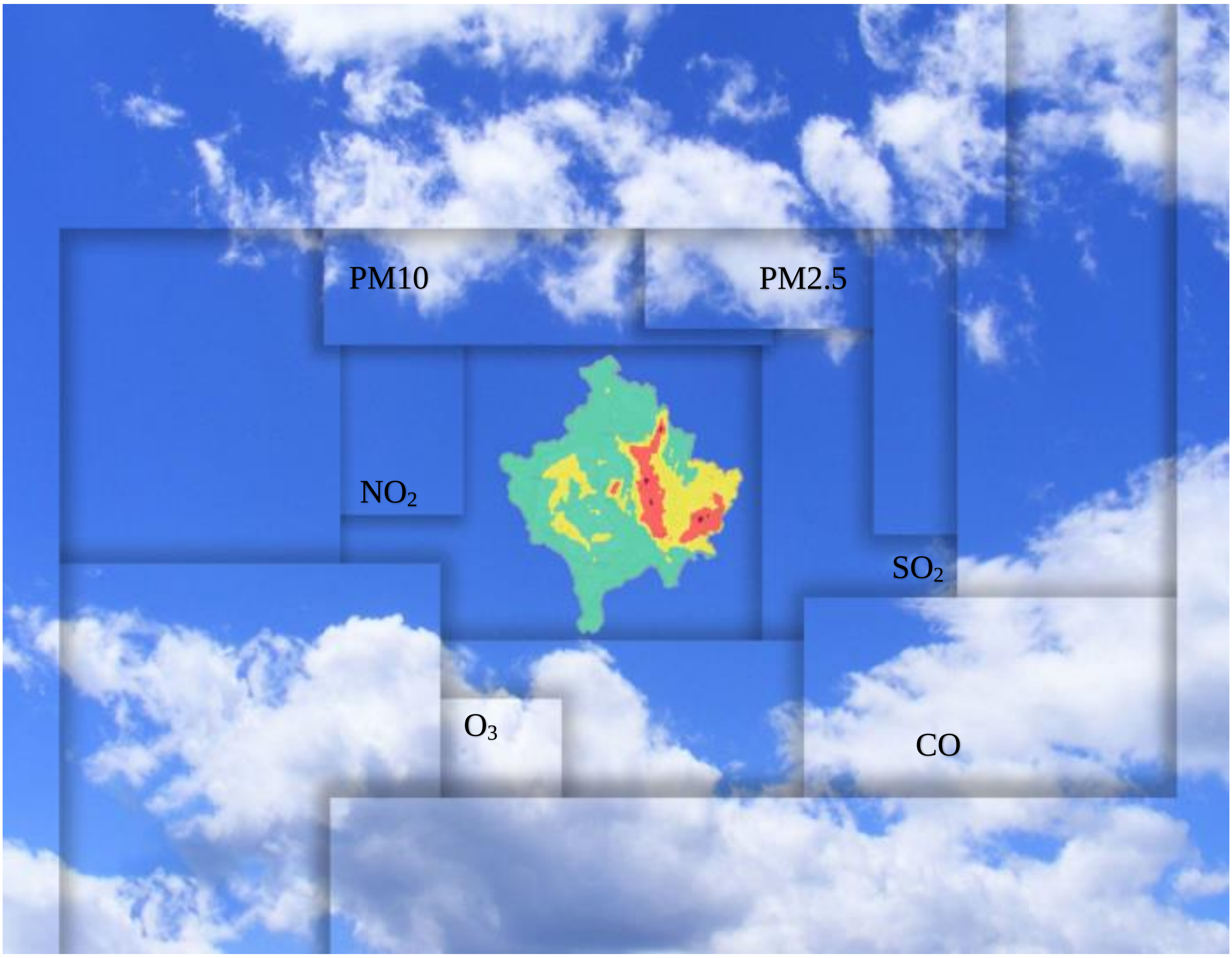
Republic of Kosovo

Government

Ministry of Environment, Spatial Planning and Infrastructure

STATE OF THE AIR REPORT 2021



2022, Prishtina

Introduction

This report provides a summary of data on air quality and emissions, investments in the air sector, legal infrastructure and recommendations for the improvement of the current state.

The data presented in the report were collected by the Hydrometeorological Institute of Kosovo, an institution that monitors air quality, economic operators and projects in the air sector, implemented by relevant institutions or donors during 2021.

The collected data were processed and assessed by the Sector for Environmental Assessment in the Directorate for Environmental Assessment of the Kosovo Environmental Protection Agency.

The data presented in the state of the air report pertain to the following five (5) pollutants:

- Carbon Monoxide (CO),
- Ozone (O_3),
- Sulphur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)
- Dust particles smaller than 10 and 2.5 microns in diameter, respectively PM_{10} & $PM_{2.5}$

While data on air emissions include assessments of air emissions of NOx, SO2 and total dust from economic operators: TPP A and TPP B, New Co Feronikel and Sharr-Cem.

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1. Legal basis and rules for air monitoring

1.1. Legal framework

Law No. 03/L-160 on Air Protection from Pollution, 2012, is the fundamental law on air protection from pollution.

The legal infrastructure for air protection from pollution is supplemented by AIs (bylaws), such as;

- ✓ Administrative Instructions (GRK) - No. 06/2007 on rules and standards of the discharges on air by the stationary sources of pollution;
- ✓ Administrative Instruction (GRK) No. 04/2009) on the control of emissions of volatile organic compounds, during the storage, emptying, filling and transportation of fuels;
- ✓ Administrative Instruction (Minister of MESP) No. 02/2011 on air quality assessment;
- ✓ Administrative Instruction No. 15/2010 on the criteria for defining of air quality monitoring points, number and frequency of measurements, classification of pollutants which are monitored, the methodology of work, form and timing;
- ✓ Administrative Instruction (GRK) No. 21/2013 for arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in air;
- ✓ Administrative Instruction (GRK) No. 16/2013 for substances that deplete the ozone layer and fluorinated greenhouse gases;
- ✓ Administrative Instruction (GRK) No. 19/2013 for access to the information for economic consumption of fuel and CO2 emission of new personal vehicles;
- ✓ Administrative Instruction (GRK) No. 01/2016 on mechanism for monitoring greenhouse gas emissions;
- ✓ Administrative Instruction (GRK) No. 08/2016 on the permitted norms of emissions in the air by movable pollution sources.

1.2. **Information on air quality alert limits**

Air quality information and alert limits are defined in accordance with the Law No. 03/L-160 on Air Protection from Pollution and AI 02/2011 on air quality assessment (Fig. 1, 2, 3).

Fig.1. Alert thresholds for Sulphur Dioxide (SO2) and Nitrogen Dioxide (NO2)

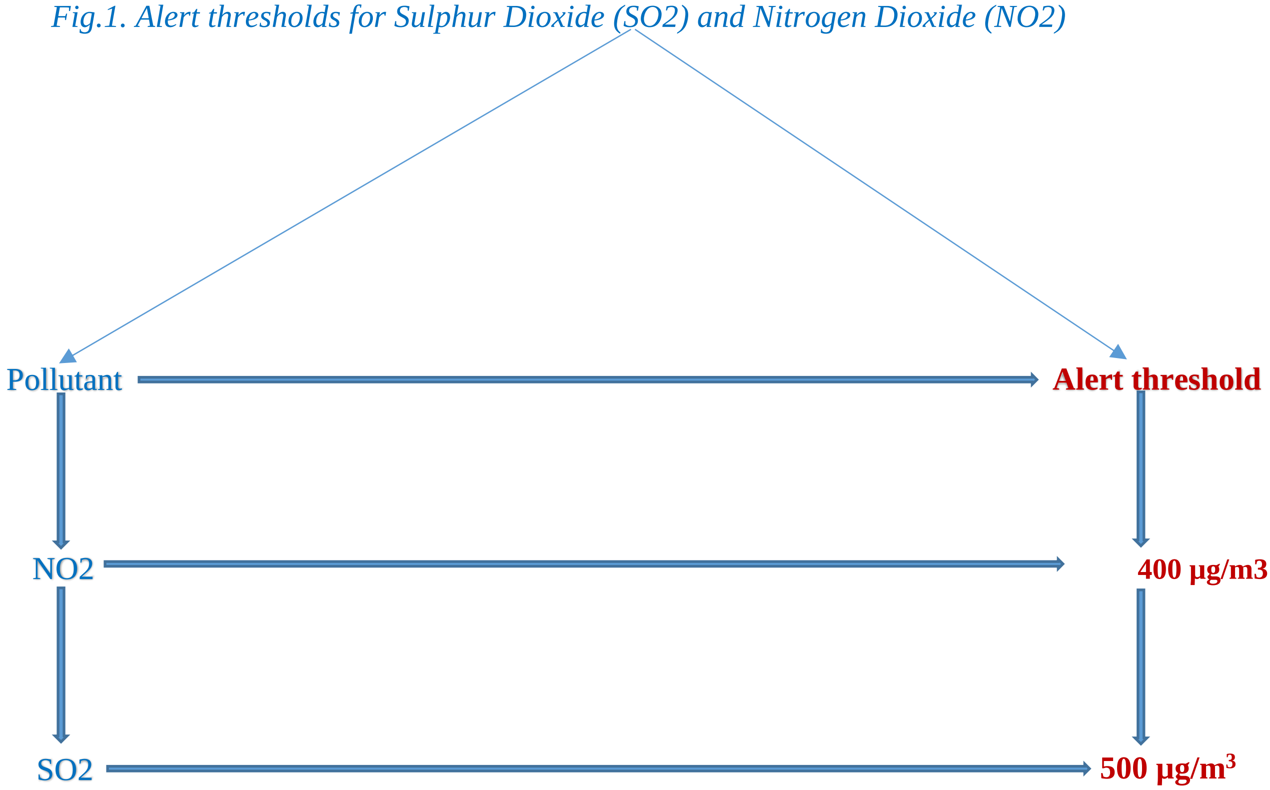

Fig. 2. Alarm threshold for PM10

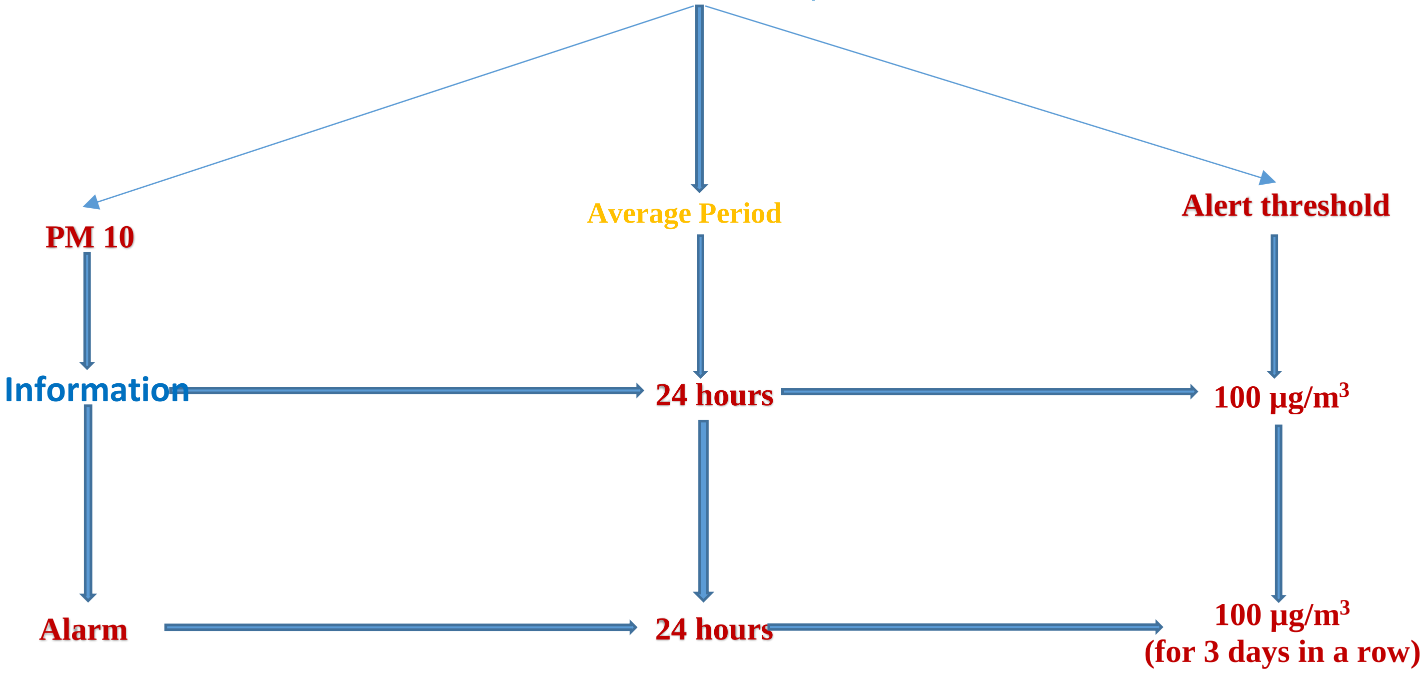

Fig. 3. Alert threshold for O3

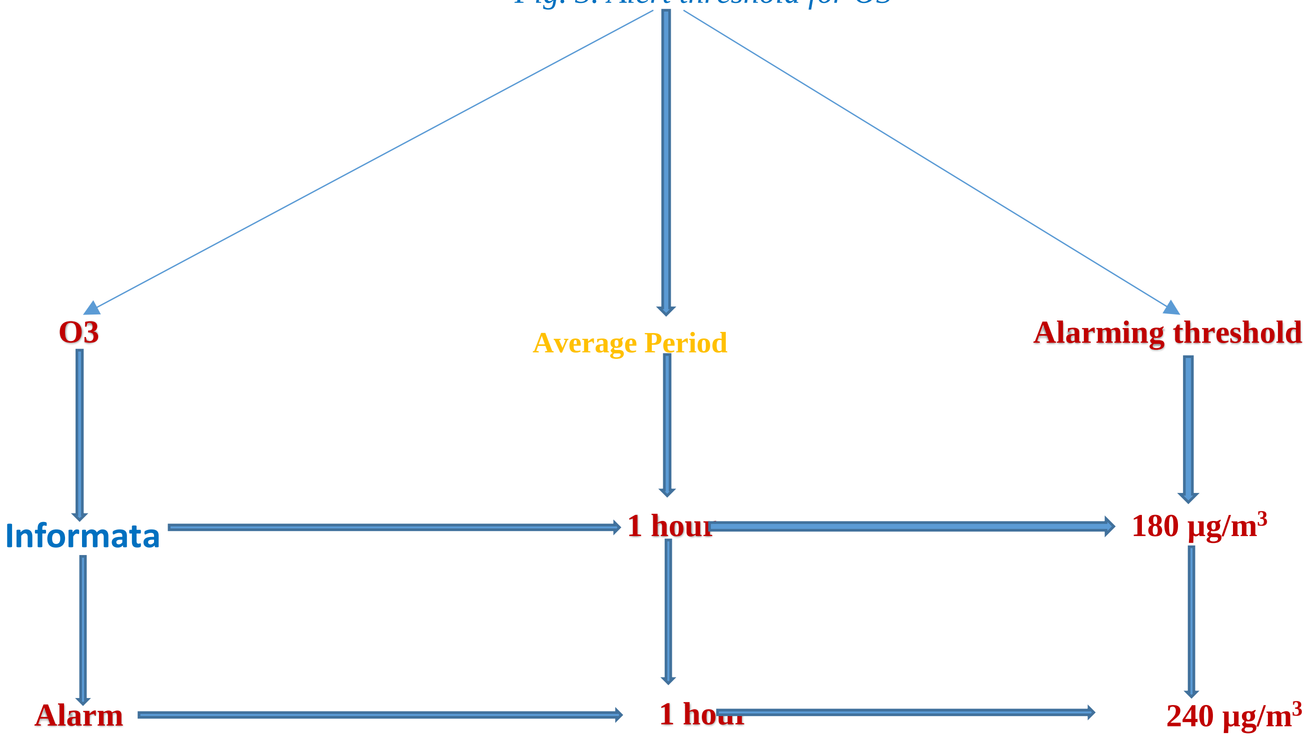

Table 1. Air quality norms (AI No. 02/2011)

Parameter	Limit values	Unit of measurement	Limit values µg/m^3	Exceedances permitted within the year
NO_2	Limit value for 1 hour for the protection of human health	µg/m^3	200	18
	Annual limit value for the protection of human health	µg/m^3	40	Not foreseen
	Annual limit value for the protection of vegetation	µg/m^3	30	Not foreseen
SO_2	Limit value for 1 hour for the protection of human health	µg/m^3	350	24
	Limit value for 24 hours for the protection of human health	µg/m^3	125	3
CO	Limit value of the daily average of the 8-hour maximum for the protection of human health	mg/m^3	10	Not foreseen
PM_{10}	Limit value for 24 hours for the protection of human health	µg/m^3	50	35
	Annual limit value for the protection of human health	µg/m^3	40	Not foreseen
$PM_{2.5}$	Annual limit value for the protection of human health	µg/m^3	25	Not foreseen
O_3	The long-term objective for the protection of human health	µg/m^3	120	Not foreseen

Table.2. Air quality index for air pollutants, index level and impact on health

Quality	Good	Acceptable	Average	Poor	Very poor	Extremely poor
Dust particles smaller than 2.5 µm ($PM_{2.5}$)	0-10	10-20	20-25	25-50	50-75	75-800
Dust particles smaller than 10 µm (PM_{10})	0-20	20-40	40-50	50-100	100-150	150-1200
Nitrogen dioxide (NO_2)	0-40	40-90	90-120	120-230	230-340	340-1000
Ozone (O_3)	0-50	50-100	100-130	130-240	240-380	380-800
Sulphur dioxide (SO_2)	0-100	100-200	200-350	350-500	500-750	750-1250
Air quality index level (based on the concentration of pollutants expressed in µg/m^3)						

1.3. Prerequisites for assessment of air quality data

As a prerequisite for the assessment of air quality data, other information related to meteorological conditions for the territory needs to be obtained, such as:

- Description of the location (position of monitoring station, orography, residential buildings around, industrial facilities, road infrastructure, traffic, background of the station and other data that reflect the respective situation in time and space);
- Continuation of 24-hour measurements and monthly measurements;
- Temperature, ^{0}C;
- Pressure; in bar or hPa;
- Relative air humidity in %;
- Air velocity in m/s;
- Precipitation in millimetres (mm);
- Wind rose for data evaluation time;
- Impact of cross-border pollution from countries of the region

1.4 Description of air pollutants

Brief description of pollutants monitored by monitoring stations:

Carbon monoxide (CO)

Carbon monoxide is a gas formed during incomplete combustion of fuel. CO is colourless, odourless and tasteless and is lethal in high concentrations. Its levels peak during the colder months, mainly due to cold temperatures affecting the combustion efficiency of engines or other sources.

Sources: CO is released whenever fuel or other carbon-based materials are burned. Sources of external exposure include vehicle exhausts, industrial processes (metalworking and chemical production) and combustion of non-vehicle fuel. Natural resources include volcanoes, forest fires and photochemical reactions in the atmosphere. Sources of indoor exposure include wood stoves and fireplaces, gas beams with continuous pilot flame ignition, unopened gas or kerosene heaters, and cigarette smoke.

Effects: CO enters the bloodstream through the lungs, where it takes the place of oxygen delivered to organs and tissues. Elevated levels can cause visual impairment, interfere with mental acuity, reduce the ability to learn and manual dexterity as well as being able to reduce job performance in completing complex tasks. In extreme cases, loss of consciousness and death can occur. CO also alters atmospheric photochemistry, contributing to the formation of O3 at ground level, which can cause serious breathing problems.

People at risk: Those suffering from cardiovascular (heart and respiratory) diseases, foetuses, infants and the elderly are at more risk of exposure to high CO levels. People with angina and peripheral vascular disease are particularly at risk, as the circulatory systems are already compromised and less efficient at carrying oxygen. However, elevated CO levels can also affect healthy people.

