Europe nowadays.

The objective of this study is to analyse Georgian state air quality monitoring and provide recommendations resulting from the many years of experience of the Czech Republic. The Czech state institutions, as well as non-governmental organisations, are ready to support the struggle of Georgia for a better environment for its people.[1]

[1] WHO Air quality database 2022: https://www.who.int/data/gho/data/themes/air-pollution/who-air-quality-database/2022

ABOUT THE AUTHOR

Jáchym Brzezina currently works as the head of Air quality department at the Czech Hydrometeorological Institute in Brno, Czech Republic. He also co-operates with the European Environment Agency with headquarters in Copenhagen, Denmark. In his free time he creates various materials aimed to educate the public about the topics of air quality as well as the climate and other environmental topics.

LEGISLATION

Some of the information and text below is based on data from the National Report on the State of the Environment of Georgia for 2014-2017 and the National Report on the State of the Environment for 2018-2021. It therefore cannot be guaranteed that this represents the most recent state of Georgia air quality monitoring.

Ambient air protection issues in Georgia are regulated by the Law of Georgia on Ambient Air Protection from 1999 and its bylaws. Legislation provides threshold values for ambient air pollutant concentration levels, as well as emission limits for larger industrial concerns. Emissions from vehicles are regulated by technical regulations governing vehicle emissions, in particular Decree No. 510 of the Government of Georgia of Dec 1, 2017 on the Approval of the Technical Regulation on the Periodic Technical Inspection of Motor Vehicles and their Trailers.

Since Aug 1, 2018, ambient air quality in Georgia has been assessed by modern European standards (Resolution No. 383 of the Government of Georgia of Jul 27, 2018 on the Approval of the Technical Regulation on the Ambient Air Quality Standards).

THRESHOLD VALUES

Specific threshold values are specified for various harmful substances. For each substance a limit (threshold) value is specified, as well as the averaging period and in some cases the number of allowable exceedances per year.

Pollutant	Limit value	Averaging period	Number of allowable exceedances per year
Sulphur dioxide (SO_2)	350 $\mu g \cdot m^{-3}$	1 h	24
	125 $\mu g \cdot m^{-3}$	24 h	3
Nitrogen dioxide (NO_2)	200 $\mu g \cdot m^{-3}$	1 h	18
	40 $\mu g \cdot m^{-3}$	1 year	
PM_{10}	50 $\mu g \cdot m^{-3}$	24 h	35
	40 $\mu g \cdot m^{-3}$	1 year	
$PM_{2.5}$	20 $\mu g \cdot m^{-3}$	1 year	
carbon monoxide (CO)	10,000 $\mu g \cdot m^{-3}$	max. daily 8h moving average	
benzene	5 $\mu g \cdot m^{-3}$	1 year	
ozone (O_3)	120 $\mu g \cdot m^{-3}$	max. daily 8h moving average	25 (for a three-year averaging period)
lead (Pb)	500 $ng.m^{-3}$	1 year	
arsenic (As)	6 $ng.m^{-3}$	1 year	
cadmium (Cd)	5 $ng.m^{-3}$	1 year	
nickel	20 $ng.m^{-3}$	1 year	
benzo[*a*]pyrene (BaP)	1 $ng.m^{-3}$	1 year	
manganese dioxide (MnO_2)	1 $\mu g \cdot m^{-3}$	24 h	

The above threshold values, averaging periods, and number of allowable exceedances correspond to the limit values used in the EU. In the Czech Republic the limit values are specified in exactly the same way.

AMBIENT AIR QUALITY MONITORING STATIONS

Ambient air quality monitoring in Georgia is carried out by the National Environment Agency of the Ministry of Environmental Protection and Agriculture of Georgia.

In 2014, only one modern automated ambient air quality monitoring station was in operation in the country (the Vashlijvari Meteorological Station in Tbilisi). In addition, three other outdated non-automated stations were in operation in Tbilisi.

In the period from 2014 to 2017 the outdated equipment was gradually replaced by modern European-standard systems. In 2017, passive sampling was carried out in 20 municipalities. As of 2017, four modern fully automated stations were available in Tbilisi and one in each of Kutaisi and Batumi. At the end of 2021, there were seven stationary automatic stations operating in the country, which measured concentrations of PM, NO_2, SO_2, CO, and O_3. In 2018–2021, atmospheric air quality was monitored in 25 municipalities of the country through quarterly indicator measurements.

Data from passive samplers cannot be directly compared to data from other stations, for example in Europe. The methodology of these passive samplers does not comply with modern European air quality standards. Thus, only the data from automated ambient air quality monitoring stations is used and compared with the legal threshold values.

Current air pollutant concentrations are available at: https://air.gov.ge

Data is presented using an interactive map. Markers in the map are coloured on the basis of the actual value of the current concentration. Various filters can be applied to the map (location, pollutants, etc.).

Historical data from the ambient air quality automated monitoring stations is available at: https://air.gov.ge/reports_page

This web page allows historical data to be downloaded from all the automated stations as daily, monthly, and annual reports. Daily reports include hourly data, monthly reports daily averages. Each report includes concentrations of the following air pollutants:

- nitrogen dioxide (NO_2)
- sulphur dioxide (SO_2)
- suspended PM_{10} particles
- suspended $PM_{2.5}$ particles

- ozone (O_3)
- carbon monoxide (CO)

Data about meteorological parameters (air temperature, wind speed and direction, etc.) is only available from Georgian meteorological stations. It is thus not measured directly at the ambient air quality monitoring stations.

Data can be downloaded in the form of a PDF document or machine-readable Excel spreadsheets.

As of May 2023, data is available for seven different automated air quality monitoring stations:

- Batumi (BTUM) – traffic station
- Tbilisi (TSRT) – traffic station
- Tbilisi (KZBG) – traffic station
- Tbilisi (VRKT) – traffic station
- Tbilisi (AGMS) – background station
- Rustavi (RST18) – background station
- Kutaisi (KUTS) – traffic station

Out of the seven automated stations, five are traffic stations located by roads and two are background stations, which monitor background concentrations and represent air quality in a larger area than the traffic stations.

Four stations are located in the capital, Tbilisi (pop. 1.184 mil.); the remaining three are in the cities of Batumi (pop. 204,000), Kutaisi (pop. 147,600), and Rustavi (pop. 125,100). Four stations are located in the largest city, the capital (Tbilisi), and the remaining stations in the second, third, and fourth largest cities, one in each. All these stations can, therefore, be classified as "urban" stations. No stations are available in rural locations.

While the daily and monthly reports are up to date, as of May 2023, annual reports are only available up to the year 2017. The links to the annual reports for 2018 to 2021 are non-functional. The most recent daily report available is for "yesterday", the most recent monthly report for the previous month.

Monitoring is performed in a 24/7 regime, i.e. the automated stations provide data at hourly intervals and the data is updated every hour.

