

AIR QUALITY INDEX (AQI) AND PM-(PM-10, PM-2.5), AIR POLLUTION IN SOME CITIES IN THE REPUBLIC OF NORTH MACEDONIA

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ABSTRACT

Air pollution in urban cities is a serious problem. This happens as a result of weak cooperation between central and local institutions. This problem is more present in some cities in the Republic of North Macedonia. With the start of the heating season in winter, like every other season, air pollution is undoubtedly updated. Due to the large use of fuels, solid and liquid, there is a lot of pollution in some larger cities in our country. The paper collects some data from measuring stations in several cities that have caused and presented greater pollution and risk. The data were collected every day in the period from January 30, 2019 to February 04, 2019, at different times of the day such as in the morning: at 8.00 and 9.30, and in the evening at 18.00, and 19.30. In addition to PM particles (Pm10 and Pm2.5), data have also been collected for some gases such as: CO, SO₂, and NO₂, as well as the percentage of AQI (Air quality index). Exceeding the average value is calculated if it exceeds 50 micrograms per cubic meter. We have more numerous and more drastic exceedances in the cities of Tetovo and Skopje, where in some cases the value has been exceeded several times. Several factors are considered as causes of pollution.

Keywords: Air pollution, Pm10, Pm2.5, Air quality index

INTRODUCTION

Air and water pollution are a serious problem for many countries in Europe and the world. Still, air pollution is a major and almost unsolved problem, due to the wrong approach to dealing with this phenomenon. Countries with developed industry and technology are particularly affected. However, these countries have invested a lot in improving air quality, so they have largely avoided pollution.

While ecologists involved in management or policy often are advised to learn to deal with uncertainty, there are several components of global environmental change of which we are certain—certain that they are going on, and certain that they are human—caused. Some of these are largely ecological changes, and all have important ecological consequences. (Vitousek P.M, 1994).

In some cases, some pollutants are in the form of hazardous waste. A hazardous waste (HW) is defined as any waste that possesses hazard properties (such as toxicity, flammability, carcinogenicity, reactivity, corrosivity, etc.) that make it a substantial present or potential hazard to humans and the environment and thus requires strict controls in the course of handling, transportation, processing, and disposal. Hazardous waste management systems (HWMS) entail the collection of HWs, their transportation to facilities with proper processing technologies, or final disposal. (Yilmaz, 2017). Most of the works dealing with AQI with the maximum allowed

concentration of these PM10 parameters have been published. and Pm2.5, then CO, Nox, SO2 and which he describes in his paper **by Cabaneros, et al.2019**;

But the question arises where air pollution comes from, who are the main sources of air? According to various authors and researchers on air quality, it can be concluded that different air pollutants are associated with different sources of pollution. Different air pollutants are associated with different sources: **-Residential, commercial, and institutional energy consumption** are the principal sources of **particulate matter**. The manufacturing and extraction industry were also a significant source, while **agriculture** was an equally important source of Pm10. and Pm2.5.;

-Agriculture was the principal source of **ammonia** and **methane**.

-Road transport was the principal source of **nitrogen oxides**.

-The energy supply sector was the principal source of **sulfur dioxide**.

-The manufacturing and extraction industries, and the **energy supply** sector, were the principal sources of **heavy metals** emissions, etc. (EUROPIAN AIR POLLUTION).

In 2019, with the appearance of COVID-19, this problem worsened even more, since most countries, as one of the measures to prevent this disease, recommended to the competent bodies that people isolate themselves in their homes. So, in the winter season due to the excessive use of fuels for household heating, the pollution increased even more, that is, the concentration of Pm10, Pm2.5, SO2, NOx, and O3 particles, and thus increased the Air Quality Index-AQI. Therefore, in periods with lower temperatures, as well as on days when the number of cases with Covid-19 increased, the level of AQI clearly showed higher values. The concentration of each of the components of AQI was very high. So, in most cases, this concentration level exceeded this limit or the maximum allowed concentration several times. The majority of the reviewed papers are aimed at the long-term forecasting of outdoor PM10, PM2.5, and oxides of nitrogen, and ozone. The vast majority of the identified works utilized meteorological and source emissions predictors almost exclusively. Liu, et al.2019

The aim of this paper

The purpose of this paper was to present an overview of air pollution (air quality index, air quality index-AQI). Special notes were taken for some pollution parameters such as Pm10, Pm2.5, CO2, SO2, NOx, and O3, as well as for AQI. as the main causes of pollution in some cities such as Skopje, Gjorce Petrov, Tetovo, Gostivar, Kichevo, etc., where we already knew that there is great pollution from these components.

MATERIALS AND METHODS

The data was collected every day for about a week in several cities such as Skopje, Gjorce Petrov, Tetovo, Gostivar, Kichevo, etc. They are gathered twice a day in the morning (8.00-9.30) and in the evening (18.00-19.30). We recorded the data in tables for each day. Data are recorded for all values such as Pm10, Pm2.5, CO, SO2, NOx, and O3, as well as for AQI.