Nitrogen dioxide (NO_2)

Nitrogen dioxide is a gas that in the air visually appears as reddish-brown, is highly reactive and formed by the oxidation of nitrous oxide (NO). After dilution, it becomes yellow or colourless. High concentrations produce a strong odour and lower levels have a smell like bleach. NO_X is the term used to describe the sum of NO, NO2 and other nitrogen oxides. NO_X can lead to the formation of O_3 and NO_2, which can react with other substances in the atmosphere to form particles or acidic products that are deposited in rain (acid rain), fog or snow.

Sources: NO_X compounds and their transformed products occur both naturally and as a result of human activities. Natural sources of NO_X are lightning, forest fires, bacterial processes in the soil and stratospheric interference. Stratospheric interference is when the upper atmosphere of the air (stratosphere) descends to the surface of the earth and mixes with the air at the level of respiration. Ammonia and other naturally occurring nitrogen compounds are important in the circulation of nitrogen throughout the ecosystem. The main sources of human-made NOx emissions (anthropogenic) come from high-temperature combustion processes, such as those occurring in automobiles and power plants. Home heaters and gas chambers produce significant amounts of NO2 indoors.

Effects: Exposure to NO2 occurs through the respiratory system irritating the lungs. Short-term exposure to NO2 (i.e., less than three hours) may cause cough and changes in airway response and lung function. Evidence suggests that long-term exposure to NO2 may lead to increased susceptibility to respiratory infections and may cause structural changes in the lungs. Particles of nitrate (NO3) and nitrogen dioxide (NO2) particles can block light transmission, resulting in impaired visibility (i.e., smog or fog). Nitrogen deposition can lead to fertilization, over-enrichment of nutrients or acidification of land, wetland and aquatic systems that can upset the delicate balance in the said ecosystems.

People at risk: Individuals with pre-existing respiratory disease and asthma are more sensitive to the effects of NO2 than the general population. Short-term exposure to NO2 may increase respiratory illness in children.

Sulphur Dioxide (SO_2)

Sulphur Dioxide is a gas formed by the combustion of sulphur-containing material. High and short-term concentrations of SO_2 in the environment cause irritation to the respiratory organs. When sulphur-containing fuel is burned, sulphur is oxidized to form SO_2, which then reacts with other pollutants to form aerosols.

The aerosols in question can form particles in the air causing increased $PM_{2.5}$ levels.

Sources: Coal-fired power plants are the largest source of SO_2 emissions. Other sources include industrial processes such as extraction of metal from ores, and non-road and natural transportation sources such as volcanic sources. SO_2 and particles are often emitted together.

Effects: Exposure to elevated levels can worsen symptoms in people suffering from asthma and cause breathing problems in humans. SO_2 and NOx together are the main precursors of acid rain and are associated with acidification of soil, lakes and streams, as well as accelerated corrosion of buildings and monuments.

People at risk: People suffering from asthma, children and the elderly are particularly susceptible to SO_2 exposure. People suffering from asthma that are exposed in short-term to moderate exertion may experience decreased lung function and symptoms such as wheezing, chest tightness, or shortness of breath.

Ozone (O_3)

O_3 at ground level is created by reactions involving nitrogen oxides (NO_X) and volatile organic compounds (VOCs), or hydrocarbons, in the presence of sunlight as the illustration to the right shows (courtesy image of USEPA) see fig. 4. These reactions usually occur during the hot summer months, as ultraviolet radiation from the sun initiates a sequence of photochemical reactions. In the Earth's upper atmosphere (stratosphere), O_3 helps absorb most of the sun's ultraviolet radiation, but in the lower atmosphere (troposphere) ozone is an air pollutant. O_3 is also a key component of urban smog and can be transported hundreds of miles under certain meteorological conditions.

Sources: The main sources of NOX and VOC are engine emissions, emissions from industrial facilities, combustion from power plants, gasoline vapours, chemical solvents and bio-genetic emissions from natural sources. O_3 at ground level can also be transported hundreds of miles under certain wind regimes. As a result, long-range transport of air pollutants affects the air quality of the windward regions of the current formation area.

Other effects include increased hospital stays associated with difficulty breathing, chest pain, shortness of breath, sore throat and cough. O_3 can reduce the ability of the immune system to fight bacterial infections in the respiratory system. Long-term exposure to O_3 can result in permanent lung damage. O_3 also affects vegetation and forest ecosystems, including reducing the yield of agricultural and forest crops, reducing resistance to pests and pathogens, and reducing the survival of tree seedlings.

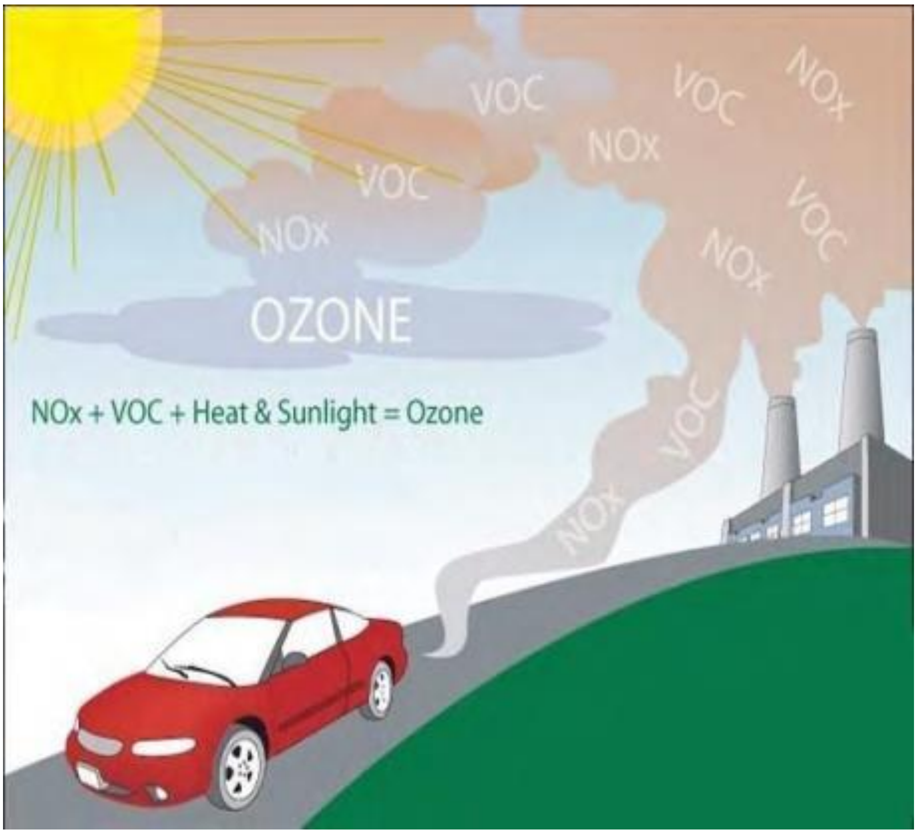

Fig.4. Creation of O_3 (Source: USA EPA)

People at risk: Individuals most susceptible to the effects of O_3 exposure include those with a pre-existing or chronic respiratory illness, children active outside, and adults exercising or working actively outside.

PM_{10} and $PM_{2.5}$

Particulate Matter (PM) is a general term used for a mixture of solid particles and liquid droplets (aerosols) found in the air. These are further categorized by size. PM_{10} consists of particles of size 10 μm and $PM_{2.5}$ as fine particles of 2.5 μm. Fig.5, presents an image is regarding the diameter of a human hair and the ratio to PM10 and PM2.5.

Sources: PM can be emitted directly (primary) or can be formed in the atmosphere (secondary). The vast majority of human-made particle emissions are classified as total suspended particles. Airborne PM_{10} may originate from power plants, other manufacturing industries, fossil fuels by households, transportation, agricultural activities, waste, sources of escaped dust (road dust and wind-blown soil), forest fires, etc. $PM_{2.5}$ may come directly from primary particulate emissions or through secondary reactions, including VOC, SO_2 and NO_X emissions originating from power plants, motor vehicles (especially diesel trucks and buses), industrial facilities and other types of combustion sources.

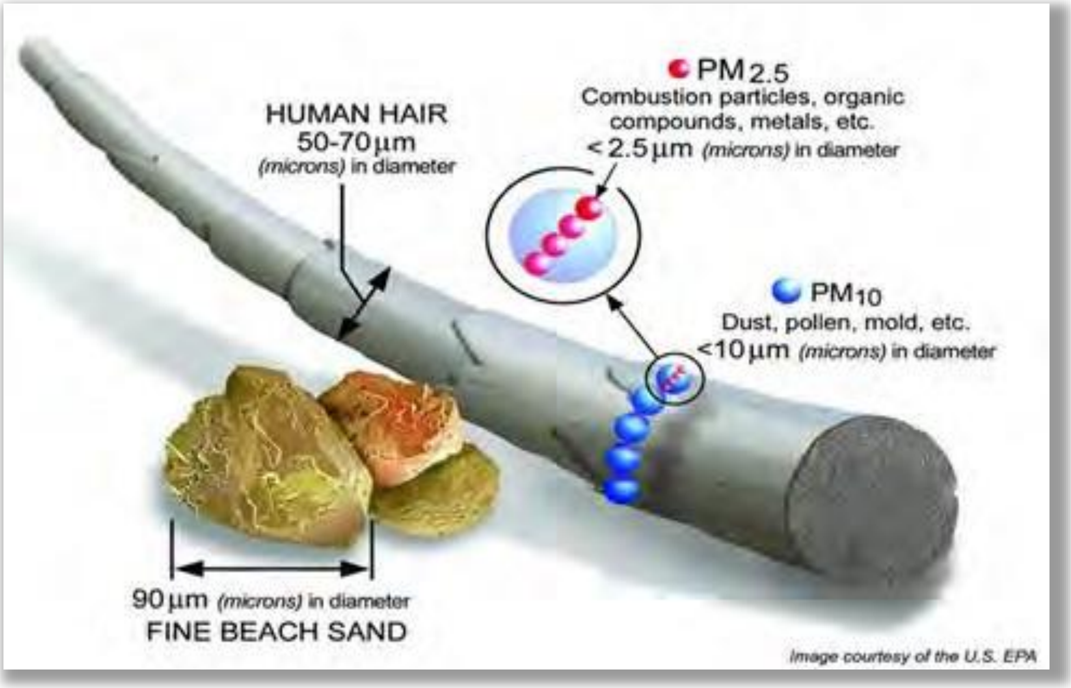

Fig.5. Diameter of PM_{10} and $PM_{2.5}$. in proportion to human hair (Source: USA EPA)

Effects: Exposure to PM can exacerbate existing cardiovascular diseases and may even result in the death of susceptible individuals, affecting respiration and cellular protection of the lungs. $PM_{2.5}$ particles pose the biggest health problems because they can penetrate deep into the lungs. PM affect vegetation ecosystems and damage paints, building materials and facade surfaces.

2. Air quality

2.1. Model-measurements for air quality

Measuring air quality data, regardless of accuracy, can only provide information at the location of a particular air quality monitoring station. In order to provide accurate air quality assessments and air quality forecasts for the whole of Kosovo, a mathematical model has been developed whereby the same is used to generate 3-day forecasts available on the Air Quality Portal (AQP). The model utilizes weather forecast and models of air pollution distribution in the atmosphere based on the reduced number of 4 pollutants: PM_{10}, $PM_{2.5}$, nitrogen dioxide (NO_2) and ozone (O_3), see fig. 6.

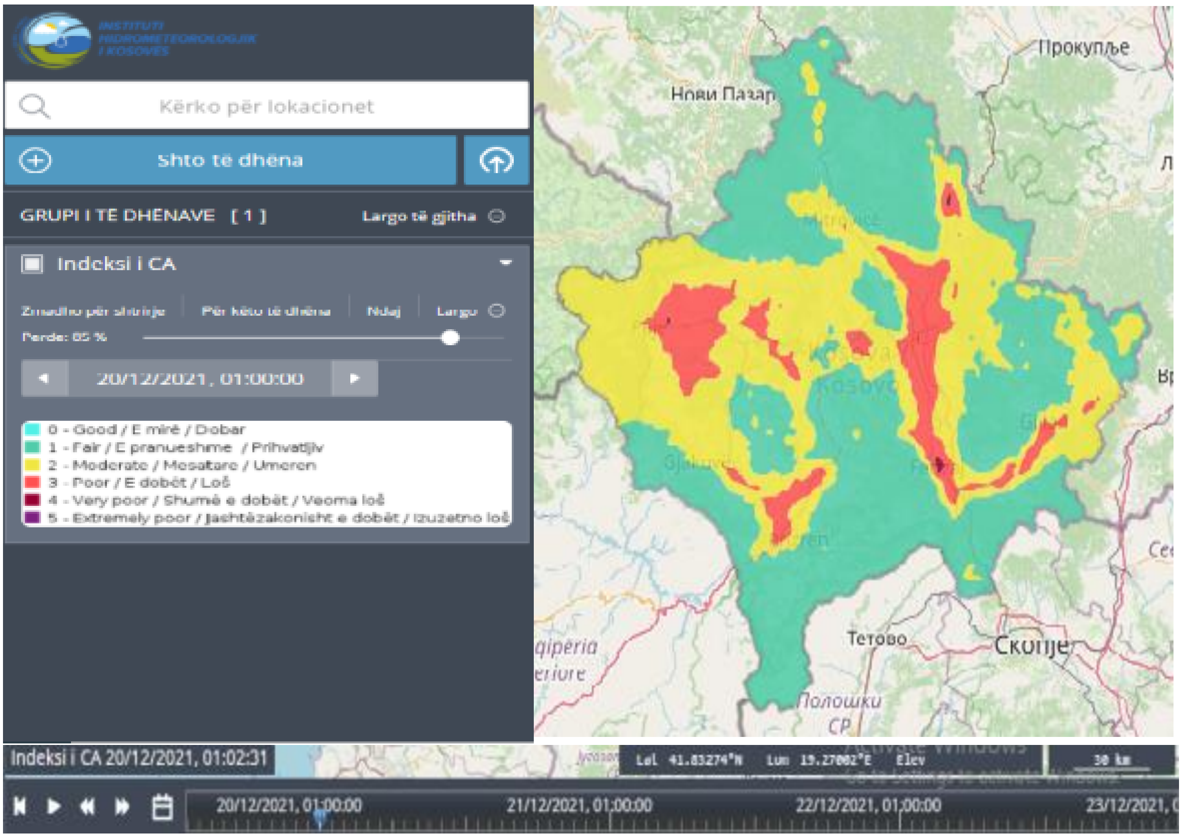

Fig.6. Air quality index and forecast

2.2. Air quality monitoring

Air quality is monitored by 12 monitoring stations separated in Agglomeration AKS1 and ZKS 1 Area, see table 3.

Table 3. Air quality monitoring stations, Agglomeration AKS 1 and ZKS 1 Area

Agglomeration		Name of the monitoring station	Station Sign (Code)	Location	Parameters to be measured	Station type	Date of operation
Agglomeration - AKS 1	1	KHMI	KS0101	Prishtina	PM_{10}, $PM_{2.5}$, SO_2, NO_X, O_3, CO.	Urban background	09.01.2009
	2	Rilindja	KS0102	Yard of the building "Rilindja"	PM_{10}, $PM_{2.5}$, O_3, SO_2, CO, NO_2.	Urban background	06.05.2010
	3	Obiliq	KS0110	FMC	PM_{10}, $PM_{2.5}$, SO_2, NO_X, O_3, CO.	Urban background	01.03.2013
	4	Dardhishte	KS0111	Elementary School “Abdurrahmon Gërguri”	PM_{10}, $PM_{2.5}$, O_3, SO_2, CO, NO_x.	Urban/industrial background	01.03.2013
	5	Palaj	KS0112	Building Kosova Montim	PM_{10}, $PM_{2.5}$, SO_2, NO_X, O_3, CO.	Urban/industrial background	01.03.2013
AREA – ZKS 1	6	Peja	KS0305	Elementary School “Lidhja e Prizrenit”	$PM_{2.5}$, PM_{10}, NOx, O_3, SO_2, CO.	Urban background	04.04.2012
	7	Prizren	KS0406	Elementary School “Abdyl Frashëri”	$PM_{2.5}$, PM_{10}, NOx, O3, SO2, CO.	Urban background	01.04.2012
	8	Hani i Elezit	KS0508	Elementary School “Ilaz Hallaqi”	$PM_{2.5}$, PM_{10}, NOx, O_3, SO_2, CO.	Sfondi urban /industrial	05.04.2012
	9	Gjilan	KS0609	Elementary School “Selami Hallaqi”	$PM_{2.5}$, PM_{10}, NOx, O_3, SO_2, CO.	Urban background	01.04.2012
	10	Drenas	KS0103	Address str. “Beqir Sinan”	$PM_{2.5}$, PM_{10}, NOx, O_3, SO_2, CO.	Urban background	05.04.2011
	11	Mitrovica	KS0204	Elementary School “Eqrem Qabej”	$PM_{2.5}$, PM_{10}, NOx, O_3, SO_2, CO	Urban background	06.2013
	12	Brezovica	KS0507	Ski centre	$PM_{2.5}$, PM_{10}, NOx, O_3, SO_2, CO.	Rural	

In the continuation of this report we present some photographic images that show the state of air in some cities of the Republic of Kosovo.

Photo 1. *Prishtina in the days when the level of pollutants is below the permitted values (Photo taken in September 2021, former Rilindja building, M. Kozhani).*

- PM 10 - 24.05 µg/m^3
- PM 2.5- 11.84 µg/m^3
- NO_2 - 21.23 µg/m^3
- O_3 - 86.93 µg/m^3
- SO_2 - 5.96 µg/m^3
- CO - 2.06 mg/m^3

Photo 2. *Prishtina in the days when the level of pollutants is below the permitted values (Photo taken in September 2021, former Rilindja building, M.Kozhani).*

Photo 3. *Hani i Elezit in the days when the level of pollutants is within the permitted values (Photo taken in November 2021, Hani Elezit, M.Kozhani)*

Reference of Hani i Elezit Station

- PM10 -30.3 µg/m^3
- PM2.5 -23.2 µg/m^3
- NO_2 - 21.23 µg/m^3
- O_3 - 30.9 µg/m^3
- SO_2 - 2.7 µg/m^3
- CO - 0.3 mg/m^3

Photo 4. *Istog in the days when the level of pollutants is within the permitted values (Photo taken in November 2021, Istog M.Kozhani)*

Reference of Peja Station as a Region

- PM10 - 45.4 µg/m^3
- PM2.5 - 32.3 µg/m^3
- NO_2 - 27.4 µg/m^3
- O_3 - 27.5 µg/m^3
- SO_2 - 7.4 µg/m^3
- CO - 1 mg/m^3

2.3 . Air quality online access system

Kosovo Environmental Protection Agency has an online air quality monitoring system monitored by the Kosovo Hydrometeorological Institute, see photo 5.

Real-time air quality data system can be accessed by clicking directly on the data system link on the website of the Kosovo Hydrometeorological Institute;

- http://ihmk-rks.net/?page=1,21, or even through the link:
- https://airqualitykosova.rks-gov.net/

The Kosovo Environmental Protection Agency continues to provide information and reporting on air quality through monthly reports and periodic annual assessments, as well as through additional information for the public in cases of exceeding the information thresholds or alarm thresholds for certain parameters as defined by law.