STRENGTHS AND WEAKNESSES

Strengths	• Threshold values – the threshold values, averaging periods. and number of allowable exceedances per year are in accordance with the values used in the EU. • Monitored pollutants – the pollutants that are monitored include those that are of the highest importance. • 24/7 monitoring – ambient air quality monitoring is performed by automated stations in a 24/7 regime, providing hourly values of the various pollutants that are monitored at each station. • Current data is presented in a clear manner via an interactive filterable map with colour-based value encoding. • Historical up-to-date data is publicly available at the government website. Daily reports are available for the previous day, monthly reports for the previous month. • Historical data is available in a machine-readable Excel format.
Weaknesses	• The station network only includes seven automated stations. more than half of which are located in the capital, Tbilisi. This means the representativeness of these stations for the country as a whole is limited. • All the available automated stations are located in the largest cities of the country. No information about air quality is therefore available from smaller towns, from villages, and from remote rural locations. • Over 70 % of the automated stations are traffic stations, which provide information about concentrations near major roads. Very little is therefore known about the background concentrations and there is therefore very limited knowledge of what the concentrations are like in the majority of areas in the country • Annual reports are only available up to year 2017. The links for the annual reports for 2018 and later are broken. • Historical data files do not include units, which is particularly problematic given the fact they are not the same for all the pollutants (all in μg.m-3, carbon monoxide in mg.m-3). • The longest interval for historical data downloads is one month; thus downloading data for a particular year means one has to download 12 files and then merge them into one document. • Meteorological data is not monitored at the ambient air quality stations – particularly information about wind speed and direction at the measuring site is very valuable in the identification of potential sources of pollution.

AIR POLLUTION SOURCES

Apart from the anthropogenic (man-made) sources, natural sources are also of significance in Georgia. Desert dust from the Sahara Desert and the Arabian Peninsula can occasionally cause high concentrations of suspended particles via transboundary transport.

As for the anthropogenic sources, the most important emission sectors are industry, transport, energy, and, for ammonia, agriculture. The particular shares of the various sectors differ for different pollutants. The chart below shows the share of sectors of the economy in total emissions of various air pollutants, as provided by the Ministry of Environmental Protection and Agriculture of Georgia.

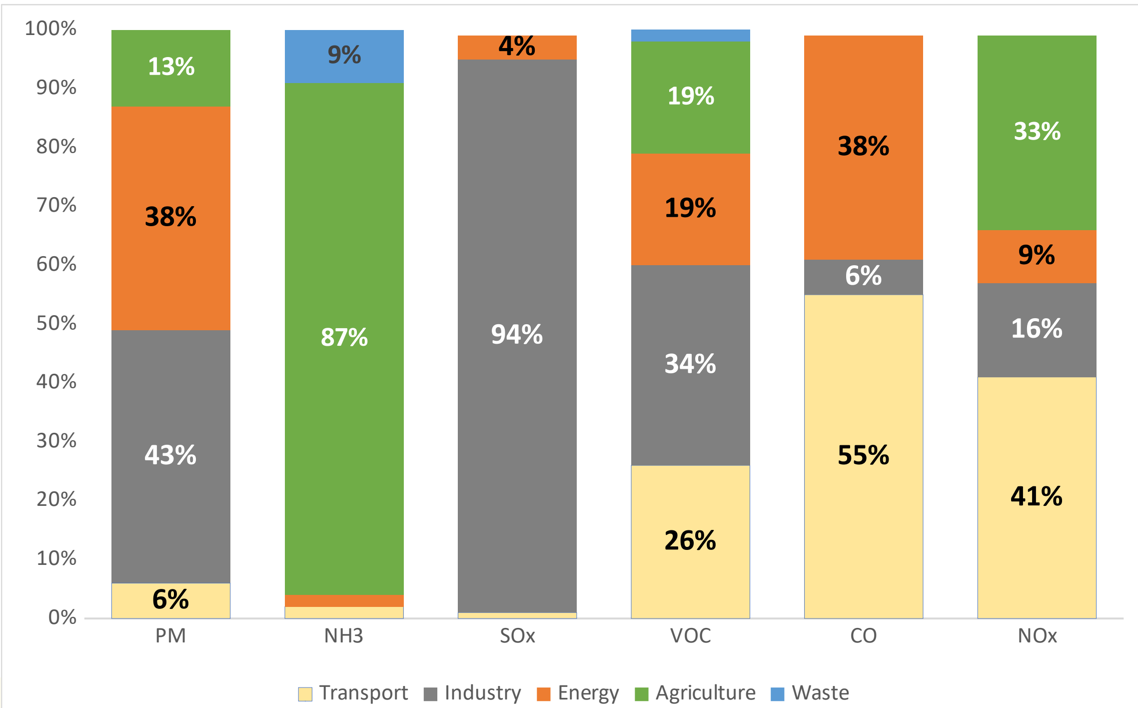

Figure 1 – Share of sectors of the economy in total emissions of various air pollutants. PM – particulate matter (suspended particles), NH_3 – ammonia, SO_x – sulphur oxides, VOC – volatile organic compounds, CO – carbon monoxide, NO_x – nitrogen oxides. Source: Ministry of Environmental Protection and Agriculture of Georgia

For particulate matter the most significant sector is industry, followed by energy, both having a share of approximately 40%. Industry is also by far the most significant source of sulphur oxides. Transport is the most significant source of especially nitrogen oxides and also carbon monoxide and volatile organic compounds. Agriculture has a relatively low share for all the pollutants, with the exception of ammonia, where it is the almost exclusive source, accounting for 95% of total emissions.

The categorisation above is very general; in reality, there are more sources of emissions; for example, in cities, especially those that are developing, construction works can be a significant contributor towards PM emissions.

Data from the four-year period 2014–2017 show that PM emissions remain more or less constant in absolute values, though changes can be observed in the sector shares – energy sector emissions are decreasing, industry sector emissions are increasing. There is a minor increase in nitrogen oxide emissions as a result of the increasing number of vehicles in the country. It should, however, be noted that there is no linear relationship between the number of cars and emissions of NO_x. The number of cars is increasing faster because newer cars have lower exhaust emissions and vehicle fleet rejuvenation thus helps to reduce emissions per vehicle.

The average annual concentrations of PM_{10} in the capital, Tbilisi, showed a decreasing trend between the years 2017 and 2021.

From the perspective of air quality, a problematic factor is the burning of coal with a high sulphur content, for example in the cement production process.

ANALYSIS - AIR QUALITY IN 2022

Monthly files with daily average concentrations of various pollutants were downloaded for all the automated ambient air quality stations and all months of the year 2022 from the website of the National Environmental Agency of Georgia at https://air.gov.ge/reports_page. The data is not verified.

Stations included in the analysis:

LOCATION	STATION DESIGNATION	STATION TYPE
Batumi	BTUM	traffic station
Tbilisi	TSRT	traffic station
Tbilisi	KZBG	traffic station
Tbilisi	VRKT	traffic station
Tbilisi	AGMS	background station
Rustavi	RST18	background station
Kutaisi	KUTS	traffic station

DATA AVAILABILITY

Apart from the actual data values, an important factor in air pollution assessment is data availability. It is important for the assessment that there is a certain minimum data availability for the data to be representative and comparable with the threshold values for ambient air pollutant concentrations.

In order to be able to assess annual means and number of exceedances per calendar year, there should be data for at least 90% of days per year (data can be missing for a maximum of 36 days per year). If there is no data for a significant portion of the year, the annual mean and number of exceedances could be biased.

The table below shows data availability for the various pollutants and ambient air quality stations in 2022:

Station	NO_2	SO_2	$PM_{2.5}$	PM_{10}	O_3	CO
KUTS	60.6%	63.0%	56.4%	56.4%	48.0%	—
TRST	98.4%	92.3%	97.0%	97.0%	98.9%	98.9%
KZBG	96.7%	97.0%	96.2%	96.2%	97.0%	97.0%
AGMS	99.2%	98.9%	98.6%	98.6%	99.2%	—
VRKT	98.9%	97.0%	98.4%	98.4%	98.6%	98.6%
RST18	96.7%	98.6%	99.2%	99.2%	100.0%	84.9%
BTUM	97.5%	98.6%	98.1%	98.1%	97.0%	97.5%

With the exception of the Kutaisi station, which had a major outage in the last third of the year, the data availability is very high, in most cases above 95%. Annual means can therefore be calculated and compared with the threshold values for all the pollutants measured at the various stations, with the exception of the KUTS station.