Methods and calculations for determining the common index of air quality

Air quality index (AQI) and Common Air quality index (CAQI)

Countries around the world measure air quality, both for regulatory and reporting purposes but also to better understand the nature of air pollution and explore potential solutions to mitigate its effects. Several compounds constitute air pollution, including particulate matter-Pm (Pm.10;

Pm_{2,5}; etc), which is a mixture of solid and liquid particles suspended in air, as well as common gases such as NO₂, CO, and O₃ to name a few. In this scientific work, we have only recorded the results noted in contrast to other works that have made more accurate calculations and computational measurements such as **Wang L. A, et al 2018**.

In the Republic of North Macedonia, this problem remains an unsolved puzzle. In our country, in some larger cities, during the winter season for several years, high levels of pollution have been shown by various pollutants. Of the air pollutants in visible quantities in the winter season, they spoil the air quality in the country's biggest cities. Particularly polluted is the air in cities where there is more developed industry and technology but which are still under construction, than in cities that have not regulated the issue of central heating at the global level, urban transport (traffic) in large cities of the Northern Republic of Macedonia. During these last 6-7 days, Macedonia is facing enormous air pollution.

Measures for measuring the amount of concentration of parameters are standard for most countries in the world, which parameters are valid and used in our country as well.

AQI Category Index Values Previous Breakpoints (1999 AQI) (µg/m³, 24-hour average) Revised Breakpoints (µg/m³, 24-hour average) Good 0 - 50 0.0 - 15.0 0.0 - 12.0 Moderate 51 - 100 >15.0 - 40 12.1 - 35.4 Unhealthy for Sensitive Groups 101 - 150 >40 - 65 35.5 - 55.4 Unhealthy 151 - 200 > 65 - 150 55.5 - 150.4 Very Unhealthy 201 - 300 > 150 - 250 150.5 - 250.4 Hazardous 301 - 400 > 250 - 350 250.5 - 350.4 401 - 500 > 350 - 500 350.5 - 500.

RESULTS AND DISCUSSIONS

Residential, commercial, and institutional energy consumption was the principal source of particulate matter in 2020. The manufacturing and extraction industry were also a significant source, while agriculture was an equally important source of Pm₁₀. Between 2005 and 2020, emissions of particulate matter, Pm₁₀, and Pm_{2.5}, fell by 30% and 32%, respectively. EUROPEAN ENVIRONMENT AGENCY).

The paper collects some data from measuring stations in several cities that have caused and presented greater pollution and risk. The data were collected every day in one week (from 30.01.2019 to 04.02.2019), at different times of the day such as in the morning: at 8.00 and 9.30, and in the evening at 18.00, and 19.30.

During the registrations (notes) of the first air pollution measurements in some cities in the country, it was found that the maximum allowed concentration (KML) for the air quality index (AQI) was exceeded. In **Tab.1** it can be seen that PM₁₀ has been exceeded several times in Tetovo (106), Gostivar (219), Gjorce Petrov (185), and Skopje (113) as well as for Pm 2.5 until the records of other cities were within the permissible limits.

Tab.1. results of AQI (Air quality index), and calculations, in some cities in the Republic of North Macedonia on January 30, 2019 (18.00)

VALUES	O3	Pm-10	Pm-2.5	AQI	CO	SO2	NO2
Kichevo	17	82	82	45	-	2	28
Tetovo	13	106	105	96	2	23	141
Gostivar	35	219	121	45	4	3	118

Skopje	-	113	58	62	-	-	-
Gjorce P.	105	185	89	-	-	-	-
Bitola	50	74	55	-	-	-	-

While in the notes of the evening results for air pollution in some cities in the country, it was found that the maximum allowed concentration (KML) for the air quality index (AKI) was exceeded, in the morning results (8:00 a.m.) those are even higher, which indicate exceeding the pollution values. So they are as follows: In Tetovo (106), Gostivar (219), Kicevo (230), and Skopje (189) and for PM 2.5, the highest are as follows: in Tetovo (105), Kicevo (230), Gjorce Petrov (185) and Skopje (113) as well as for Pm 2.5, while in the registrations of other cities it was within the permissible limits. For AKI values it is as follows: Tetovo (96), Gostivar (121), Gjorce Petrov (185) Skopje (105), Kicevo (209), etc. Table 2

Tab.2. results of AQI (Air quality index), and calculations, in some cities in RNM on January 31, 2019 (8.00)

VALUES	O3	Pm-10	Pm-2.5	AQI	CO	SO2	NO2
Kichevo	120	230	230	209	-	1	8
Tetovo	13	106	105	96	2	2	
Gostivar	35	219		121	4	13	
Skopje	-	189	89	105	-	-	-
Gjorce P.	-	-	-	-	-	-	-
Bitola	-	74	55	50	-	-	-