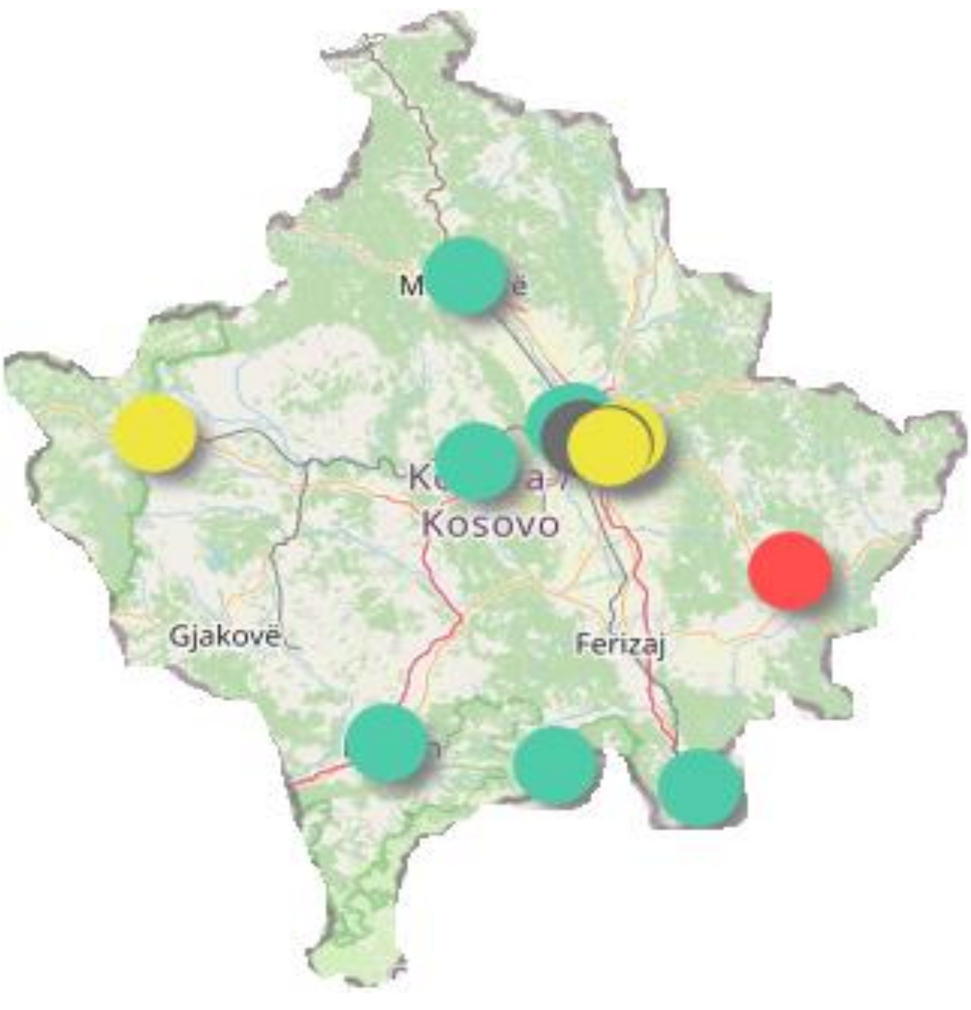

Photo.5. *Locations of air quality monitoring stations*

2.4 Air quality in the agglomeration AKS1 (Prishtina Area)

The agglomeration includes the territory monitored for air quality, in the following centres: KHMI (Prishtina), Rilindje (Prishtina), Palaj, Obiliq, Dardhishte (Obiliq). In this area the air quality is monitored with these parameters; PM_{10}, $PM_{2.5}$, O_3, NO_2, SO_2 and CO.

PM_{10}

Table 4 presents the average monthly values of PM_{10} for 2021, where it is estimated that there were exceedances of the limit value according to the standard 50 µg / m^3 in monitoring stations:

- KHMI / Prishtina, during the month of February;
- Rilindje / Prishtina, during the month of February.

The average annual values for the pollutant emission of PM_{10}, were below the allowed values according to the standard which is 40 µg / m^3. In the Rilindja station this average is recorded as the highest 33.4 µg / m^3, compared to other stations (Fig.7).

Table 4. Monthly average values of PM_{10} in AKS1 Agglomeration, 2021

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.2021
KHMI	30.1	51.5	32.7	24.4	18.9	24.3	22.5	21.4	21.5	25.6	34.1	24.6	27.63
Rilindje	38.7	54.6	40.4	30.3	24	29.3	28.8	24.7	23.4	30.2	39.7	36.7	33.4
Palaj	14.5	24	16.3	10.1	7.6	9.8	7.2	14.9	17.4	18.3	25.2	15.4	15.05
Obiliq	26.3	39.4	27.2	19	13.5	17.1	16.6	15	14.7	21	31.3	25.8	22.24
Dardhishte	22.7	40.6	27.7	17.4	10.7	17.7	18.5	19.7	22.2	19.4	33.9	22.7	22.76

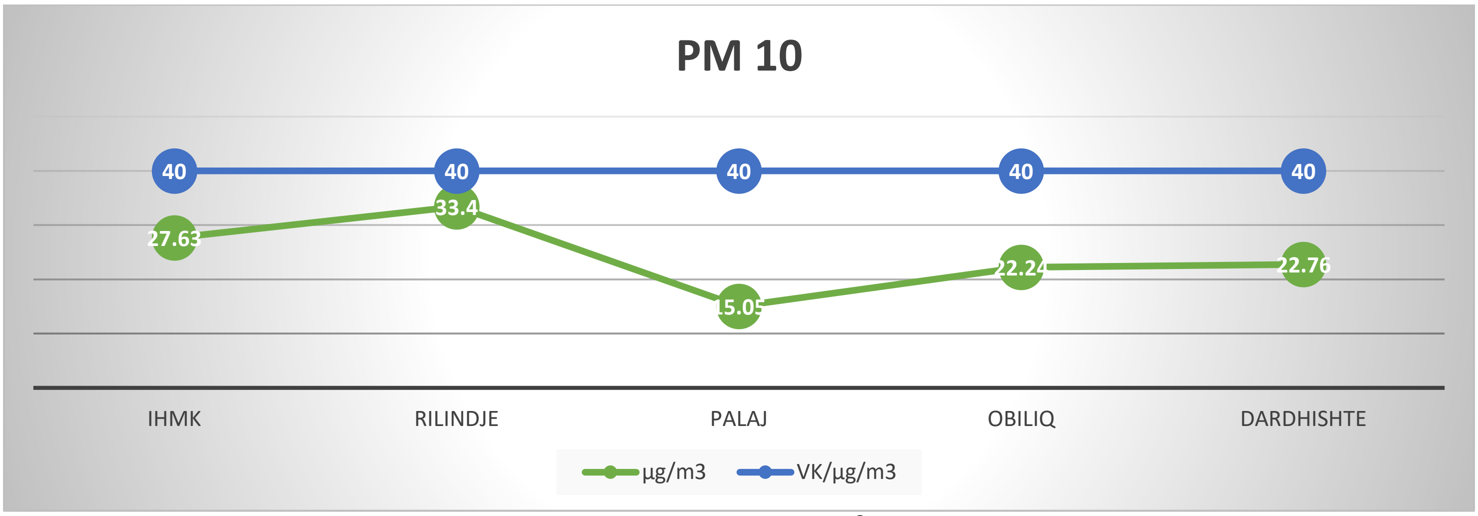

Fig. 7. Annual limit values of PM_{10} µg / m^3 in AKS1 for the year 2021

$PM_{2.5}$

Table 5 indicates the values in the monthly average of $PM_{2.5}$ where it is assessed that there are exceedances of the limit values of 25 µg / m^3, in monitoring stations such as:

- KHMI / Prishtina, in January, February and November;
- Rilindje / Prishtina, in January, February and March, November and December;
- Obiliq, in February;
- Dardhishtë, in February and December.

The average annual values for the parameter $PM_{2.5}$, were below the permitted values according to the standard which is 25 µg / m^3. At the Rilindja station, this average was recorded as the highest 21.8 µg / m^3, compared to other stations (Fig.8).

Table 5. Average monthly values of $PM_{2.5}$ in AKS1 Agglomeration during 2021

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.2021
KHMI	25.7	38.3	24	16.1	9.1	14	13.6	11.4	11.3	18.2	27.9	18.9	19.04
Rilindje	30.8	37.2	27.5	17.6	9.6	14.3	14.4	24.7	12.3	20.4	26.2	27.4	21.87
Palaj	12.5	19	12.5	7.2	3.8	6.6	4.9	7.1	9	12.8	16	13.1	10.38
Obiliq	23.6	32.2	21.1	12.8	6.2	9.2	9	7.6	8.6	15.7	21.2	21.7	15.74
Dardhishte	20.6	34.3	21.5	12.4	5.8	9.6	9.2	8.8	10.1	14.2	24.3	19.8	15.88

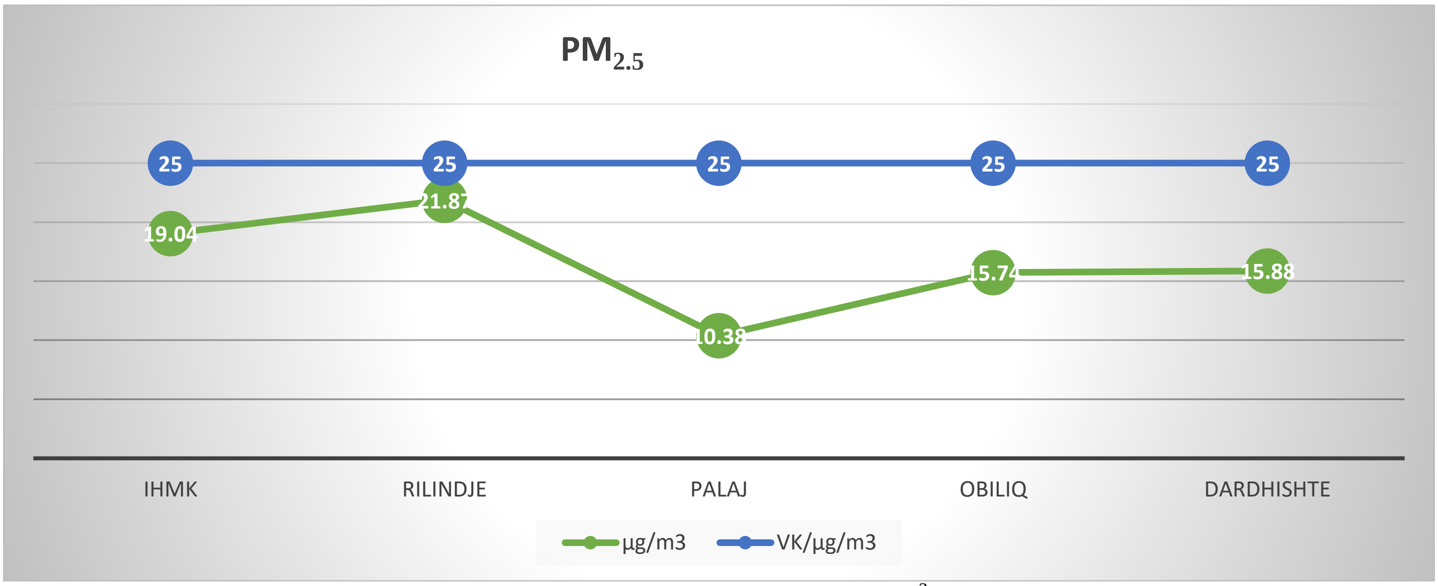

Fig.8. Annual limit values of PM 2.5 µg / m^3 in AKS1 for 2021

Ozone (O_3)

Table 6 presents the values in the monthly average for O_3, where it is assessed that there were no exceedances of the limit values during 2021.

The average annual values for the O_3 parameter were below the permitted values according to the standard which is 120 µg / m^3. This value is recorded as higher in Palaj station with 49.76 µg / m^3 compared to other stations (Fig.9).

Table 6. Average monthly values of Ozone in AKS1 Agglomeration during 2021

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.2021
KHMI	36.2	37.2	53.6	58.8	65.2	50.1	49.4	44.2	34.5	29.1	18.7	19.4	41.37
Rilindje	37.8	32.7	49	57.1	63	54.9	58.6	65.7	57.9	34	26.8	28.6	47.18
Palaj	43.7	42.4	48.4	51.2	57.4	54.5	56.6	73	59.2	39.8	34.3	36.6	49.76
Obiliq	43.3	46.1	60.5	66.1	36.8	65.1	71.5	56.8	15	11.6	12.6	17.1	41.88
Dardhishte	20.6	18	24.3	30	35.4	38.4	48.4	45.9	20.9	21.3	27.3	25.8	29.69

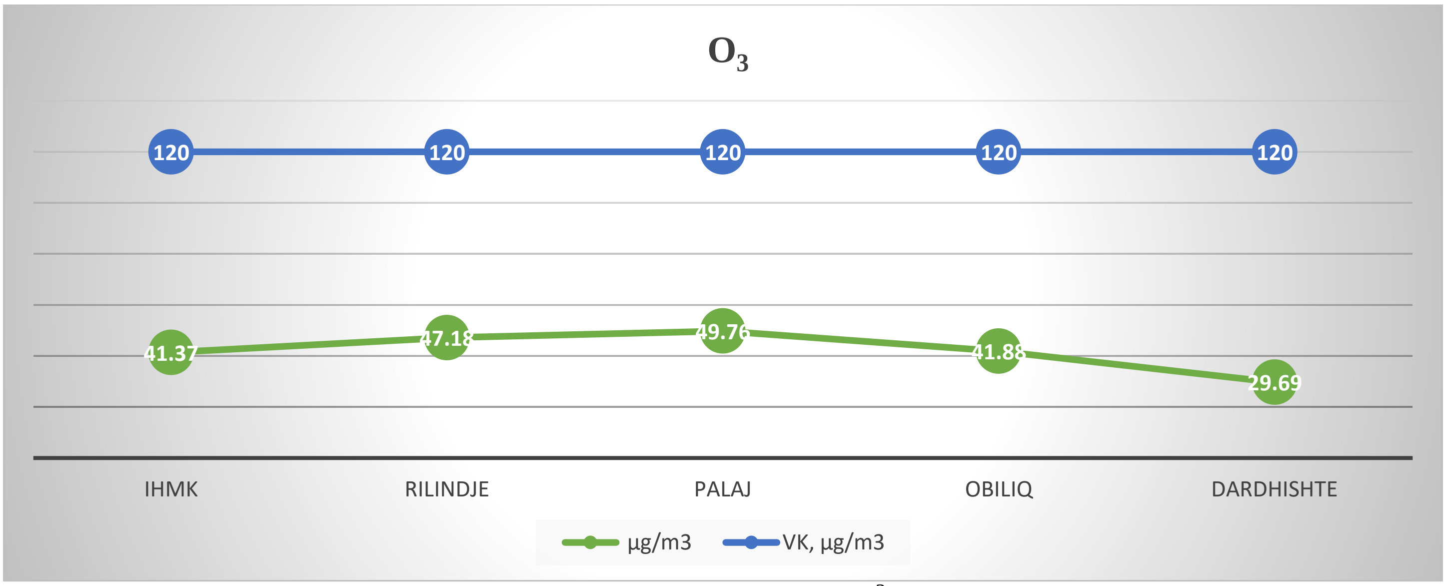

Fig.9. Average annual values of O_3 µg / m^3 in AKS1 for 2021

Nitrogen Dioxide (NO_2)

Table 7 presents the average values per month for NO_2, where it is assessed that there were no exceedances of the limit values during 2021.
The average annual values for the NO_2 parameter were below the permitted values according to the standard which is 40 µg / m^3. This value is recorded as the highest in Obiliq station with 9.44 µg / m^3 compared to other stations (Fig.10).

Table 7. Average monthly values of NO_2 in AKS1 Agglomeration during 2021

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.2021
KHMI	23.5	29.1	23.3	19.4	15.3	21.6	26.5	24.9	19.9	19.5	20.3	23.6	22.24
Rilindje	16	34.5	32.7	23.8	22.3	24.6	27	24.8	20.7	21	35.8	33.9	26.42
Palaj	10.3	11.1	7.3	5.2	3.9	4.4	5.4	5.4	5.7	6.8	12.8	13.9	7.68
Obiliq	16.3	18.9	14.7	10.8	22.7	9.5	11.5	14.6	23.2	17.8	16.2	21.7	16.49
Dardhishte	10.1	11.1	7.9	6	1.4	1.1	1.1	1.1	1.1	1.1	1.1	1.1	3.68

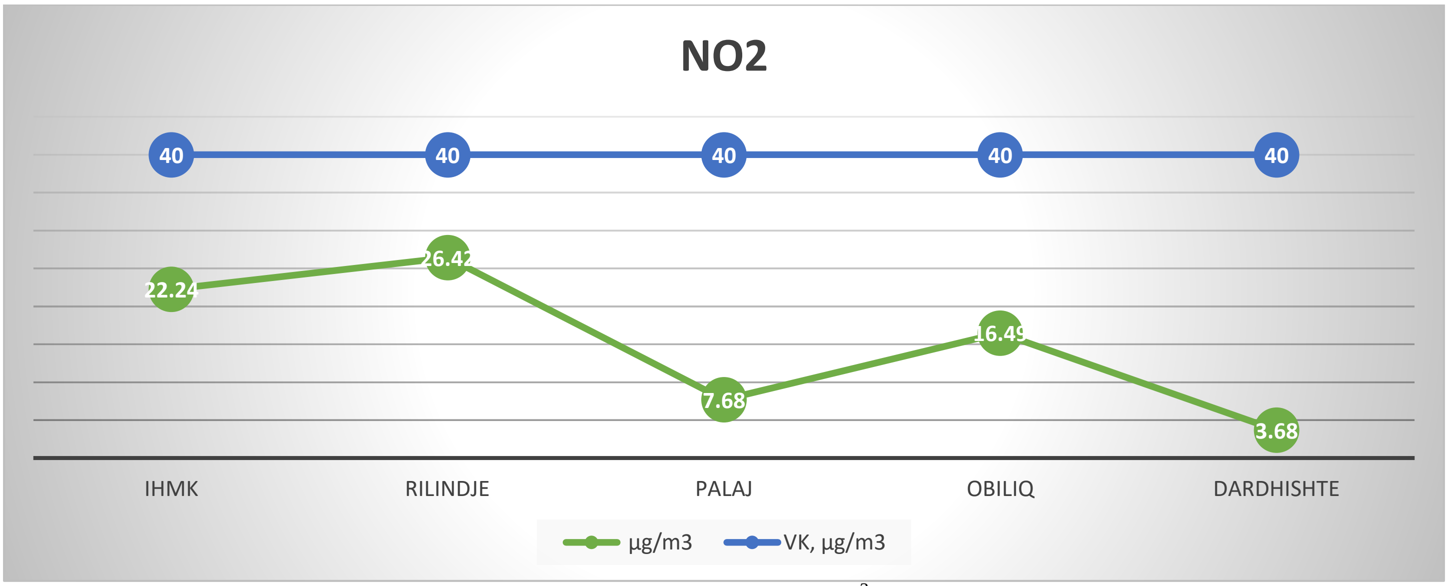

Fig.10. Average annual values of NO_2 µg / m^3 in AKS1 for 2021

Sulphur Dioxide (SO_2)

Table 8 presents the average monthly values for SO_2, where it is assessed that there were no exceedances of limit values during 2021.

The average annual values for the SO_2 parameter were below the permitted values according to the standard - 125 µg / m^3. The highest value was recorded at the Obiliq station with 19.3 µg / m^3 compared to other stations (Fig.11).