SUSPENDED PM_{10} PARTICLES

The bar chart below shows the annual mean values of suspended PM_{10} particles.

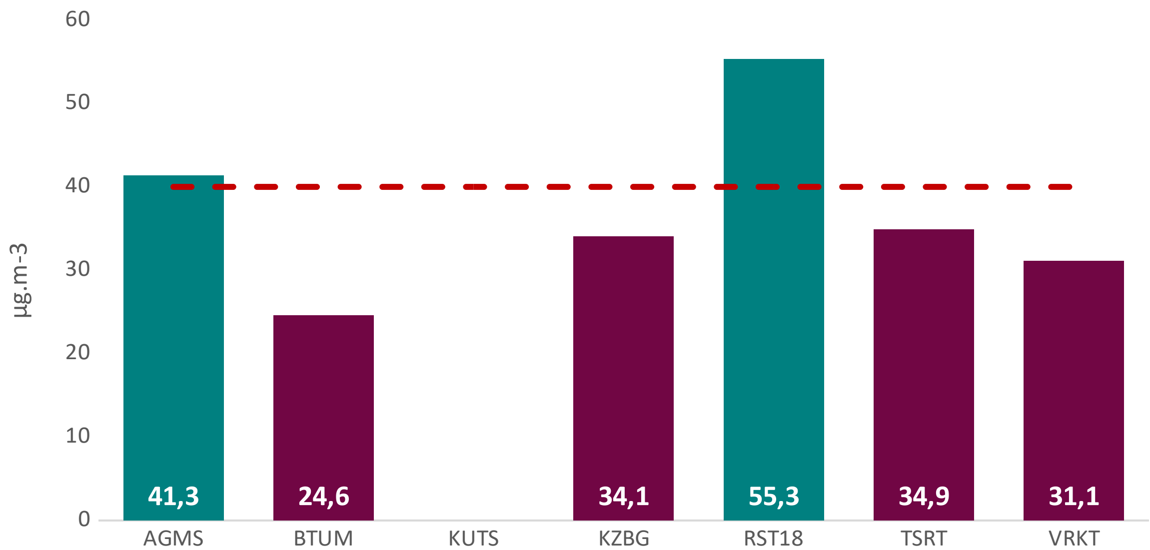

Figure 2 – Mean annual concentrations of PM_{10} for the year 2022. Background stations are shown in green, traffic stations in purple. The dashed red line shows the value of the annual threshold limit value for ambient concentrations of PM_{10}.

The annual mean PM_{10} concentrations in 2022 varied between approximately 25 and 55 $\mu g.m^{-3}$. The limit value of 40 $\mu g.m^{-3}$ was exceeded at two out of the six stations that were assessed, the only two background stations.

The monthly variation in 2022 is shown in the chart below, which shows the monthly average concentrations of PM_{10} for all the stations assessed.

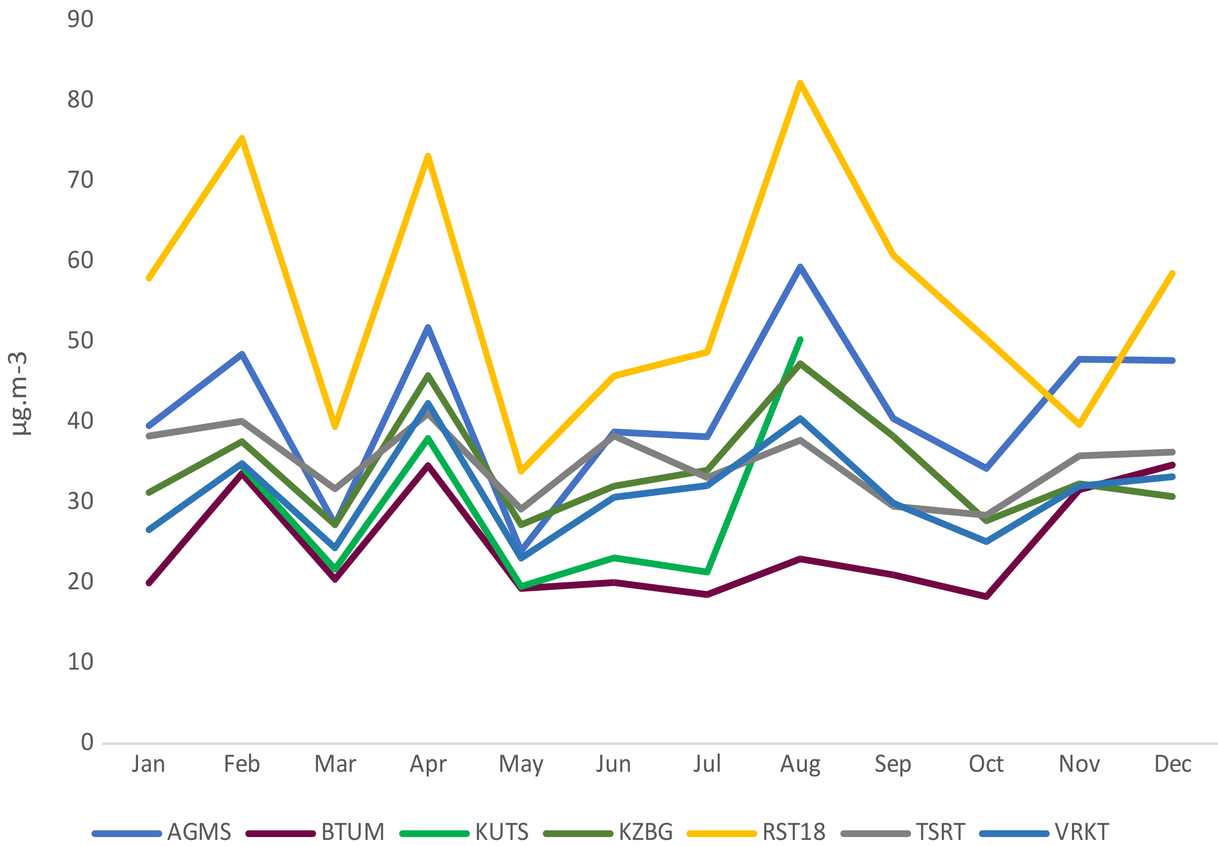

Figure 3 – Mean monthly concentrations of PM_{10} for the year 2022.

For suspended PM_{10} particles there is also a limit value set for the 24h concentration (50 $\mu g.m^{-3}$), which is considered exceeded if the number of exceedances per calendar year is higher than 35. The chart below shows the number of exceedances of the 24h limit value for PM_{10} in 2022.