For the next several days, the values of PM10, PM2.5 and AKI (AQI) have been exceeded. So in the following records are the results of 01.02.2019 at 9.00 am. The values for PM10 show the following: In Tetovo (160), Gostivar (154), Kichevo (109), and Skopje (99), while the highest was in Gjorce Petrov (200), where it exceeds the values for 4 times, and Strumica (221), while for PM 2.5, values were recorded only for Tetovo (158), and Gjorce Petrov (81), as well as for the registrations of other cities, there are no data. For AKI values it is as follows: Tetovo (144), Gostivar (86), Gjorce Petrov (111) and Skopje (73), Kičovo (61) and Strumica (123). Table 3.

Tab.3. results of AQI (Air quality index), and calculations, in some cities in RNM on February 01, 2019 (9.00)

VALUES	O3	Pm-10	Pm-2.5	AQI	CO	SO2	NO2
Kichevo	12	109	-	61	-	2	38
Tetovo	6	160	158	144	4	1	127

Gostivar	26	154	-	86	4	3	112
Skopje	-	99	-	73	-	-	-
Gjorce P.	-	200	81	111	-	-	2
Bitola	-	-	-	-	-	-	-
Strumica	8	221		123	5	2	83

Sometimes the results are higher in the morning time and in some cases in the evening time. The highest values are especially for PM10 on 02.02.2019 in the evening (19.00) and are as follows: In Gostivar (210), Kichovo (111), and Skopje (135), while the highest were in Tetovo (338), where it exceeds the allowed values by nearly 7 times, while for PM 2.5, values were recorded only for Gostivar (206), and Skopje (94), while there are no records of other cities. For AKI values it is as follows: Tetovo (188), Gostivar (187), Gjorce Petrov (111) and Skopje (86), Kicevo (61). Table 4.

Tab.4. Results of AQI (Air quality index), and calculations, in some cities on RNM on February 02, 2019 (19.00)

VALUES	O3	Pm-10	Pm-2.5	AQI	CO	SO2	NO2
Kichevo	14	111	-	61	-	1	28
Tetovo	45	338		188	7	4	82
Gostivar	5	210	206	187	6	11	87
Skopje	-	135	94	86	-	-	25
Gjorce P.							
Bitola							

A day later on the night of February 03, 2019 in the evening (19.30), the values have started to fall so that they are slightly higher especially for Pm10 and are as follows: In Gostivar (136), in Tetovo (143), and for Pm 2.5, values were recorded only for Gostivar (168), and Tetovo (142), while the records of other cities are not very high. The data for AKI (AQI) are as follows: Tetovo (129), Gostivar (75), Gjorce Petrov (80) and Kichevo (62). Table 5

Tab.5. Results of AQI (Air quality index) and calculations, in some cities in RNM on February 03, 2019(19.30)

VALUES	O3	Pm-10	Pm-2.5	AQI	CO	SO2	NO2
Kichevo	16	11	-	62	-	2	32
Tetovo	5	143	142	129	3	13	97

Gostivar	22	136	168	75	3	2	70
Skopje	-	48	33	30	30	-	-
Gjorce P.	-	144	58	80	-	-	-
Bitola							

The lowest values were recorded on February 04, 2019 in the morning (9.00) and are calculated at the limit or below the value that may exceed the limits, which means that the AKI (AQI) together with the concentrated values of PM10 and PM2.5, are lower. These values do not endanger people's health. This is proven by the values presented in Tab.6

Tab.6. Results of AQI (Air quality index) and calculations, in some cities in RNM February 04, 2019 on (9.00)

VALUES	O3	Pm-10	Pm-2.5	AQI	CO	SO2	NO2
Kichevo	16	35	35	19	-	-	10
Tetovo	4	61	60	13	1	11	46
Gostivar	13	60	-	33	1	2	40
Skopje							
Gjorçe P.							

CONCLUSIONS

From the measurement of the AKI (Air Quality Index) in Macedonia, it has been established that there is an excess concentration of polluted air in some cities.

Exceeding the concentration of polluted air was registered in the largest cities with population and where there is industry and higher construction, but also in cities where urban transport and central heating are not regulated at the city level.

The cities with the greatest excess are: Skopje, Tetovo, Gostivar, Kichevo, Gjorce Petrov municipality, etc.

The pollution is especially high in the morning (8.00-9.00) and in the evening (18.00-19.30) and in the winter season.

Therefore, cities should work on the regulation of organized urban transport and the regulation of central heating at the city level, which are probably the two main factors of air pollution.

At the end of this paper, we conclude that some cities of our country have a large amount of pollution that exceeds the maximum allowed concentration, where sometimes it is 10 times greater than the average values.

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