Table 8. Monthly averages of SO_2 in Agglomeration AKS1 during 2021

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.2021
KHMI	13.6	11.2	9.1	5.8	9.2	12	18.4	15.4	3.5	2.2	2.8	3.1	8.85
Rilindje	8.8	8.1	5.3	2.7	5.3	4.8	8.6	12.7	7	6.5	10	12.3	7.67
Palaj	11	10.9	4.6	2.6	3.6	5	6.6	9.1	4.8	2	1.6	2	5.31
Obiliq	19.3	17.6	10	7.1	6.2	9.8	13.6	15.5	1.9	1	4	7.3	9.44
Dardhishte	8.4	8.3	8.7	5.3	6.4	7.2	7.6	8.6	1.4	1.5	3.8	5.5	6.05

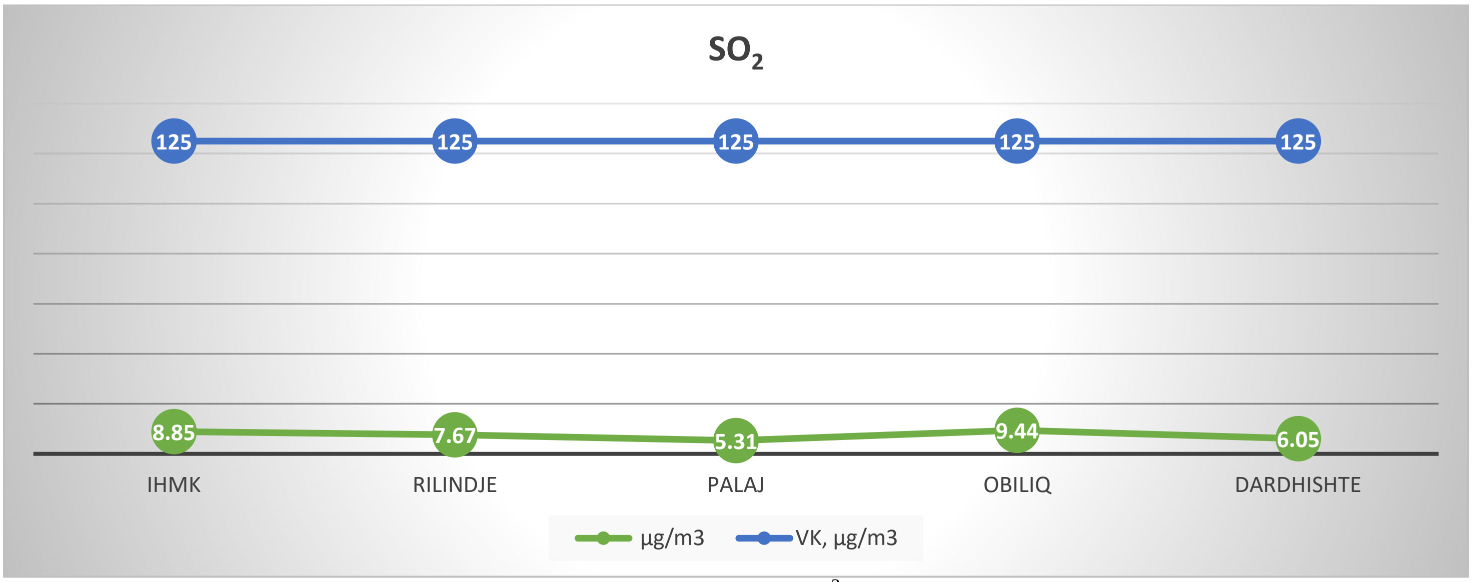

Fig.11. Average annual values of SO_2 µg / m^3 in AKS1 for 2021

Carbon Monoxide (CO)

Table 9 presents the monthly average values for CO, where it is assessed that there were no exceedances of the limit values during 2021.

The average annual values for the CO parameter were below the permitted values according to the standard which is 10 mg / m^3. This value is recorded as the highest in the Rilindja station with 1.84 mg / m^3 compared to other stations (Fig.12).

Table 9. Annual averages of CO in Agglomeration AKS1 during 2021

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.2021
KHMI	1.3	2.6	1.5	1.7	1.8	1.1	1.1	1.8	1.3	1.5	1.9	1.5	1.59
Rilindje	1.6	1.6	1.9	1.7	1.2	1.4	1.1	1.7	1.8	2	2.3	3.8	1.84
Palaj	0.2	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.1	0.1	0.29
Obiliq	1.1	1.3	1	1	0.9	1	1.1	1	0.4	0.7	1.1	1.4	1
Dardhishte	1	1.4	0.9	0.7	1.1	1.1	1.9	1.8	0.5	0.7	1.3	1.1	1.12

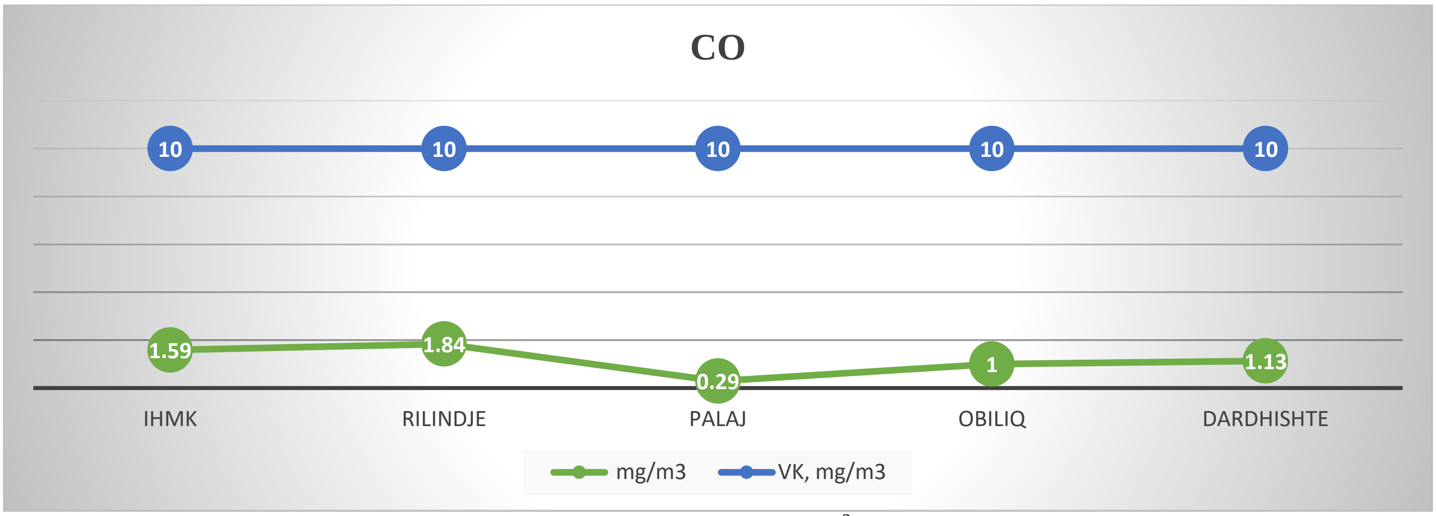

Fig.12. Average annual values of CO mg / m^3 in AKS1 for 2021

Days with PM_{10} exceedances during 2021

From the air quality monitoring stations located in the area of Agglomeration AKS1 144 days with exceedances of the permitted values of PM_{10} in 2021 were recorded. The highest number of days with exceedances of the values of PM_{10} have been recorded in the stations of KHMI, Rilindja, Obiliq and Dardhishte. These exceedances were in the winter/autumn/spring season (Table 10).

Table 10. days with exceedances for the AKS1 Agglomeration area

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	2021
KHMI	4	14	6	0	0	0	0	1	0	4	6	2	37
Rilindje	6	15	10	0	0	5	2	1	0	5	8	7	59
Palaj	2	0	0	0	0	0	0	0	0	0	3	0	5
Obiliq	2	8	4	0	0	0	0	0	0	1	5	1	21
Dardhishtë	2	9	3	0	0	0	0	0	0	2	4	2	22
Total	16	46	23	0	0	5	2	2	0	12	26	12	144

Photo.6. *Air pollution from Power Plants A & B-Obiliq (photo by T. Veselaj, 2021)*

Photo.7. *Air pollution from Power Plants A & B-Obiliq (photo by T. Veselaj, 2021)*

2.5. Air quality in ZKS1 Area

ZKS1 area includes the territory monitored for air quality in the following centres: Drenas, Mitrovica, Peja, Prizren, Hani i Elezit, Gjilan and Brezovica. In ZKS1 Area, the air quality is monitored with the following parameters: PM_{10}, $PM_{2.5}$, O_3, NO_2, SO_2 and CO.

Photo.8. *Air quality in the Dukagjini region (photo by T.Veselaj-2021)*

PM_{10}

Table 11 presents the monthly average values of PM_{10} for 2021, where it is assessed that there were exceedances of the limit value at the monitoring station in Gjilan in February.

The average annual values for PM_{10} were below the permissible values according to the standard which is 40 µg / m^3. The highest value has been recorded in the station in Gjilan with 31.39 µg / m3 and in Peja with 29.12 µg / m^3, compared to other stations (Fig.13).

Table 11. Monthly averages of PM10 in ZKS1 during 2021

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.2021
Drenas	21.6	35	21.3	11.5	10.1	17.5	18.7	15.4	15	16.8	24.2	16.1	18.6
Mitrovicë	33.7	40.6	23.7	19.2	17.9	21.3	23.8	21.3	18.2	26.3	39.9	25.8	25.97
Pejë	42.5	49.7	30.3	16.9	17.1	23.1	23	20.3	18	22.8	45.4	40.3	29.11
Prizren	28.4	32.2	24.9	16.2	12	17.1	15.9	16.7	14.1	21.5	43	27.8	22.48
Brezovicë	3.9	9.3	9.9	6.7	11.5	22	23.5	21.4	14.3	6.2	5.9	3.1	11.47
Hani Elezit	28.4	35.3	27.1	10.6	4.7	5	7.6	3.9	4.7	19.1	30.3	27.3	17
Gjilan	39.9	61.1	32.4	28.7	16.4	23.6	24.2	20.4	16.8	25.9	39.7	47.6	31.39

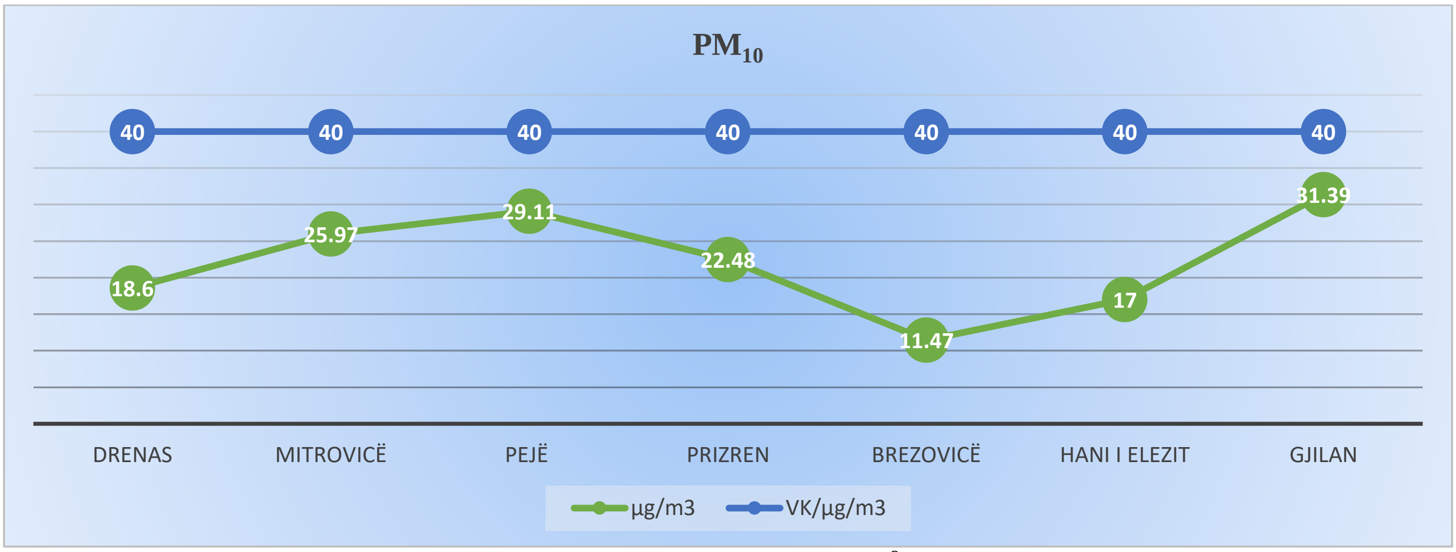

Fig.13. Annual limit values of PM_{10} µg / m^3 in ZKS1 for 2021

$PM_{2.5}$

Table 12 shows the average monthly values of $PM_{2.5}$, where it was assessed that there were exceedances of the limit values in the following air quality monitoring stations:

- Drenas, in February and November;
- Mitrovica, in January, February and November;
- Peja, in January, February, March, November and December;
- Prizren, in November;
- Hani Elezit, in February;
- Gjilan, in the months of January, February, March, November and December.

The average annual values for $PM_{2.5}$ were below the permitted values according to the standard which is 25 µg / m^3. The highest value has been recorded in the station in Gjilan with 23.99 µg / m^3 and in Peja with 21.18 µg / m^3, compared to other stations (fig.14).

Table 12. Monthly average values of $PM_{2.5}$ in ZKS1 during 2021

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.2021
Drenas	20	28.4	17.4	10	5.7	10.1	10.6	8.9	9	14.7	25.9	15.8	14.7
Mitrovicë	30.2	33.8	20.4	15	8.8	11.39	13.9	12.2	11	20	30.6	22.7	19.16
Pejë	39.3	41.4	25.2	14.5	8.1	11.6	11.4	10.4	10.9	17.1	32.3	32	21.18
Prizren	23.7	24.9	19.7	10.7	5.6	8.6	8.6	16.7	8.7	16.7	30.5	22.3	16.39
Brezovicë	2.6	5.9	6.9	5.7	7.2	14.2	16.8	14	10.2	5.1	6.2	1.2	8
Hani i Elezit	23.1	26.2	19.8	8	3.7	4.3	7	3.6	4.3	15.5	23.2	23.6	13.52
Gjilan	36.9	55.3	28	19.9	8.1	12.3	12.9	10.6	10.6	21.4	32	39.9	23.99

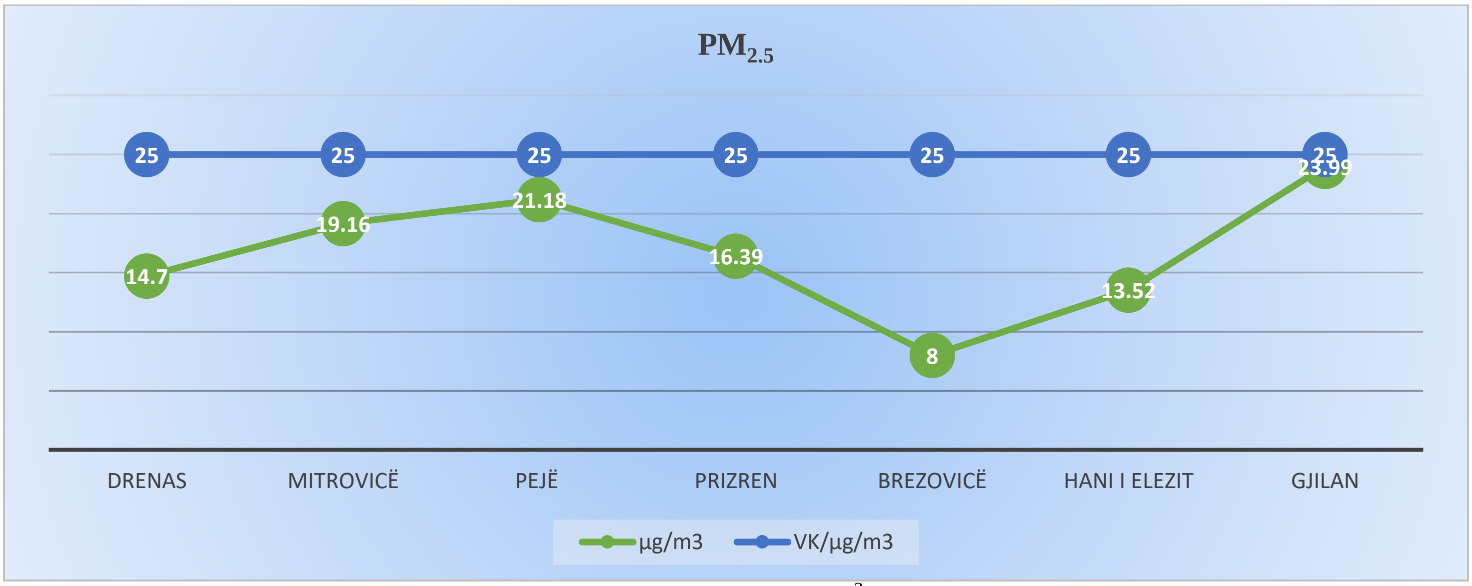

Fig.14. Annual limit values of PM $_{2.5}$ µg / m^3 in ZKS1 for 2021

Ozone (O_3)

Table 13 presents the average monthly values for O_3, where it is assessed that there were no exceedances of the limit values during 2021.

The average annual values for O_3 have been below the permitted values which is 120 µg / m^3. The highest value has been recorded in the station of Brezovica with 73.29 µg / m^3 and in Hani i Elezit with 60.28 µg / m^3, compared to other stations (Fig.15).

Table 13. Average monthly values of Ozone in ZKS1 during 2021

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.2021
Drenas	48.3	49.1	66.7	72.2	81.7	64.6	75.9	72.4	68.1	44.5	33.8	2.6	56.66
Mitrovicë	33	31.8	47.4	44.1	37.9	29.9	31.6	37.5	32.9	23.6	18.7	27.5	32.99
Pejë	37.9	48.3	65.4	70.7	77.9	73.9	86.1	84.8	73.1	44	27.5	33.3	60.24
Prizren	42.8	51.1	59.6	70.4	80.2	79.3	85.3	82.7	68.4	34.7	25.3	38.7	59.88
Brezovicë	39.9	76.7	83.1	86.5	26.4	87.6	94.5	96.8	85.3	70.7	65.5	66.5	73.29
Hani i Elezit	40.5	48.4	64.8	64.9	68.4	77.5	84.4	88.9	74.6	40.6	30.9	39.5	60.28
Gjilan	37.6	35.6	48	61.1	72.3	64	74.5	79.1	64.7	40.7	33.6	31.6	53.57

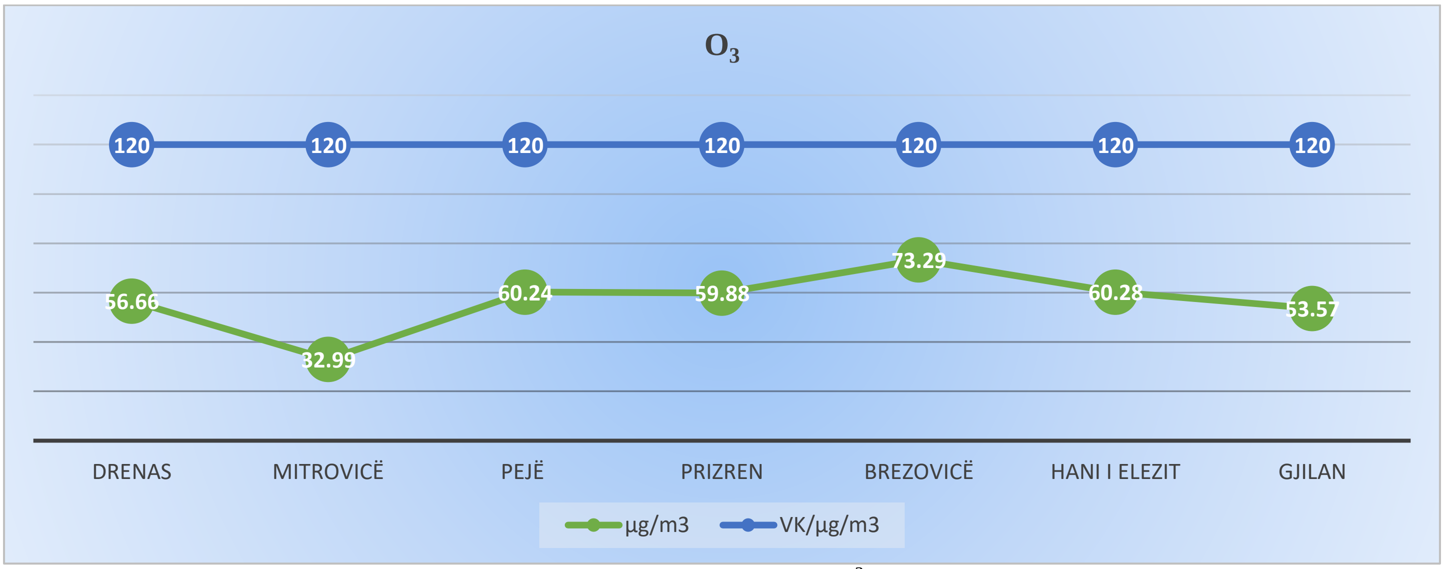

Fig.15. Annual limit values of O_3 µg / m^3 in ZKS1 for 2021

Nitrogen Dioxide (NO_2)

Table 14 presents the average monthly values for NO_2, where it is assessed that there were no exceedances of the limit values during 2021.