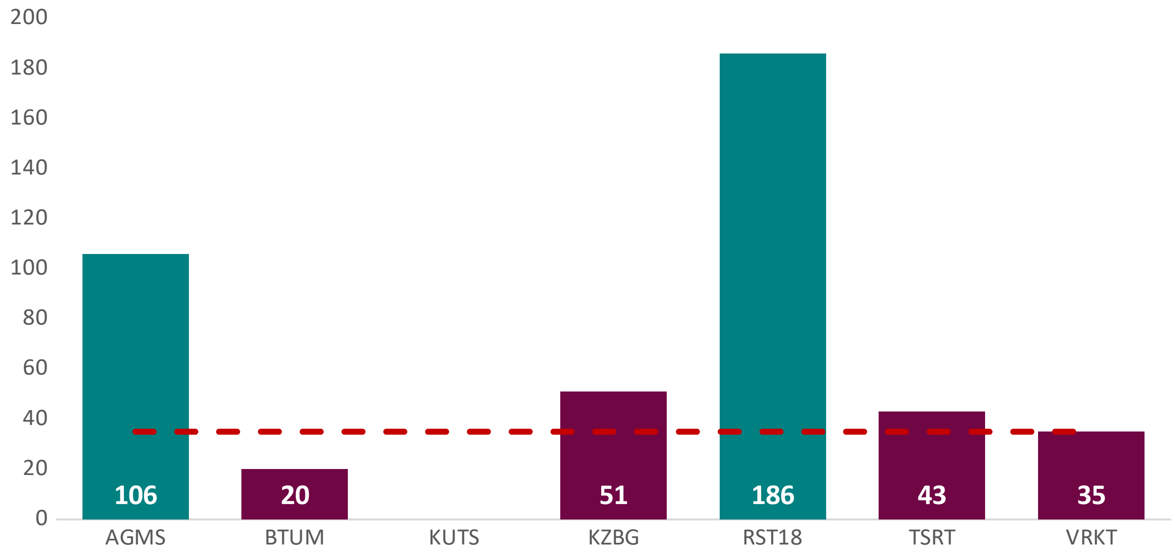

Figure 4 – Number of exceedances of the 24h limit value for PM_{10} in the year 2022. Background stations are shown in green, traffic stations in purple. The dashed red line shows the value of the maximum number of allowable exceedances as specified by the legislation.

The 24h PM_{10} limit is exceeded at over half of the monitoring stations. At the Rustavi station, the number of exceedances is very high, over five times more than the allowable number, and in 2022 the PM_{10} concentrations were higher than the 24h limit value (50 $\mu g.m^{-3}$) on more than half of the days in the year. It is unlikely that this would be caused by transboundary transport of dust because such long-range transport tends to manifest itself over a larger area. At the other stations the number of exceedances is much lower.

SUSPENDED $PM_{2.5}$ PARTICLES

The bar chart below shows the annual mean values of suspended $PM_{2.5}$ particles.

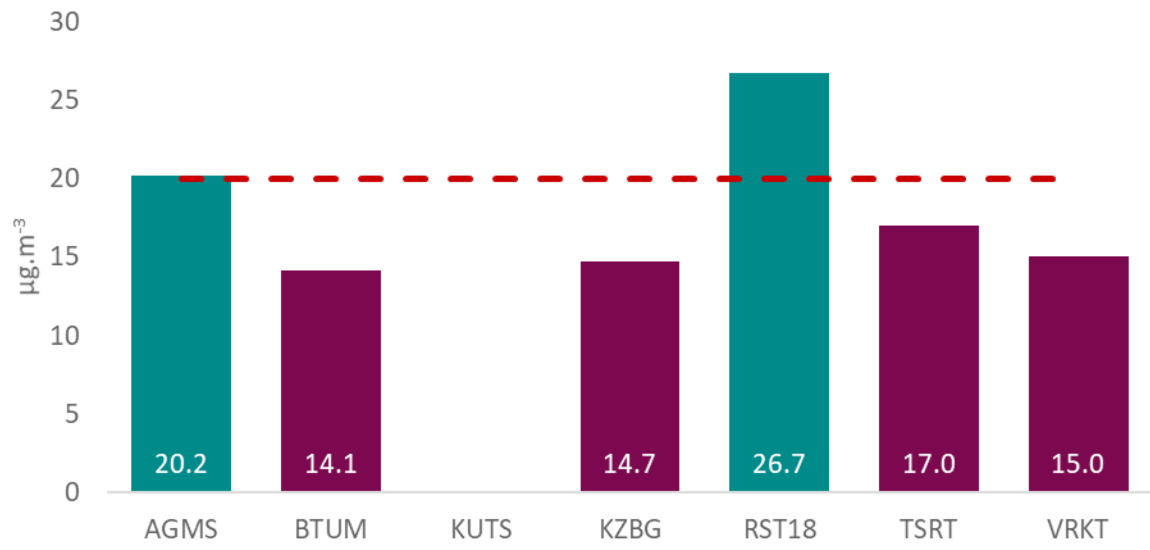

Figure 5 – Mean annual concentrations of $PM_{2.5}$ for the year 2022. Background stations are shown in green, traffic stations in purple. The dashed red line shows the value of the annual threshold limit value for ambient concentrations of $PM_{2.5}$.

The annual mean $PM_{2.5}$ concentrations in 2022 varied between approximately 14 and 27 $\mu g.m^{-3}$. The limit value of 20 $\mu g.m^{-3}$ was exceeded at two out of the six stations that were assessed, the background stations AGMS and RST18.

The monthly variation in 2022 is shown in the chart below, which shows the monthly average concentrations of $PM_{2.5}$ for all the stations assessed.

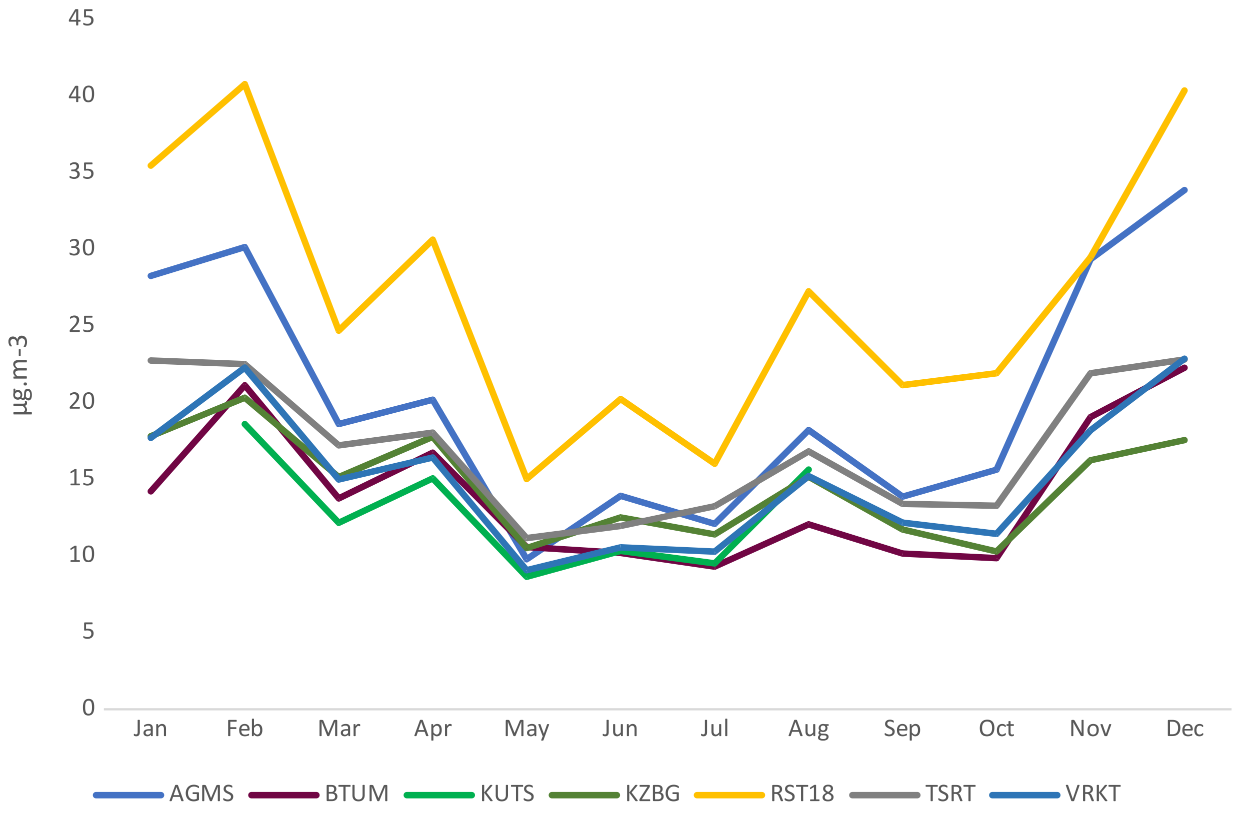

Figure 6 – Mean monthly concentrations of $PM_{2.5}$ for the year 2022.