The average annual values for NO_2 were below the allowed values, which is 40 µg / m^3. The highest value has been recorded in the station in Gjilan with 22.53 µg / m^3 and in Prizren with 19.08 µg / m^3, compared to other stations (Fig.16).

Table 14. monthly average values of NO_2 in ZKS1 during 2021

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.2021
Drenas	20.3	34.7	13.5	10.2	7.5	9.7	12	12.9	10.2	14.2	23	15.2	15.28
Mitrovicë	16.8	19.7	13.1	12.1	10.9	11.4	13.1	13.8	13.1	13.3	17.8	15.2	14.19
Pejë	24.8	27.3	19	13.2	8.8	10.7	11.2	13.5	12.9	16.9	27.4	26	17.64
Prizren	24.1	24.6	22.5	15.7	10.7	11.2	12.5	18.7	15.6	19.5	30.2	23.7	19.08
Brezovicë	1.1	1.3	2.5	2.5	2	1.8	1.6	1.9	9.1	13	8.6	9.4	4.56
Hani i Elezit	18.8	19.4	15.5	16.2	13.2	12.5	15.4	14	14.9	17	20.3	18.3	16.29
Gjilan	29.1	40.5	29.9	18.6	12.3	14.8	17.7	18.2	17.2	20.5	24.6	26.9	22.52

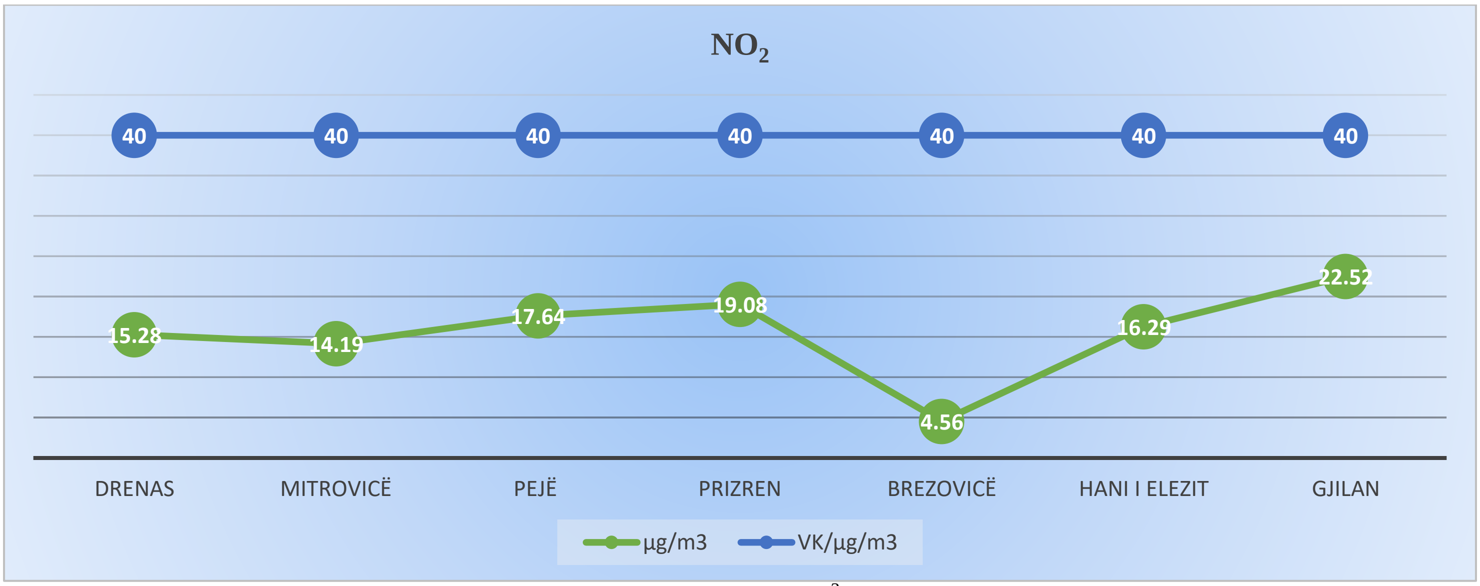

Fig.16. Annual limit values of NO_2 µg / m^3 in ZKS1 for 2021

Sulphur Dioxide (SO_2)

Table 15 shows the average monthly values for SO_2. According to estimates, it is concluded that for this parameter there were no exceedances of the limit values during 2021.

The average annual values for SO_2 have been below the allowed values which is 125 µg / m^3. The highest value has been recorded in the station in Mitrovica station with 19.88 µg / m^3 and in Hani i Elezit with 8.53 µg / m^3, compared to other stations (fig.17).

Table 15. average annual values of SO_2 in ZKS1 during 2021

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	AVg.2021
Drenas	4.5	7.1	5.5	3.6	3.6	4.6	5.6	6.8	7	6.3	8.5	5.5	5.71
Mitrovicë	19.9	18.5	18.4	23.3	29.8	20.1	14	19.9	23.5	18.1	19.3	13.7	19.87
Pejë	1.7	1.5	1.4	1.8	2.2	2.7	3.8	4.9	5.9	5.9	7.4	8.4	3.96
Prizren	5.5	5.1	5.4	4.8	5.5	6.7	5.9	8.4	8.8	4.3	8.7	10.5	6.63
Brezovicë	3.2	2.6	2.6	2	2.9	3.1	2.1	1.9	1.5	2.3	3.1	4.2	2.62
Hani i Elezit	9.6	10.2	6.6	7.2	9.6	10.3	12.7	12	3.5	1.9	2.7	16	8.52
Gjilan	12.5	13.9	6	1.6	0.9	1	0.8	1.1	1.4	1.4	2.1	2.6	3.77

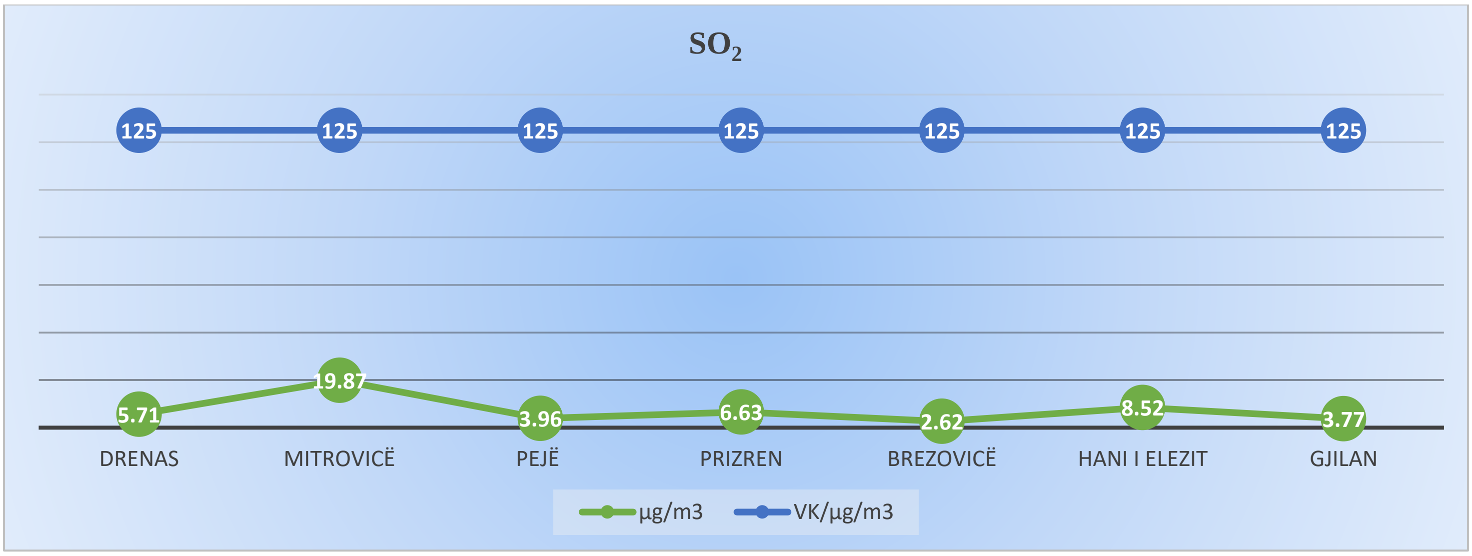

Fig.17. Annual limit values of SO_2 µg / m^3 in ZKS1 for 2021

Carbon Monoxide (CO)

Table 16 shows the average monthly values for NO_2. According to estimates, it is concluded that for this parameter there were no exceedances of the limit values during 2021.

The average annual values for the CO parameter were below the allowed values which is 10 mg / m^3. The highest value has been recorded in the station in Peja with 0.70 mg / m^3 compared to other stations (fig.18).

Table 16. Monthly average values of CO in ZKS1 during 2021

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.2021
Drenas	0.8	0.9	0.5	0.4	0.2	0.2	0.4	0.4	0.5	0.6	0.9	0.9	0.56
Mitrovicë	0.7	0.8	0.4	0.2	0.2	0.2	0.3	0.6	0.2	0.2	0.2	0.3	0.36
Pejë	1.1	1.1	0.7	0.6	0.6	0.6	0.6	0.5	0.1	0.4	1	1.1	0.7
Prizren	0.7	0.6	0.6	0.4	0.3	0.2	0.2	0.2	0.3	0.5	1	0.9	0.49
Brezovicë	0.6	0.7	1	0.5	0.7	0.6	0.7	0.7	0.4	0.5	0.7	1	0.68
Hani i Elezit	0.5	0.7	0.6	0.5	0.3	0.3	0.1	0.1	0.1	0.3	0.3	0.5	0.36
Gjilan	1.1	1.5	0.8	0.4	0.1	0.2	0.1	0.2	0.2	0.4	0.7	1.3	0.58

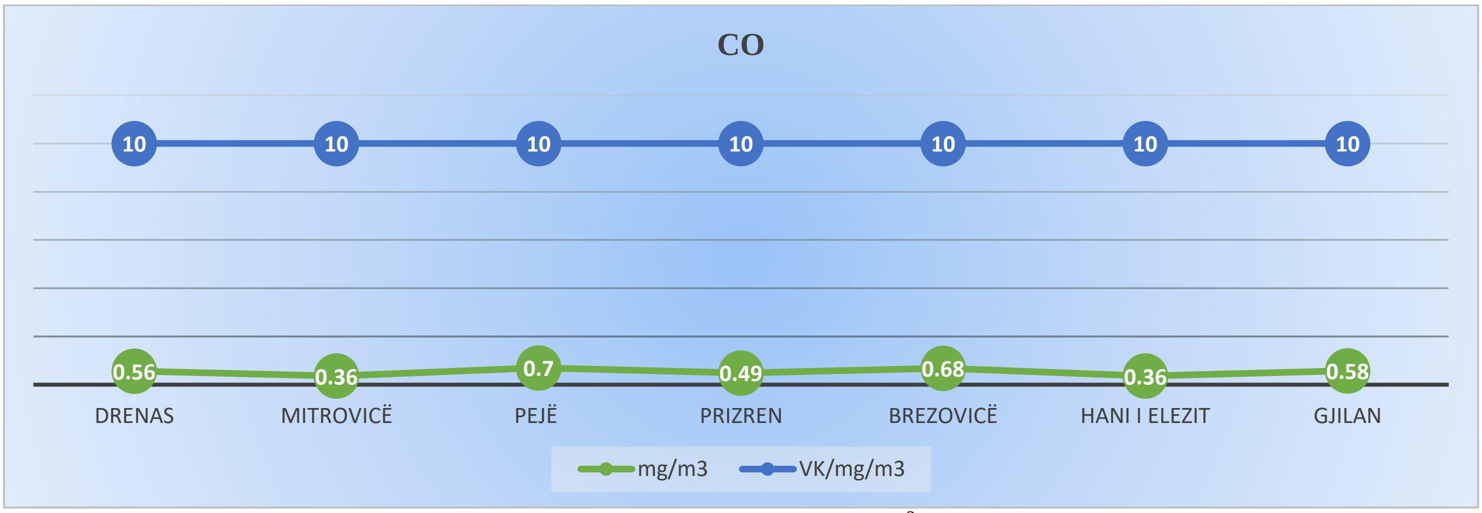

Fig.18. Annual limit values of CO mg / m^3 in ZKS1 for 2021

Days with exceedances for PM_{10} during 2021

A total of 155 days were registered in ZKS1 Zone with exceedances above the allowed values of PM_{10}. The highest number of days with exceedances of values with PM_{10} were recorded in Peja and Prizren. These exceedances were recorded during January, February, November and December (tab. 17).

Table 17 - Number of days with exceedances for PM_{10} during 2021

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	2021
Drenas	2	8	1	0	0	0	0	0	0	0	2	0	13
Mitrovicë	3	8	0	0	0	0	0	0	0	0	8	1	20
Pejë	8	13	2	0	0	1	0	1	0	0	9	7	41
Prizren	5	7	0	0	0	0	0	1	0	3	11	4	31
Brezovicë	0	0	0	0	0	1	0	0	0	0	0	0	1
Hani i Elezit	4	2	3	0	0	0	0	0	0	0	0	3	12
Gjilan	3	17	4	0	0	0	0	0	0	1	3	9	37
Total	25	55	10	0	0	2	0	2	0	4	33	24	155

2.6. Air quality trend 2013-2021

Figure 19 presents the air quality trend for PM_{10} from 2013-2021. Based on this trend, we find that progress has been made in terms of the improvement of air quality over the years.
2021 is the best year compared to previous years and there is a very satisfactory network coverage for air quality monitoring.

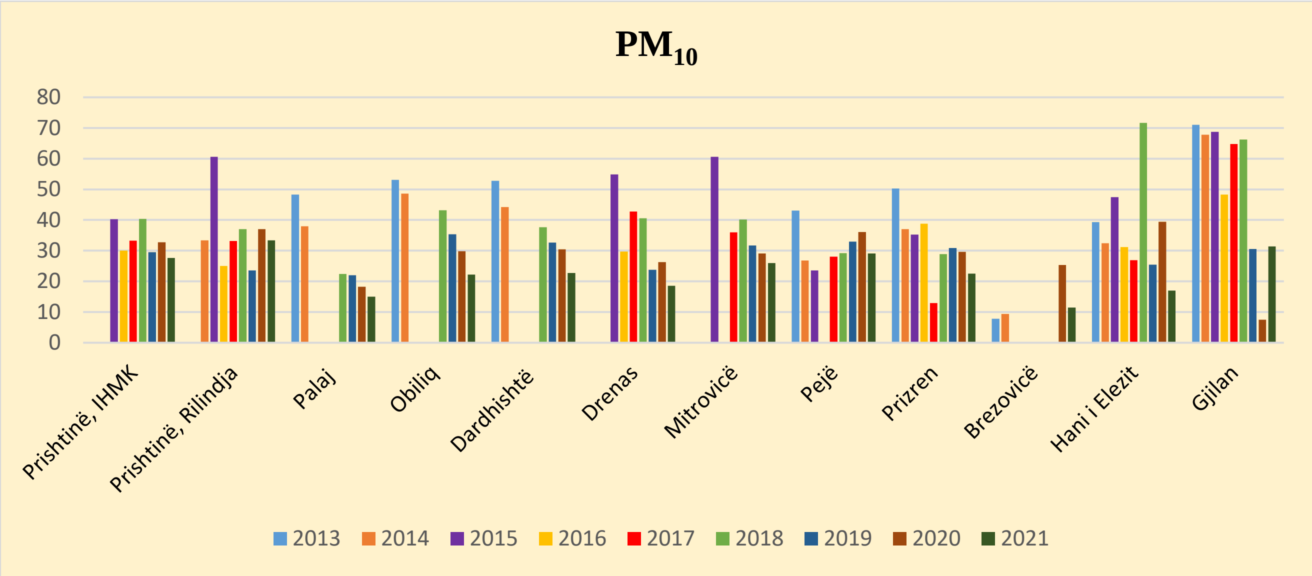

Figure 19: trends of PM_{10} 2013-2021

Figure 20 shows the air quality trend with $PM_{2.5}$ from 2013-2021. Based on this trend, we find that air quality for this parameter has improved over the years. In 2021 we have a trend of decreasing concentration of this parameter and air quality is better compared to previous years

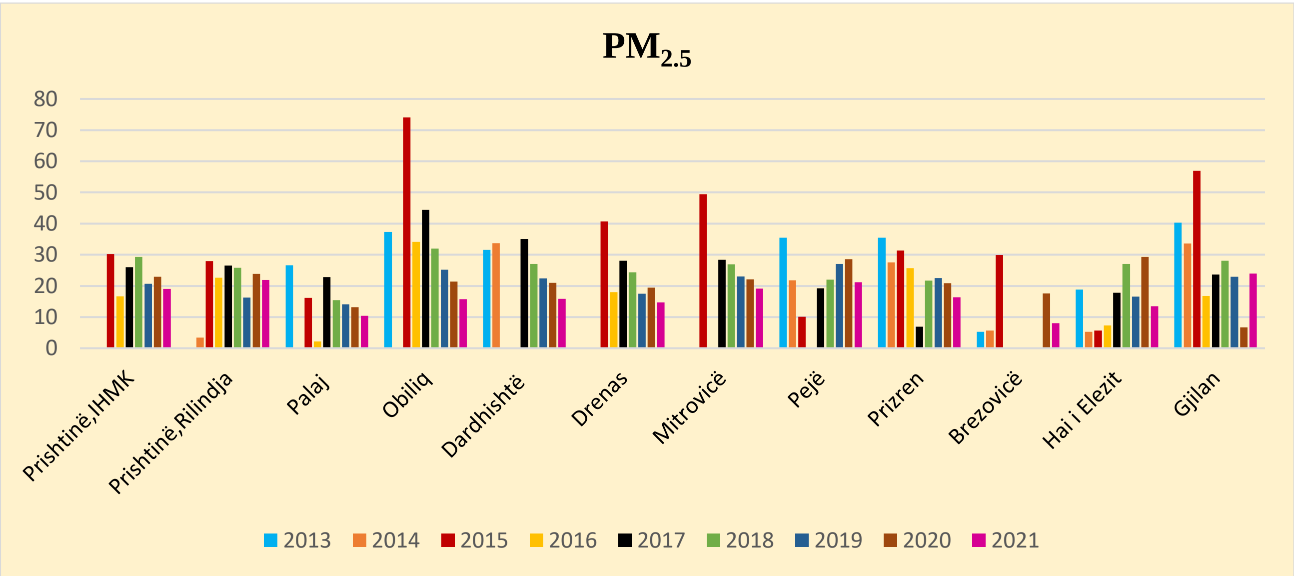

Figure 20: trend of $PM_{2.5}$ 2013-2021

Figure 21 presents the air quality trend for SO_2 from 2013-2021. Based on this trend, we find that air quality for this parameter has improved over the years. During 2021, the parameter of SO_2, as an air pollutant has had a lower level compared to the permitted standard.

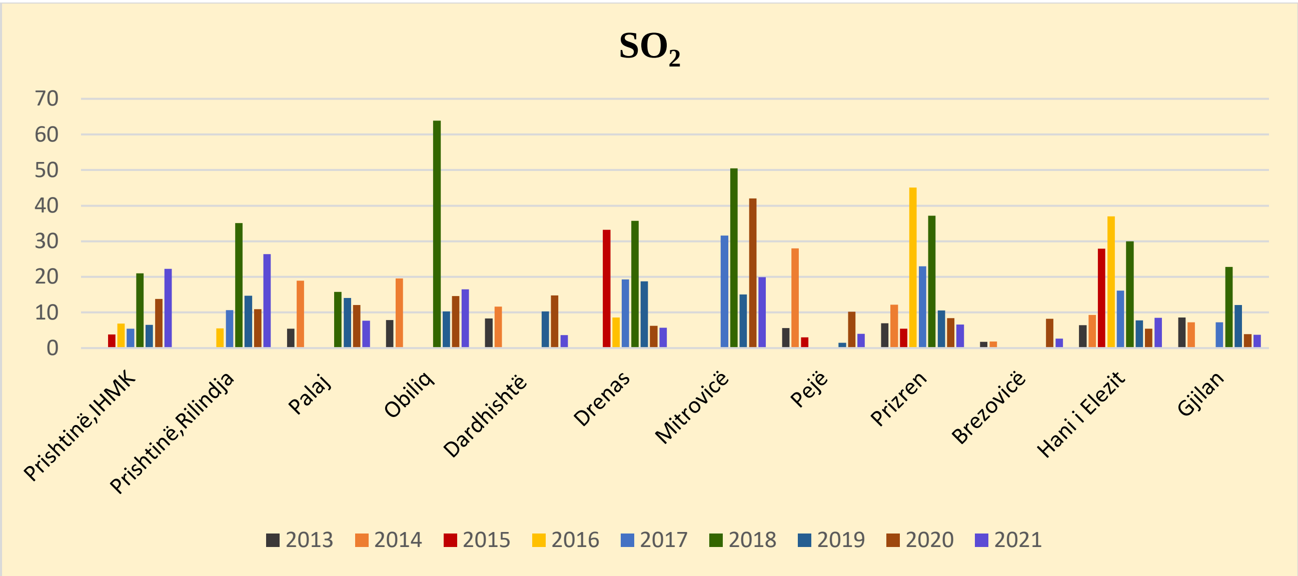

Figure 21: trend of SO_2 2013-2021

Figure 22 presents the air quality trend from 2013-2021 for NO_2. Based on estimates over the years, the trend for this polluting parameter shows that there is an improvement in the situation. In 2021, NO_2 is below the standard values permitted for this parameter.

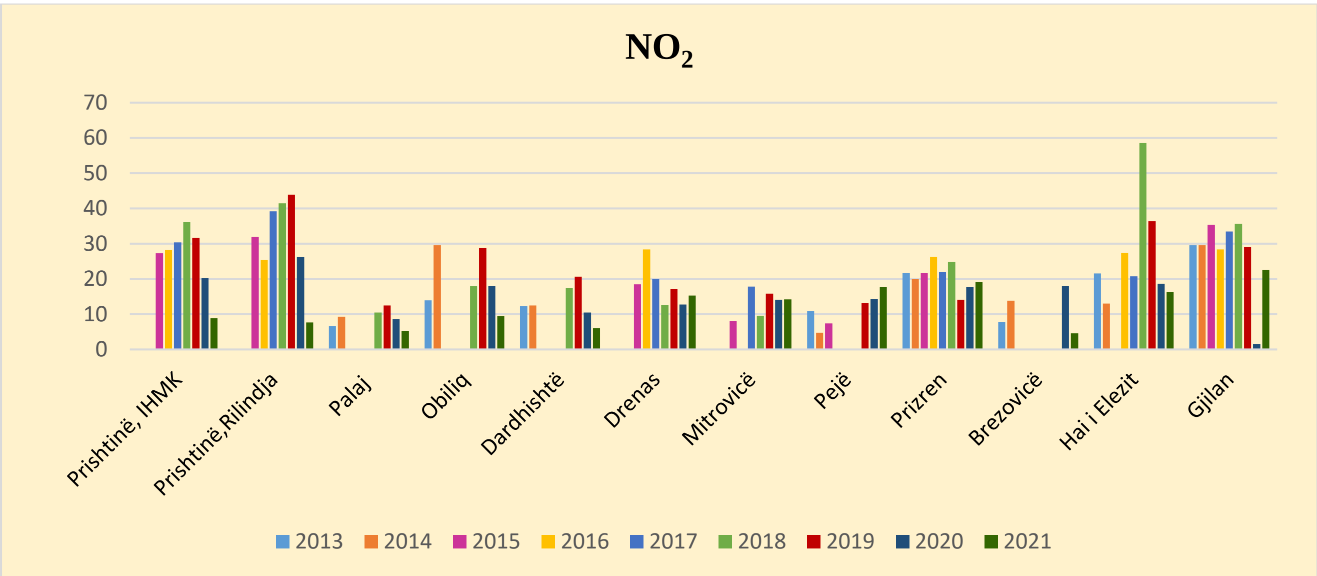

Figure 22: trend of NO_2 2013-2021

Figure 23 presents the air quality trend for O_3 from 2013-2021. Based on this trend we find that ozone has been at a higher average compared to previous years. 2017 was a year with a lower annual average and cannot be justified with better monitoring coverage in 2021 compared to other years.

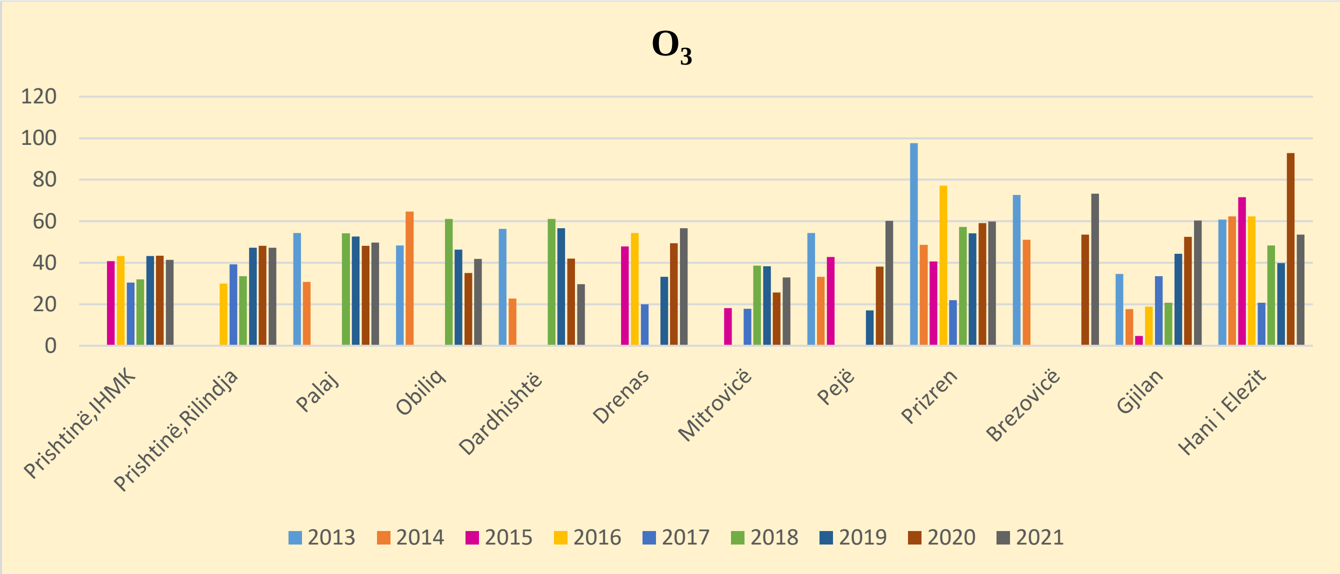

Figure 23: trend of O_3 2013-2021

Figure 24 presents the air quality trend for CO from 2013-2021. Based on the trend, it is concluded that air quality has marked progress in terms of this polluting parameter.

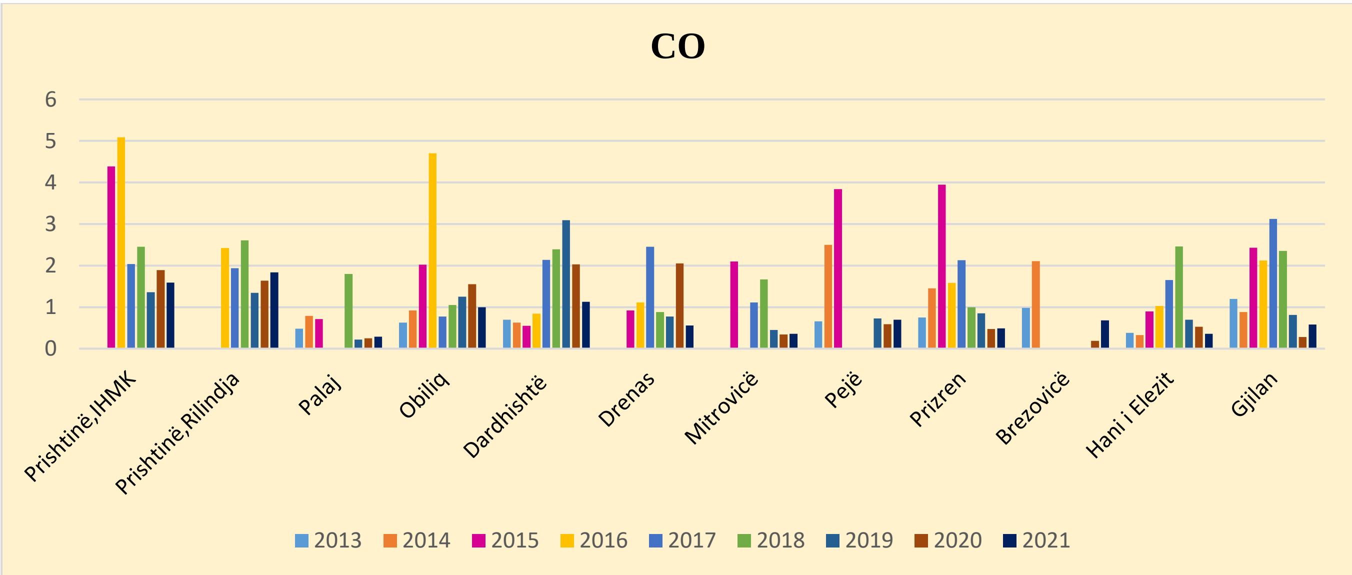

Figure 24: trend of CO 2013-2021

Figure 25 presents the comparison of days with exceedances for the years 2020 and 2021 for AKS 1 and ZKS1. The figure shows that in 2021 a smaller number of days with exceedances was recorded.

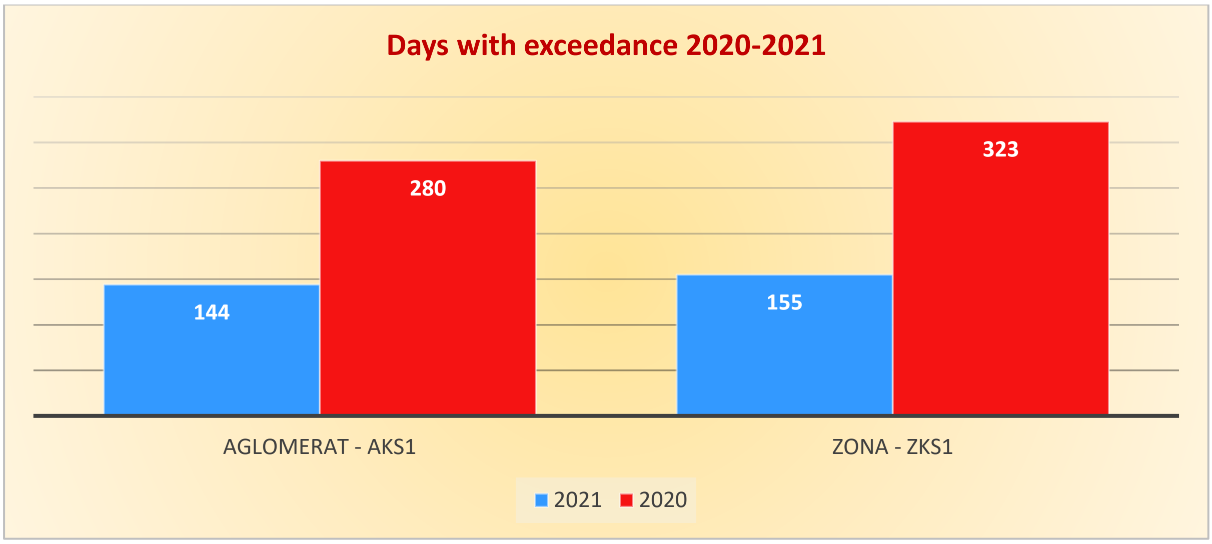

Fig.25: number of days with exceedances for PM_{10}, 2020-2021.

2.5 Photo.9. *View from Prishtina in the winter season (photo by T. Veselaj, 2021)*

2.7. **Air pollutants: Benzene, Toluene, Ethylbenzene and Xylene (BTEX)**

Monitoring of BTEX in Kosovo is not carried out by the responsible Institutions. A BTEX monitoring has been carried out under contract No: RFP/MFK/2019/QCBS/No. 006, titled "Monitoring BTEX in Kosovo", and conducted by NIRAS. As part of the MCC/MFK funded project "Supply of project management, air quality information management, behaviour change and communication services", it was operated with the BTEX monitoring network to assess the levels of benzene and other light aromatic hydrocarbons in the environment. Monitoring activities covered most of the country during the period January 2020 to July 2021, thus enabling the analysis and reporting to be completed by the end of the project in September 2021.

From the group of light aromatic compounds that are commonly monitored and are called BTEX (benzene, toluene, ethylbenzene and xylene), benzene is the lightest of them all. This group of xylene includes ortho, meta- and para-xylene, the latter two of which have been summarized due to analytical limitations. Although other components of the BTEX group are less harmful than benzene, knowledge of the levels of these aromatic compounds provides additional information for confirmation purposes as well as for the start of source separation, which can also be found in the published report of September 2021[1]

Results for BTEX[1]

Table 18. shows the benzene concentration values that vary for low values ranging from 1.4-1.6 µg/m3, with medium values of 1.8-2.2 µg/m^3 and high values ranging from 2.4-3.3 µg/m^3. For Toluene and mp-Xylene, these values are more or less similar.

Table 18. Concentration of BTEX for each city (average over 2-6 locations) in µg/m^3 units

Municipalities	Benzene	Toluene	Ethylbenzene	mp-Xylem	Oxylenes
Fushe Kosova	2.7	3.1	0.6	2.2	**0.7**
Drenas	1.4	0.9	0.2	0.6	**0.2**
Gjilan	3.3	2.4	0.5	1.7	**0.5**
Hani i Elezit	1.4	0.8	0.2	0.5	**0.2**
Ferizaj	2.8	2.5	0.5	1.6	**0.5**
Obiliq	2.0	1.3	0.3	0.9	**0.3**
Peja	2.2	1.6	0.3	1.0	**0.3**
Gjakova	2.2	2.1	0.4	1.3	**0.4**
Prizren	2.2	2.9	0.4	1.6	**0.5**
Suhareka	1.4	1.4	0.2	0.9	**0.3**
Mitrovica	1.8	1.5	0.2	1.1	**0.3**
Vushtrri	2.4	1.9	0.4	1.6	**0.4**
Prishtina	1.9	1.6	0.3	1.1	**0.3**
Prishtina, Gërmia	**0.6**	**0.5**	**0.2**	**0.4**	**0.2**

[1] *BTEX monitoring in Kosovo, NIRAS, 2021(https://www.ammk-rks.net/repository/docs/Raporti_per_monitorimin_e_BTEX_ne_Kosove.pdf).*

BTEX monitoring aimed to assess whether the limit values are in line with Kosovo standards. The limit values for benzene, listed in the instruction, are 5 μg/m^3 as an annual average value (AI and Directive 2008/50, on Air Quality). The value of 1 μg/m^3 was published as the target value.

WHO states that due to the carcinogenicity of benzene as a safe level, no value is recommended. WHO uses values for risk assessment of 1.7 and 0.17 μg/m^3 associated with excessive risk of longevity 1/100,000, respectively 1/1,000,000[2] (fig.26).

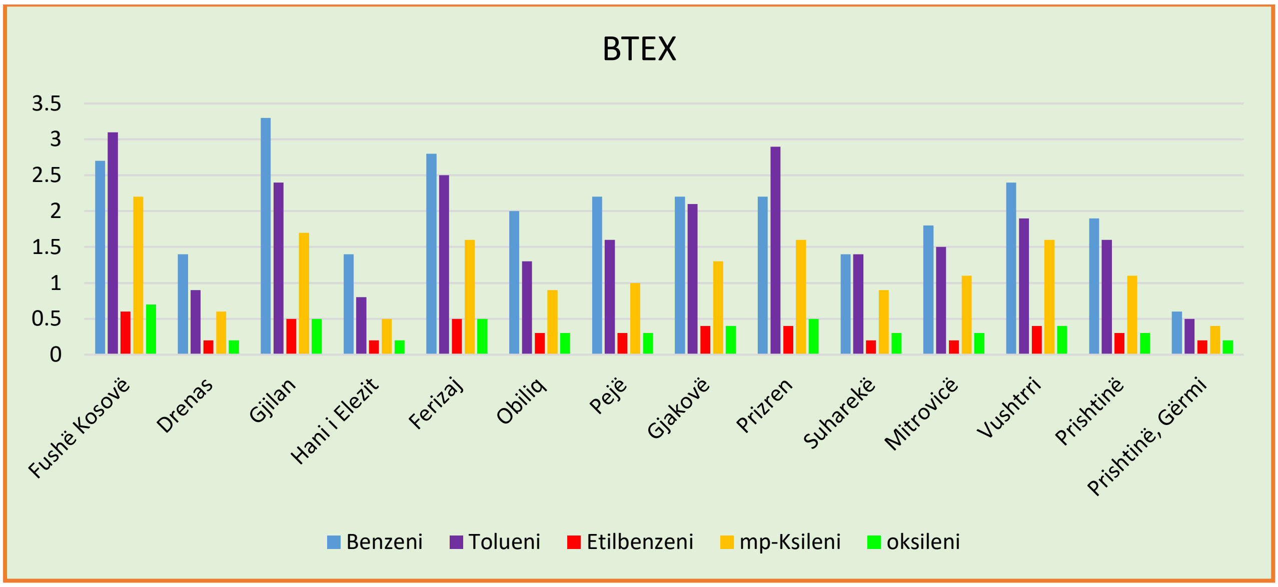

Fig. 26. Graphically presented values of BTEX results

[2]*WHO, Regional Office for Europe. (2000). Air Quality Guidelines for Europe: Second Edition.* https://apps.who.int/iris/handle/10665/107335

3. Estimation of polluting emissions by operators for 2021

3.1. Estimation of air emissions by TPP A & TPP B

Pollutant emissions estimated by the monitoring of TPP A & TPP B for 2021 are for SO_2, NO_X and Dust. According to Directive 2001/80/EC, as well as AI No. 06/2007 on the rules and standards of the discharges on air by the stationary sources of pollution from large combustion plants, such as thermal power plants, standards such as:

- *SO_2...400 mg/Nm^3*
- *NOx...500 mg/Nm^3*
- *Dust...50 mg/Nm^3*

Dust Emissions at TPP A and TPP B

In TPP-A, the pollutant emissions SO_2, NO_X and CO_2 are calculated to estimate their state in the air, while the dust emission is measured to determine the values emitted into the air. In TPP B, all parameters are calculated to determine the values released into the air.