NITROGEN DIOXIDE (NO_2)

The bar chart below shows the annual mean values of nitrogen dioxide.

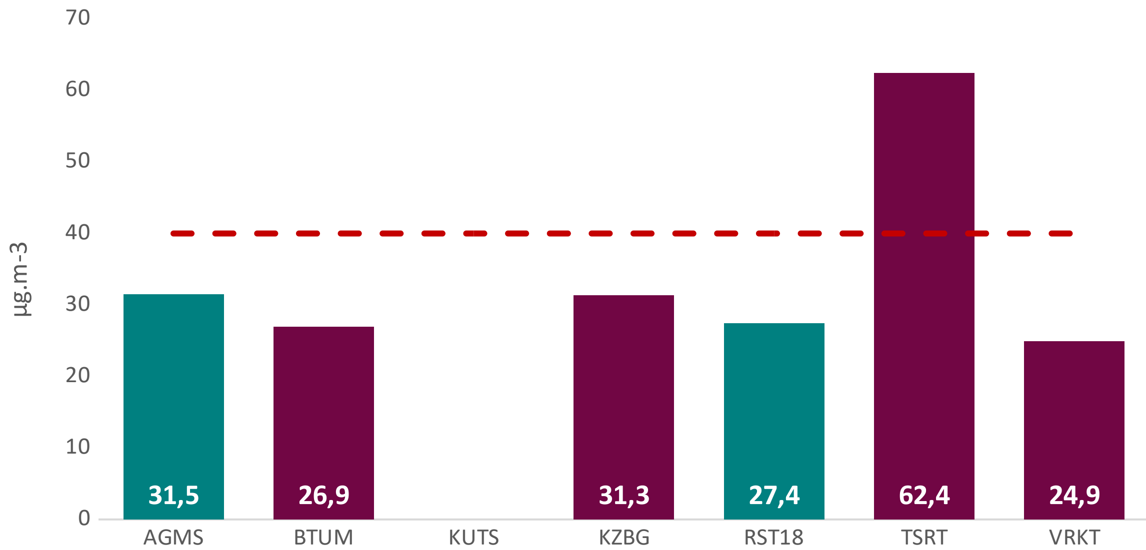

Figure 7 – Mean annual concentrations of NO_2 for the year 2022. Background stations are shown in green, traffic stations in purple. The dashed red line shows the value of the annual threshold limit value for ambient concentrations of NO_2.

The annual mean NO_2 concentrations in 2022 varied between approximately 25 and 62 µg.m^{-3}. The limit value of 40 µg.m^{-3} was exceeded at one out of the six stations that were assessed, the traffic station TSRT. Overall, we could say that at most traffic stations, similar NO_2 concentrations are observed as at the background stations, station TSRT being an exception.

The monthly variation in 2022 is shown in the chart below, which shows the monthly average concentrations of NO_2 for all the stations assessed.

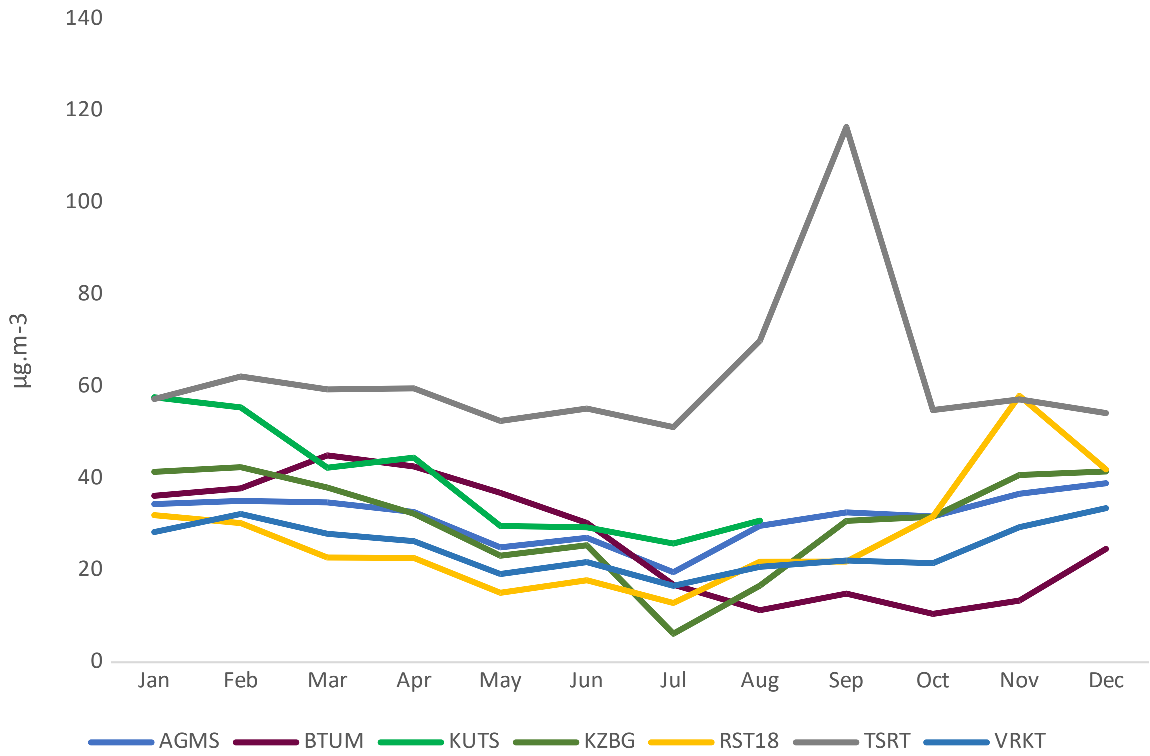

Figure 8 – Mean monthly concentrations of NO_2 for the year 2022.

SULPHUR DIOXIDE (SO_2)

The bar chart below shows the annual mean values of sulphur dioxide.