Dust emissions from Power Plant A throughout the year did not exceed the permitted limit values. At Power Plant B, the emitted values of dust emission into the air are very high throughout the year. This concludes that the dust values have managed to exceed the allowed values up to 8 times higher than the allowed limit values (fig.27).

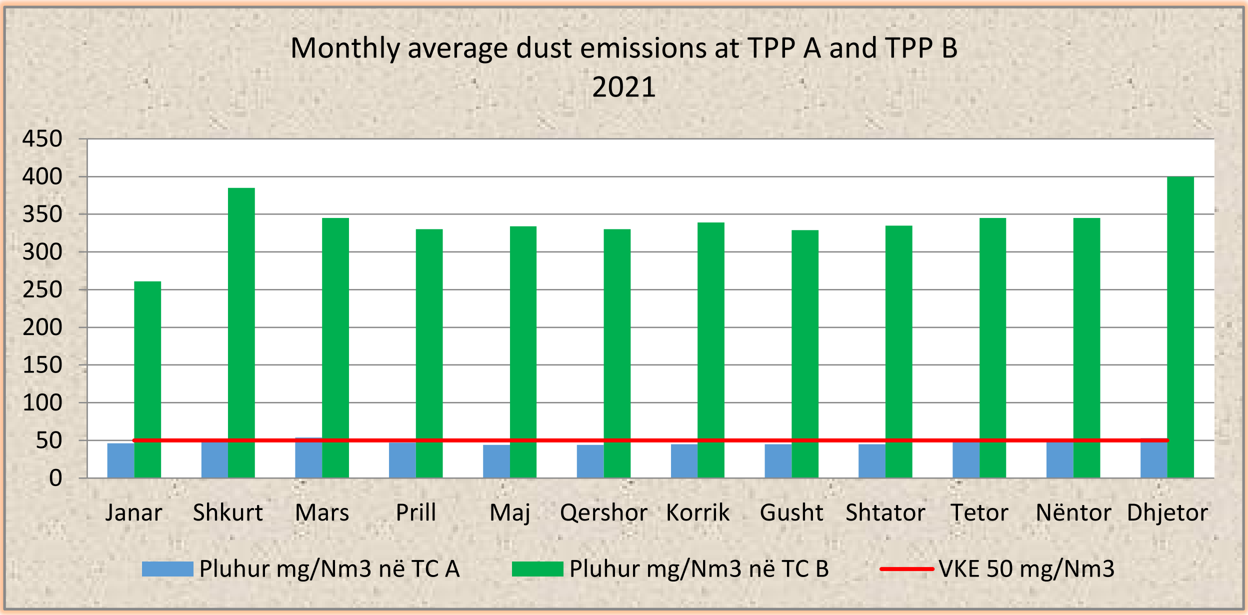

Fig.27. Dust emissions at TPP A and TPP B January - December, 2021

SO_2 emissions in TPP A and TPP B

Both Power Plants throughout the year have exceeded the allowed values of SO_2 emissions. The highest values of SO_2 were observed during February-May 2021 (fig.28).

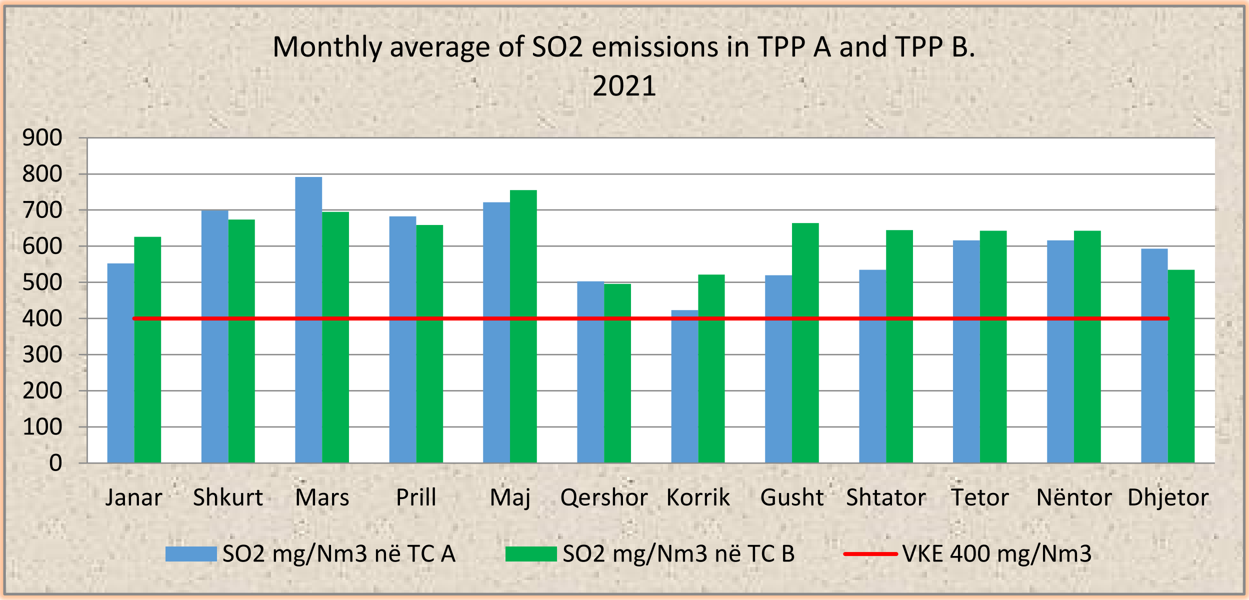

Fig.28. SO2 emissions in TPP A and TPP B January-December, 2021

NOx emissions in TPP A and TPP B

In terms of NOx emissions, the two power plants have recorded emissions above the allowable value throughout 2021. The trend of this emission during the months is almost the same, except for a slightly lower value during May-September (fig.29).

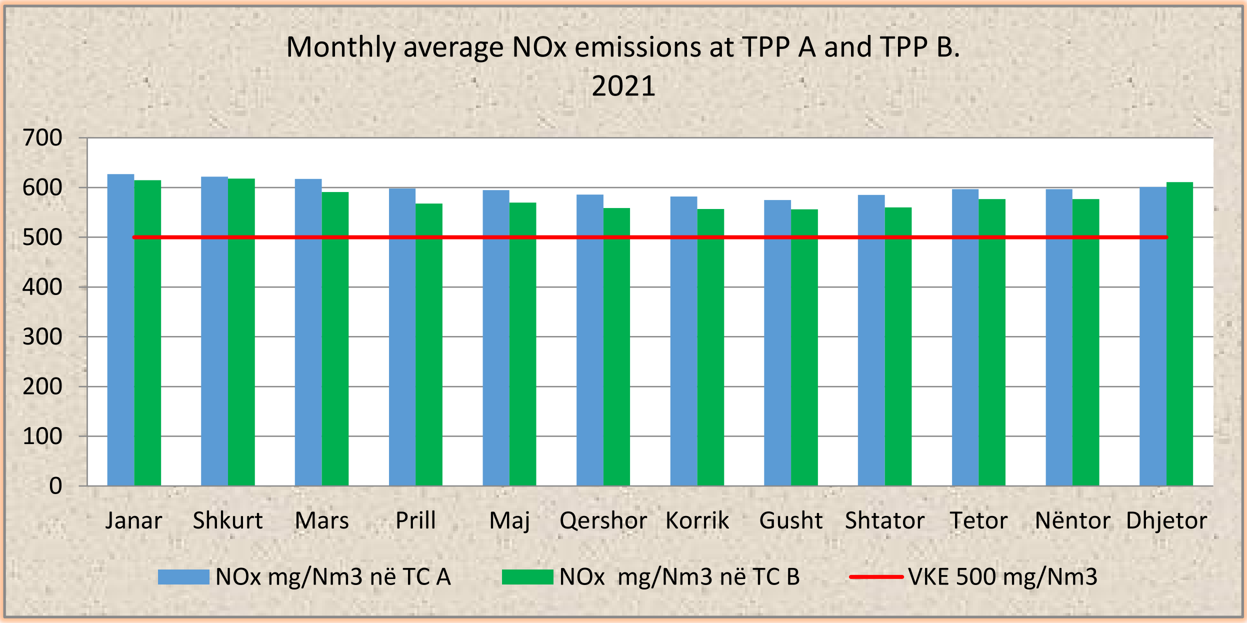

Fig.29. NOx emissions in TPP A and TPP B January - December, 2021

3.2. Estimation of air emissions by Ferronikeli

Continuous measurements of air emissions at Ferronikel were made during January - September 2021. From the beginning of October, the production has been stopped, as a result we do not have data for measuring emissions. Measurement of pollutant emissions is done for the parameters; dust, CO, SO_2 and NO_2.
Emission limit values (ELV) according to AI 06/2007 and "Integrated Environmental Permit" for Ferronikel are;

- Dust…………………30 mg/Nm^3
- CO……………………..1000 mg/Nm^3
- SO_2……………………..600 mg/Nm^3
- NOx (NO_2)…………….350 mg/Nm^3

Pollutant emission measurements are made in chimneys such as:

a) Rotary kiln chimney;
b) Converter chimney;
c) Electric kiln chimney 2.

Rotary kiln chimney

Dust emissions in the rotary kiln

Figure 30 shows the average monthly values of dust emissions in the rotary kiln. Throughout the year, there were no exceedances of the allowed limit values. Dust emissions have resulted in approximately the same values in the rotary kiln during 2021.

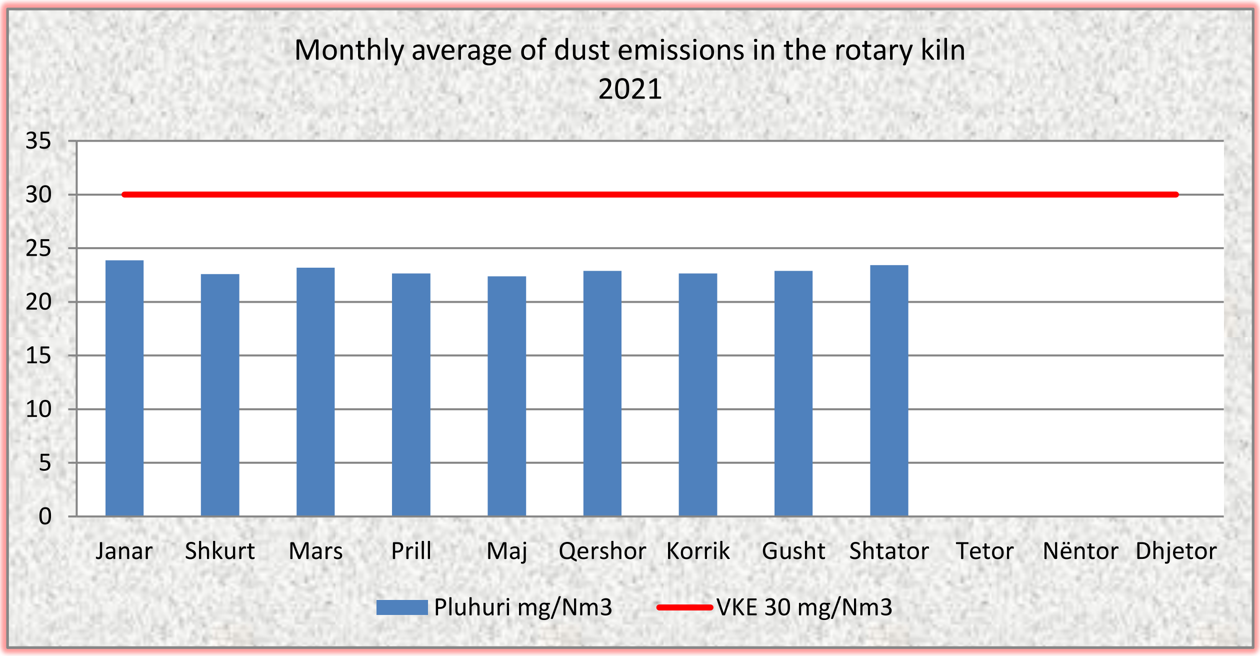

Fig.30. Dust emissions in the rotary kiln January - September 2021

CO emissions in the rotary kiln

Average monthly values of CO in the rotary kiln show that they are with lower values than the limit values allowed during 2021 (fig.31).

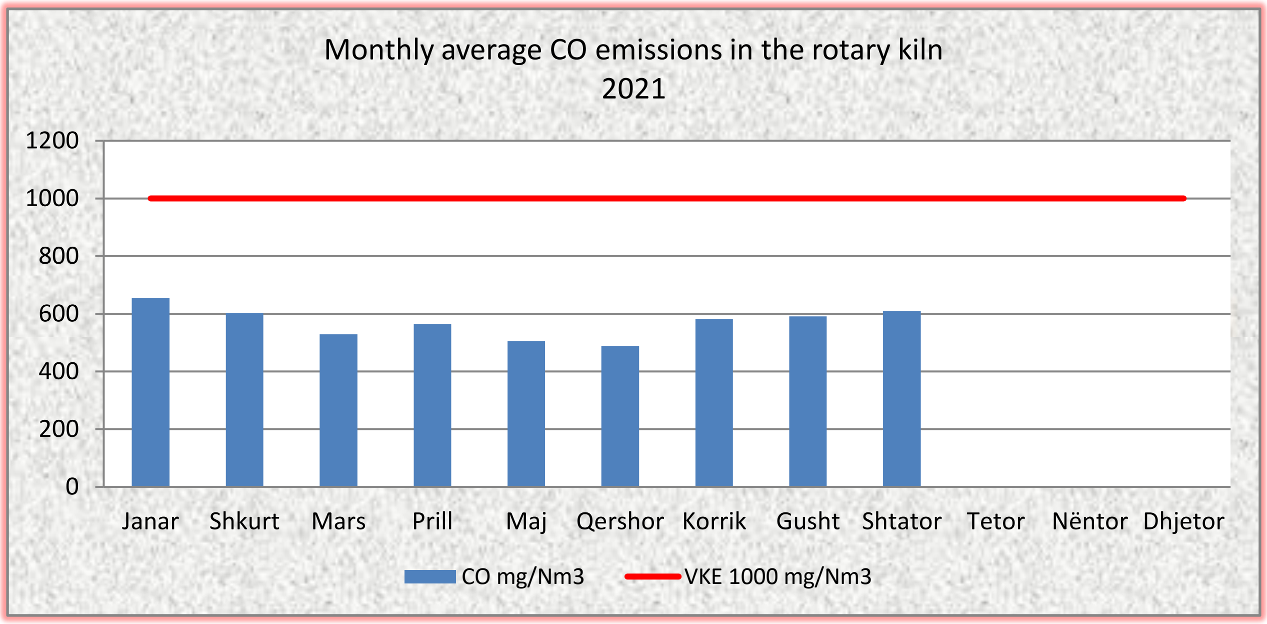

Fig.31. CO emissions in the rotary kiln January - September 2021

SO_2 emissions in the rotary kiln

The average monthly values of SO_2 in the rotary kiln have resulted in lower values than the allowable limit values. In August, there is a higher level of SO_2 emission values which reach approximately 500 mg/Nm^3 (fig. 32).

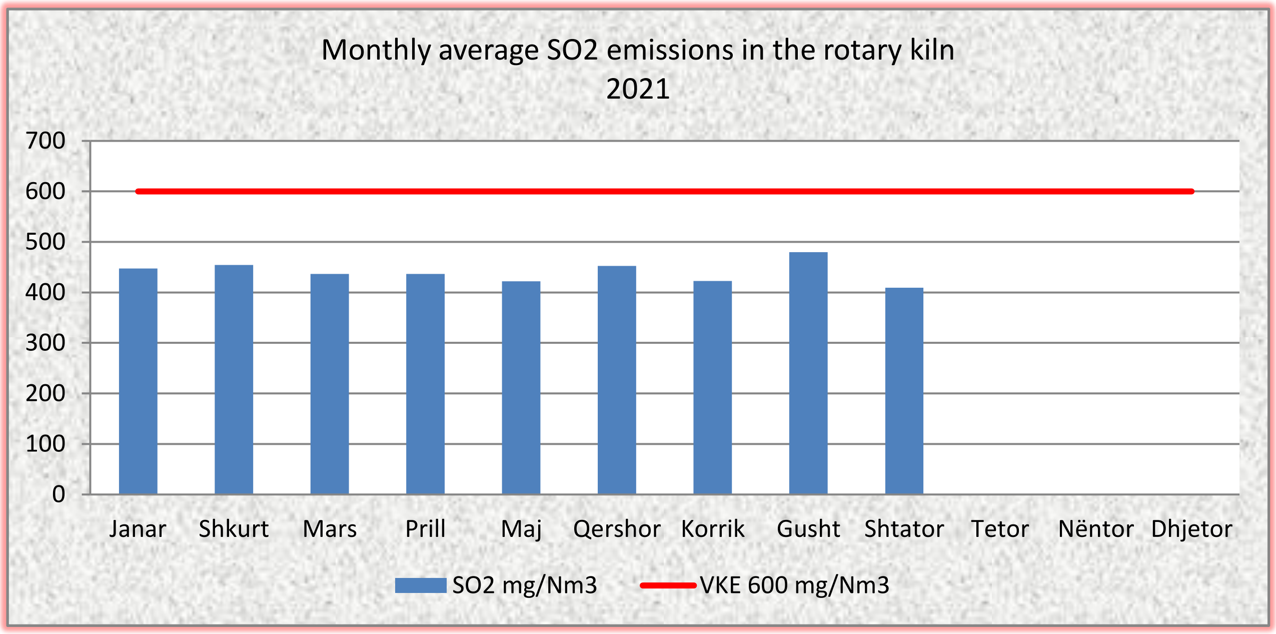

Fig.32. SO_2 emissions in the rotary kiln January - September 2021

NO_2 emissions in the rotary kiln

Figure 33 shows the average monthly values of NO_2 in the rotary kiln, resulting below the allowed limit values. In June and August 2021, NO_2 emissions had higher values than other months, which reached approximately 250 mg/Nm^3 (fig.33).

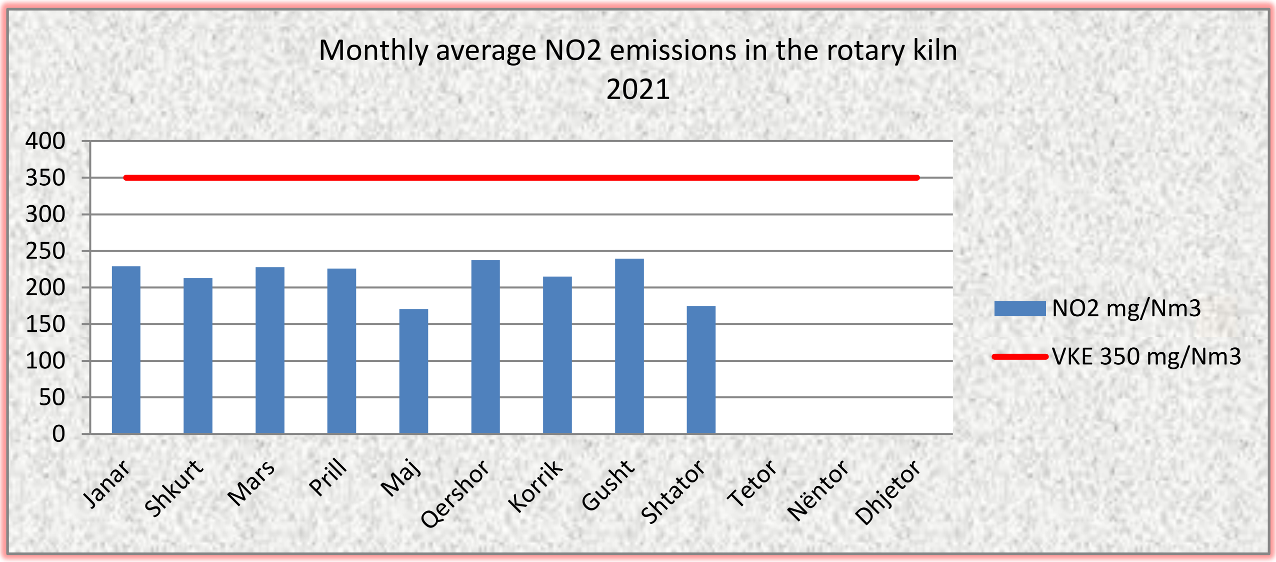

Fig.33. NO_2 emissions in the rotary kiln January - September 2021

Converter kiln

Dust emissions in the converter

The average dust emission values in the converter are with lower values than the allowed limit values. The highest values of dust emission are estimated to be in February compared to other months (fig. 34).