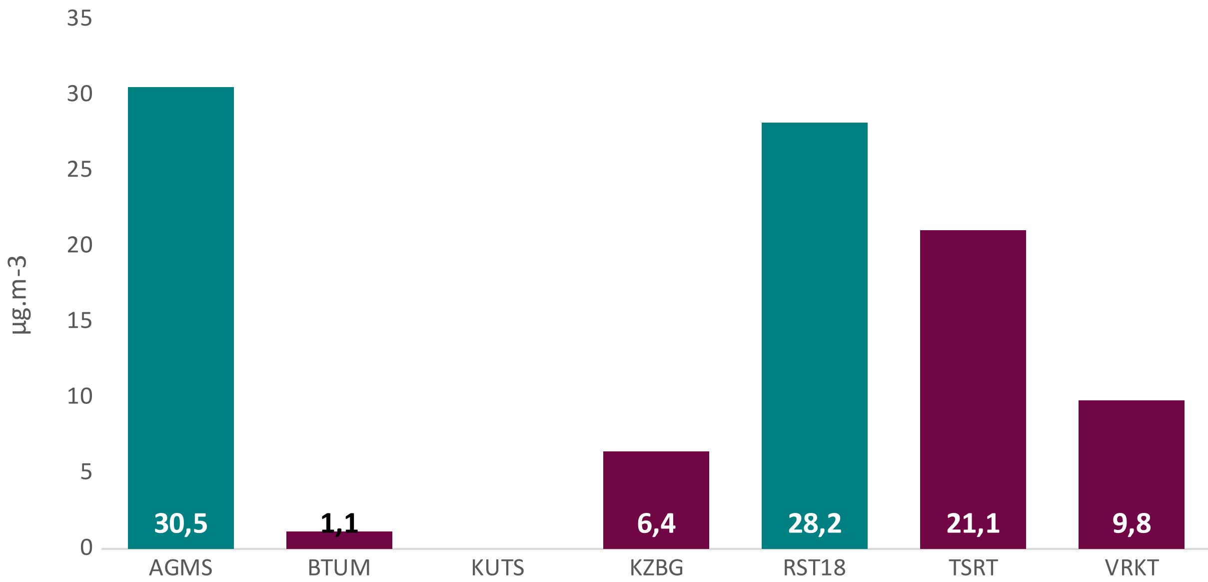

Figure 9 – Mean annual concentrations of SO_2 for the year 2022. Background stations are shown in green, traffic stations in purple.

The annual mean SO_2 concentrations in 2022 varied between approximately 1 and 31 $\mu g.m^{-3}$. The value at BTUM is suspicious because it is very low; the data, however, is not verified, and without further information about the station and data it cannot be said if it is valid or not. One can see major differences between the stations. Much higher values were observed at the background stations, possibly because they are located close to industries, which are major source of sulphur oxides and these industries are located on the outskirts of cities rather than in the city centre.

The monthly variation in 2022 is shown in the chart below, which shows the monthly average concentrations of SO_2 for all the stations assessed.

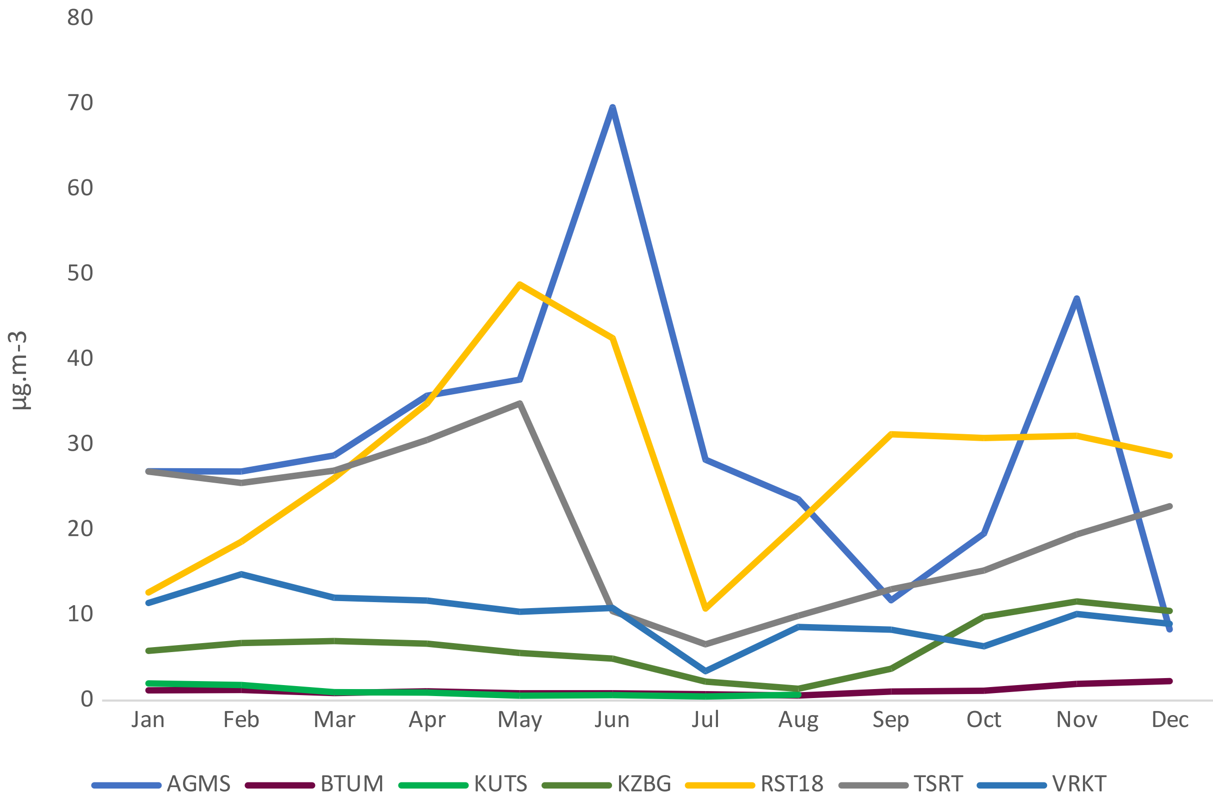

Figure 10 – Mean monthly concentrations of SO_2 for the year 2022.

For SO_2 there is also a limit value set for the 24h concentration (125 $\mu g.m^{-3}$), which is considered exceeded if the number of exceedances per calendar year is higher than three. The chart below shows the number of exceedances of the 24h limit value for SO_2 in 2022.

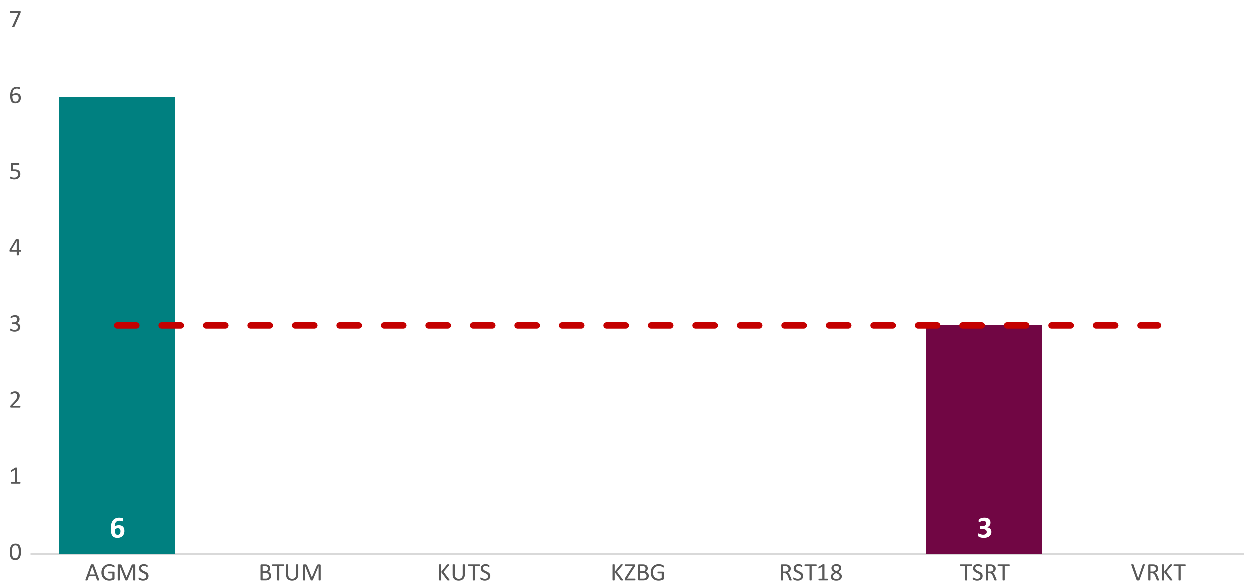

Figure 11 – Number of exceedances of the 24h limit value for the SO_2 in 2022. Background stations are shown in green, traffic stations in purple.

GROUND-LEVEL OZONE (O_3)

The bar chart below shows annual mean values of ground-level ozone.

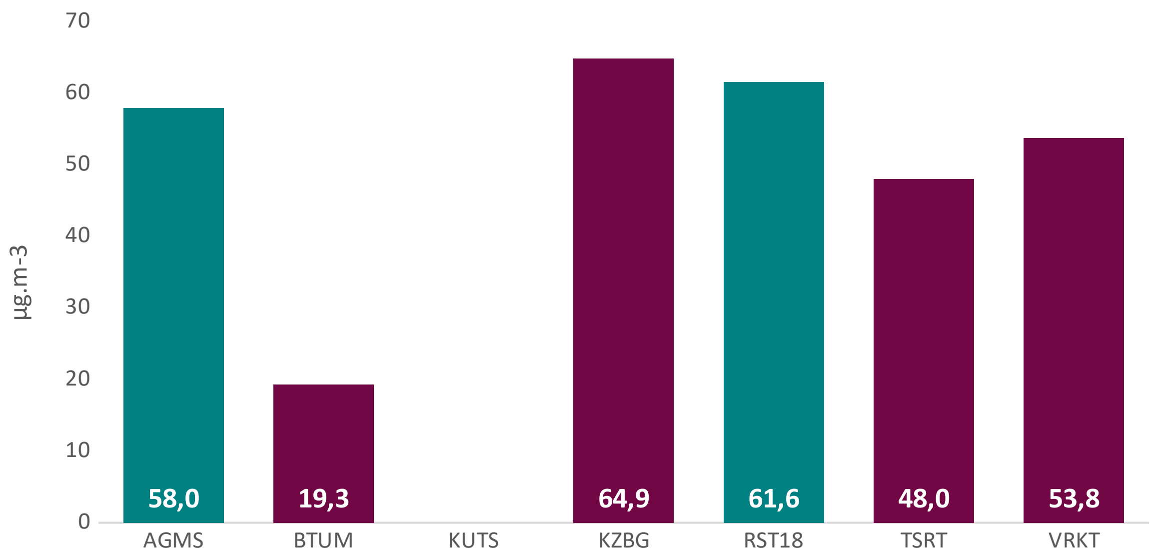

Figure 12 – Mean annual concentrations of O_3 for the year 2022. Background stations are shown in green, traffic stations in purple.

The annual mean O_3 concentrations in 2022 varied between approximately 20 and 65 $\mu g.m^{-3}$. Ozone concentrations are closely related to meteorological conditions and tend to be lower in traffic-intense zones.

The monthly variation in 2022 is shown in the chart below, which shows the monthly average concentrations of O_3 for all the stations assessed.

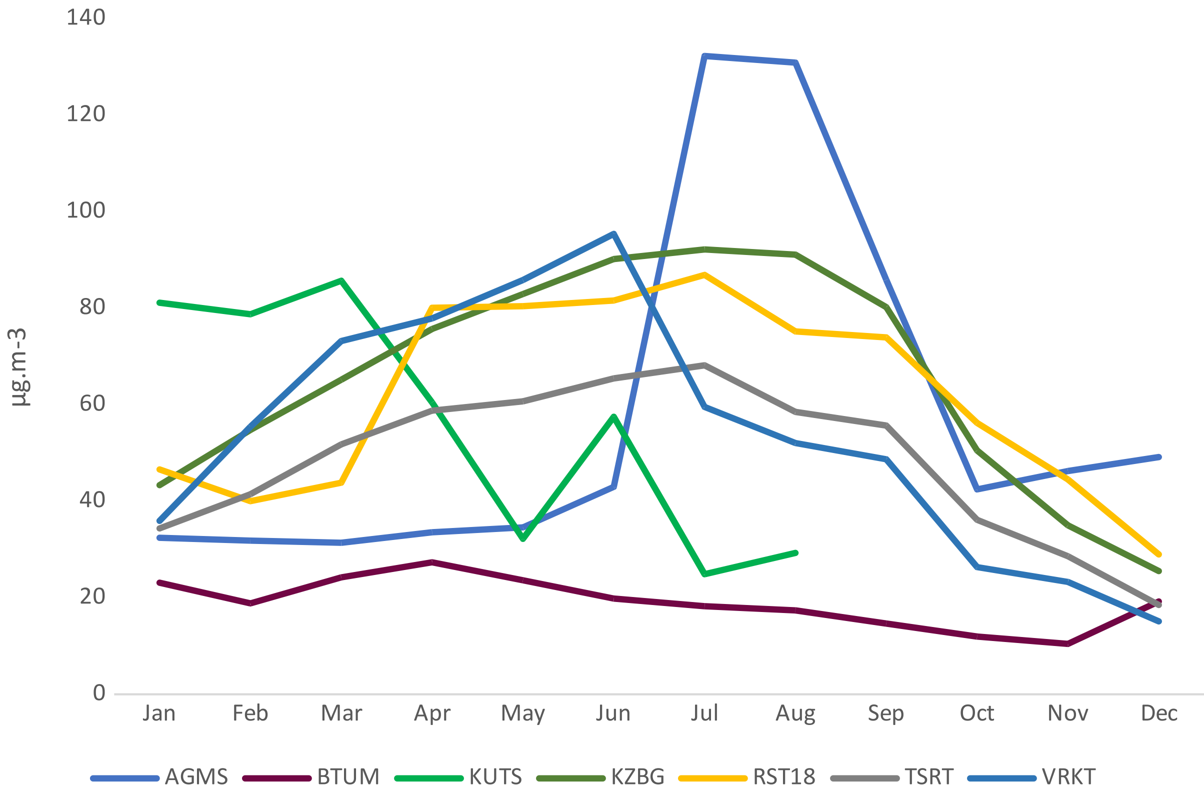

Figure 13 – Mean monthly concentrations of O_3 for the year 2022.

CARBON MONOXIDE (CO)

The bar chart below shows the annual mean values of carbon monoxide.

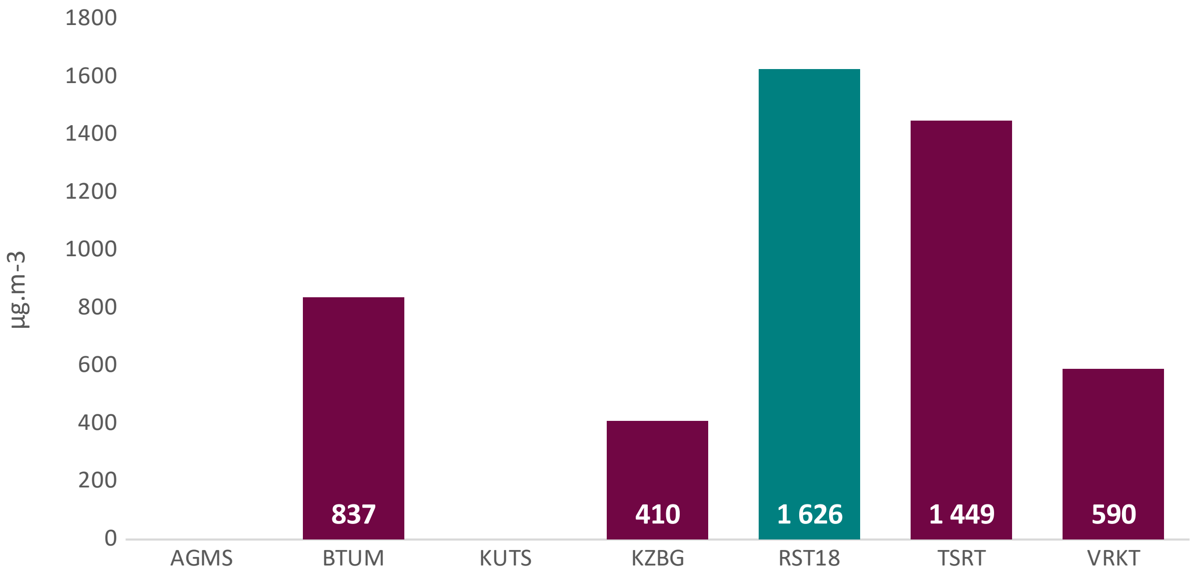

Figure 14 – Mean annual concentrations of CO for the year 2022. Background stations are shown in green, traffic stations in purple.

The annual mean CO concentrations in 2022 varied between approximately 410 and 1630 µg.m^{-3}.

The monthly variation in 2022 is shown in the chart below, which shows the monthly average concentrations of CO for all the stations assessed.

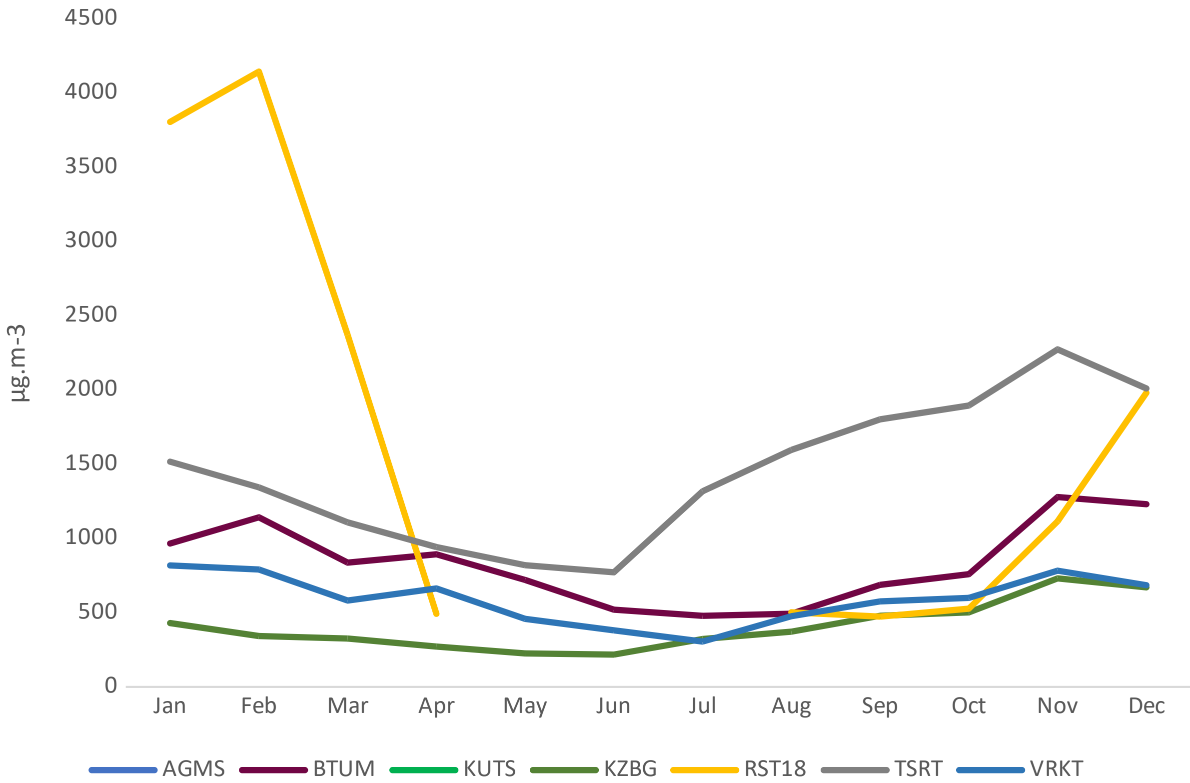

Figure 15 – Mean monthly concentrations of CO for the year 2022.

The data for the RST18 station seem suspicious in some months and in some months were incomplete or highly unreliable, so these months were not included in this evaluation.

RECOMMENDATIONS AND CONCLUSIONS

STATION NETWORK

Overall, it could be said that the Georgian air pollution monitoring system is on a good track. The implementation of European threshold values and methodologies of measurements is a major step forward. Another very positive fact is the expansion of the monitoring station network, which originally consisted of just one automated station. Now there are seven stations with hourly data.

What can also be seen as highly desirable is online data publicly available on the web, in a clear and cohesive manner. Data from the past can also be downloaded in various formats. The public have the opportunity to monitor current air quality and have all the data available to them.

There are, however, several factors that could be improved.

First, the station monitoring network is only limited to large cities. This is a major limitation because no information is available from an automated station located in a smaller town, village, or remote area. Over half of the seven available stations are in the capital, Tbilisi, the remaining ones in the other largest cities of the country. Ideally, the stations should be placed in such a way that some of them represent an industrial zone, others a traffic-intense zone, others a background residential area, and a regional background station placed in a remote area, which would give an idea of the concentrations in sparsely inhabited places etc. For example, in the Czech Republic (similar in size to Georgia, total area 13% larger), there are approximately 200 professional air quality monitoring stations, located all over the country and categorised as urban, suburban and rural and traffic, background and industrial. This makes it possible to, for example, create maps and use chemical transport models to model concentrations all over the country.

Threshold values are set for various different pollutants; however, for some no data is available in either the online data or the historical data section. Either these pollutants are not being measured or the data is not available.

While raw data is available to the public, annual reports are only available up to the year 2017 and the data from the last five years is not assessed. Having online data is important, but the public needs to be informed about aggregated data, especially in the context of its comparison with the limit values. Also, while historical data can be downloaded and is up-to-date, it is all labelled as “not verified data”, even if it is several years old. It can therefore be recommended to make sure proper validation is done and the unverified data from the past is replaced with verified data in the section where historical data can be downloaded.

POLLUTION LEVELS

In terms of the actual concentration values and air pollution levels, at some of the stations there were very high values of the number of exceedances of the 24h limit for suspended PM_{10} particles. At one of the stations the limit was exceeded on more than half of the days in the year, while the allowable number of exceedances is just 35. In cases of such major exceedance of the limit value, the sources of this pollution should be identified and maximum effort made to improve the air quality at that particular location. The limit values for, for example, SO_2 and NO_2, are also exceeded.

Arnika is uniting people seeking a better environment. We believe that natural wealth is not only a gift, but also an obligation to save it for the future. Since its foundation, Arnika has become one of the most important environmental organisations in the Czech Republic. It bases its activities on three pillars: engaging the public, arguments based on expertise, and communication. Since the beginning, Arnika has led public campaigns both in the Czech Republic and internationally. The organisation focuses on nature conservation, toxics and waste, and environmental democracy.

MY CITY KILLS ME

The civic movement "My City Kills" was first established in 2018 on Facebook with a sole purpose to emphasise and discuss existing environmental and social problems of Georgia. Since then, the team of volunteers work to safeguard the rights of all people to clean air and water, safe food, and to live in a healthy environment. Our mission is to protect the land, the air and waters on which all life depends. Our vision is a place where people act consciously to conserve nature for its own sake and for future generations.

MORE INFORMATION:

http://arnika.org/en/countries/georgia

http://greenpole.org