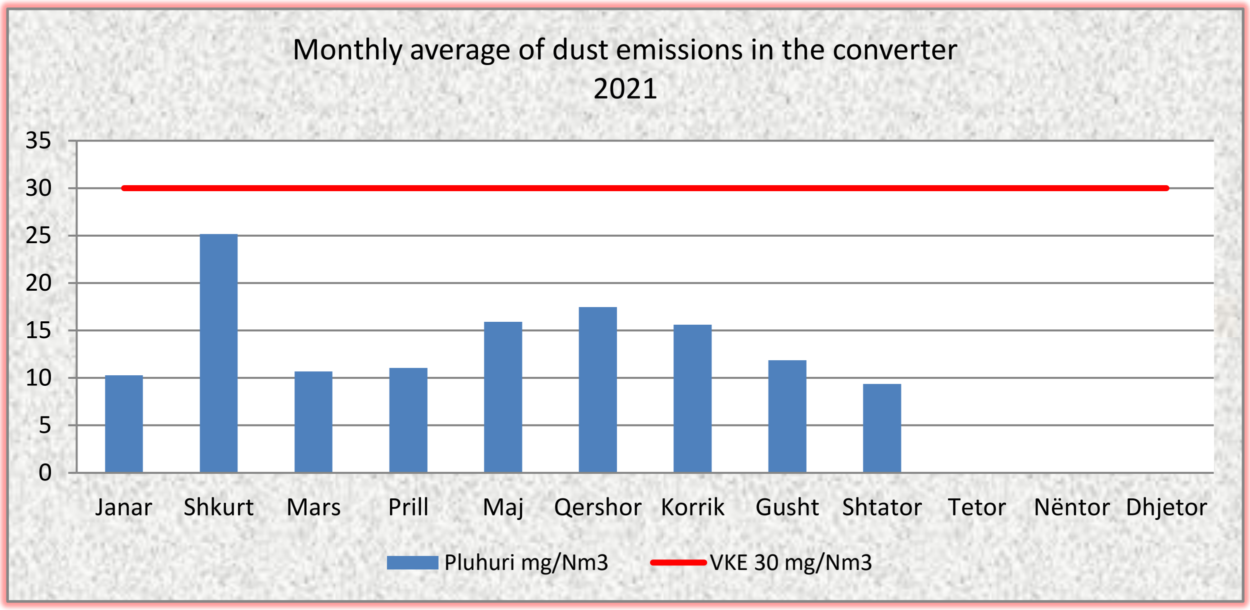

Fig.34. Dust emissions in the converter January - September 2021

CO emissions in the converter

The average monthly values of CO in the converter are with much lower values than the allowed limit values (fig. 35).

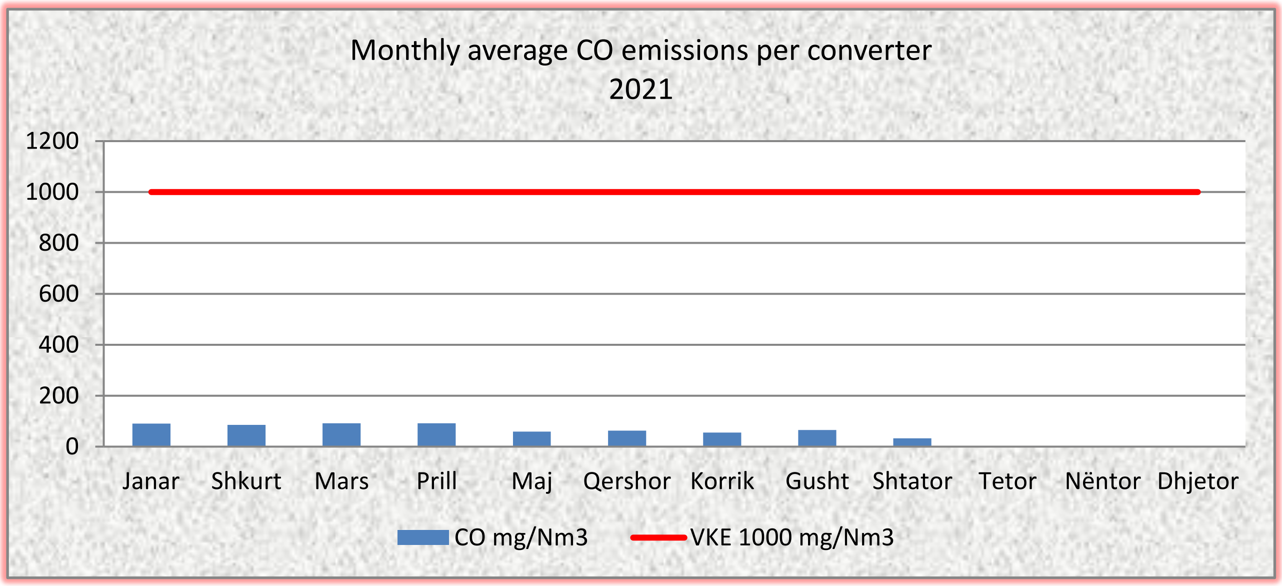

Fig. 35. CO emissions in the converter January - September 2021

SO_2 emissions in the converter

The average monthly values of SO_2 in the converter are lower than the allowed limit values. The highest values are recorded during July and August, if we compare with the other months of the year (fig. 36).

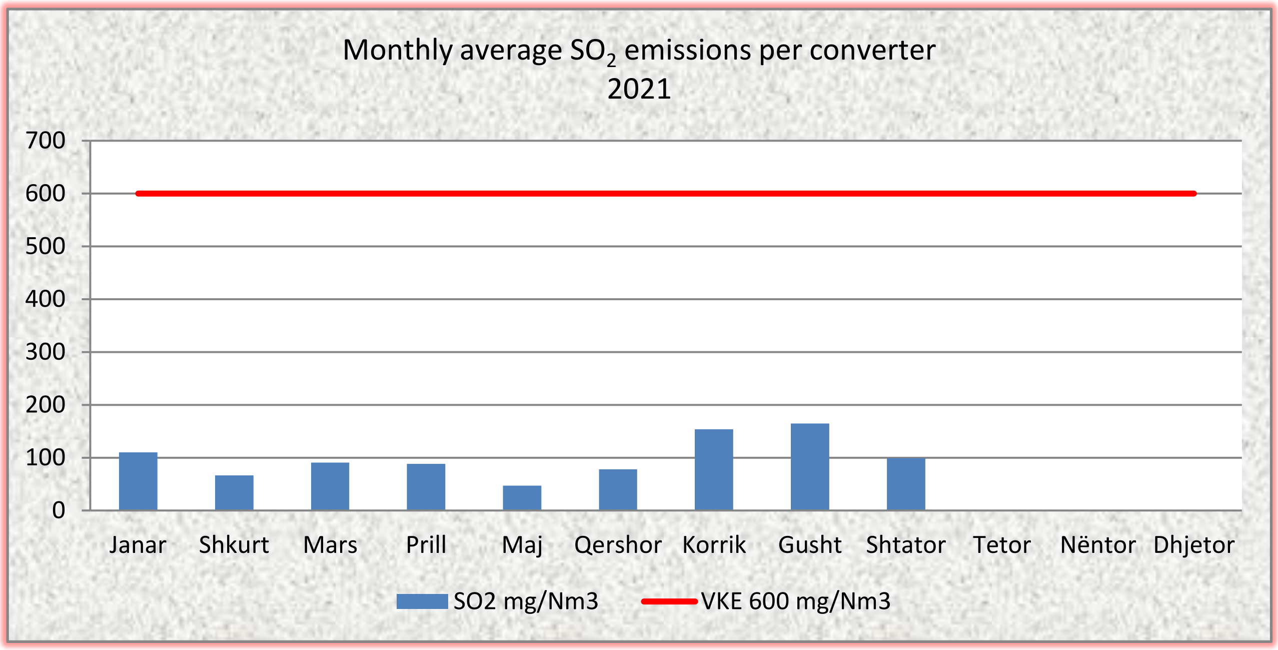

Fig. 36. SO2 emissions in the converter January - September 2021

NO_2 emissions in the converter

The average monthly values of NO_2 in the converter are below the allowable limit values. A slight increase was recorded during July and August, compared to other months of the year (fig.37).

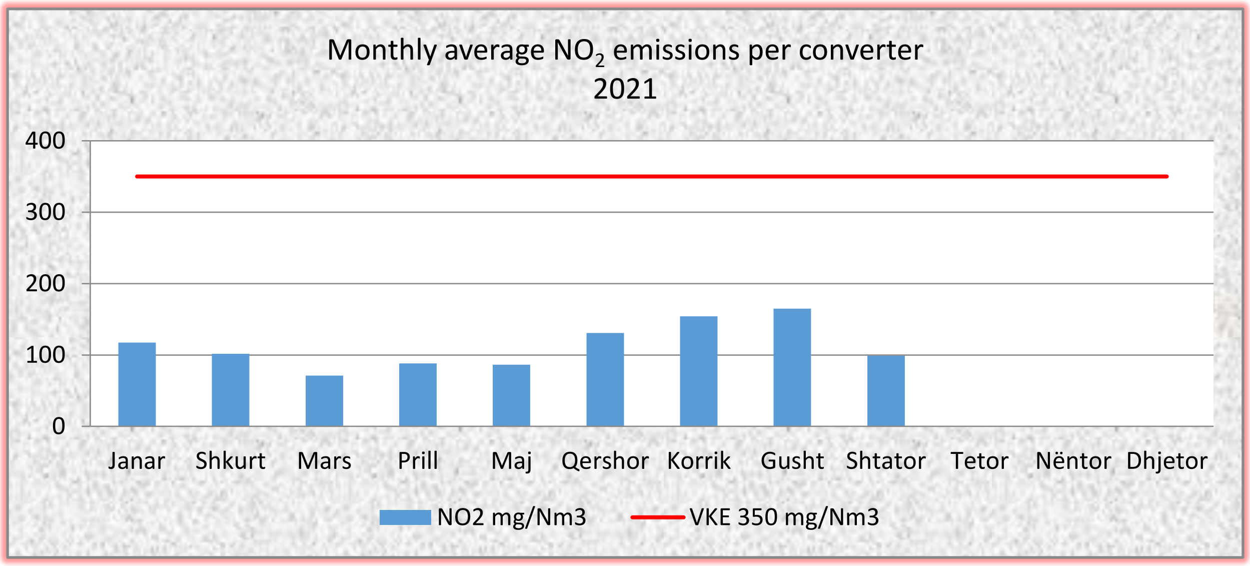

Fig. 37. NO_2 emissions in the converter January - September 2021

Electric kiln No.2

Dust Emissions in the electric kiln No.2

Figure 38 shows the average values of dust in the electric kiln No.2, that have resulted below the allowable limit value. Throughout the months, dust emissions have resulted between values 20-25 mg/Nm^3. The months that differ with the highest dust emission values are July, August and September (fig.38).

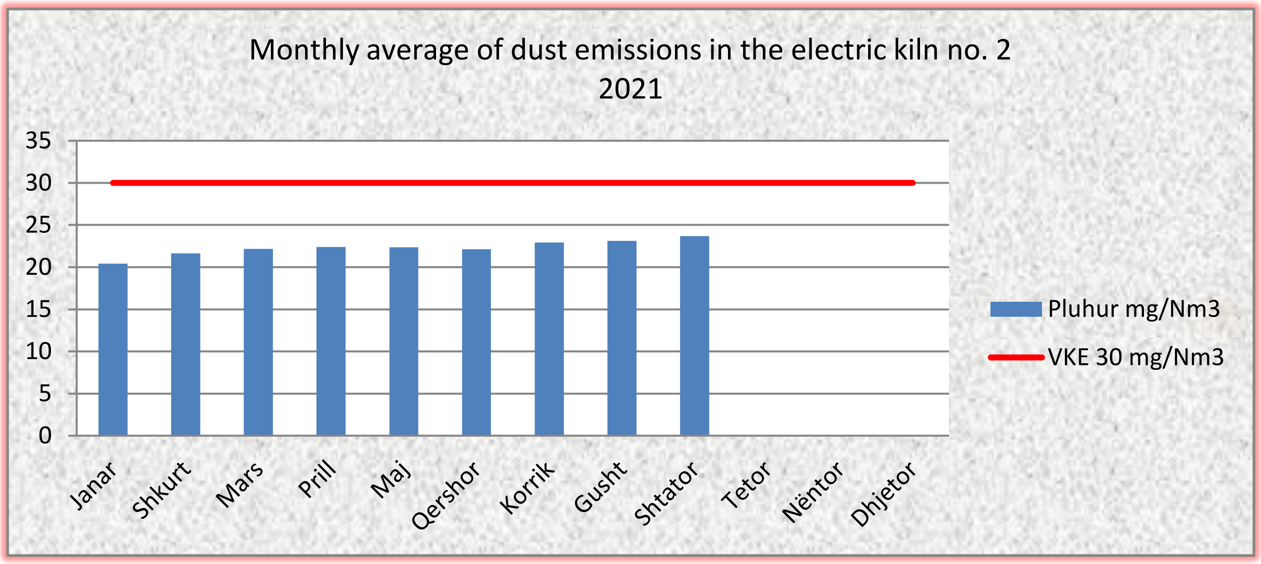

Fig. 38. Dust emissions in the electric kiln No.2 January - September 2021

3.3.Evaluation of air emissions from Sharrcem factory

Sharrcem factory, during February-March 2021, was out of operation due to technical overhaul. Also, in these two months, there is no data on polluting emissions which are discharged from Sharrcem.

Emissions from Sharrcem's own monitoring for 2021 are: dust, SO2 and NOx.

Dust emissions

Dust emissions are monitored at two factory sources:

- Dust emissions at Kiln - Raw Mill;
- Dust emissions from Clinker Cooler and Cement Mill.

Dust emissions from the kiln - raw mill

Figure 39 shows the average monthly values of dust emissions at Kiln - Raw Mill where it is estimated that the values are much lower compared to the emission limit value.

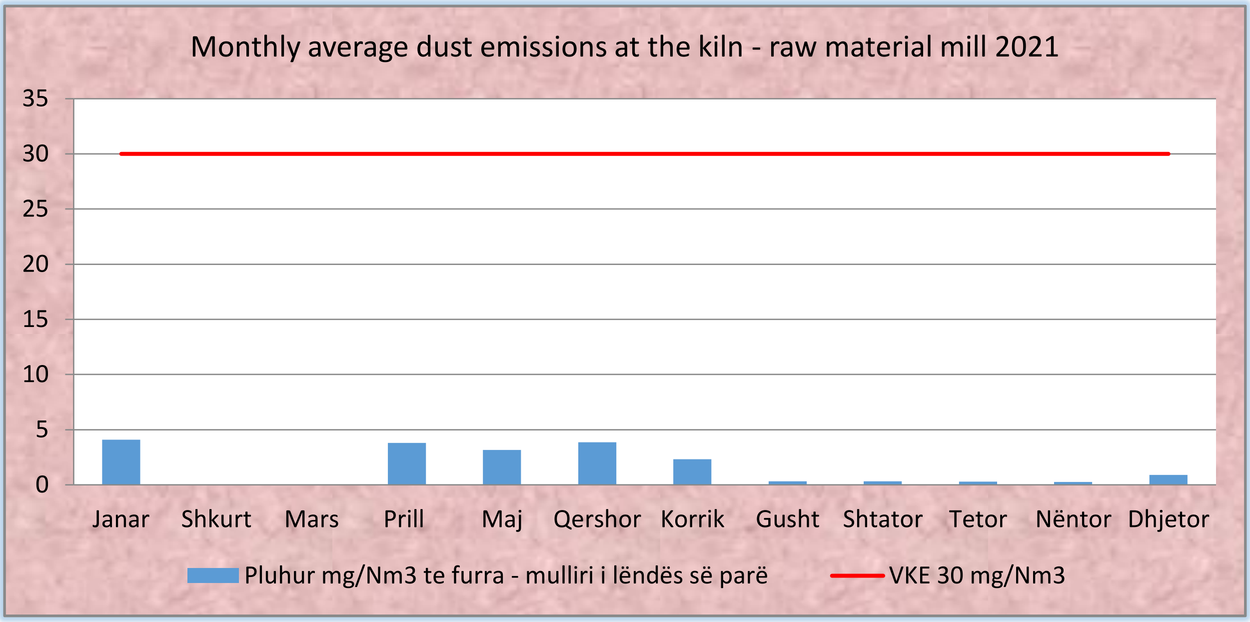

Fig. 39. Dust emissions in the kiln - raw mill January - December 2021

Dust emissions from Clinker Cooler and Cement Mill

The reference value of dust emission limit for this monitoring point is 20 mg/Nm^3, a value determined by the Integrated Environmental Permit of Sharrcem issued by MESP in 2014.

Figure 40 shows the average monthly values of dust emissions at: Clinker Cooler and Cement Mill. Average dust emission values are very low, compared to the allowable limit value.

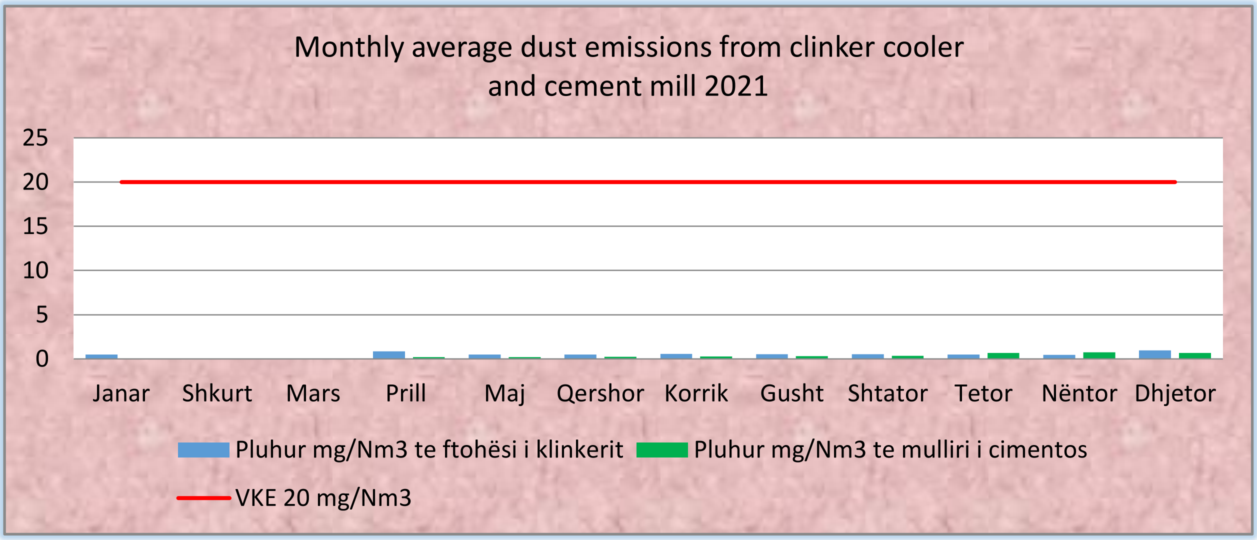

Fig. 40. Dust emissions from clinker cooler and cement mill January-December 2021

SO_2 emissions in the kiln - raw mill

Figure 41 shows the average values of SO_2 emissions in the Kiln - Raw Mill, that are much lower compared to the allowable limit value.

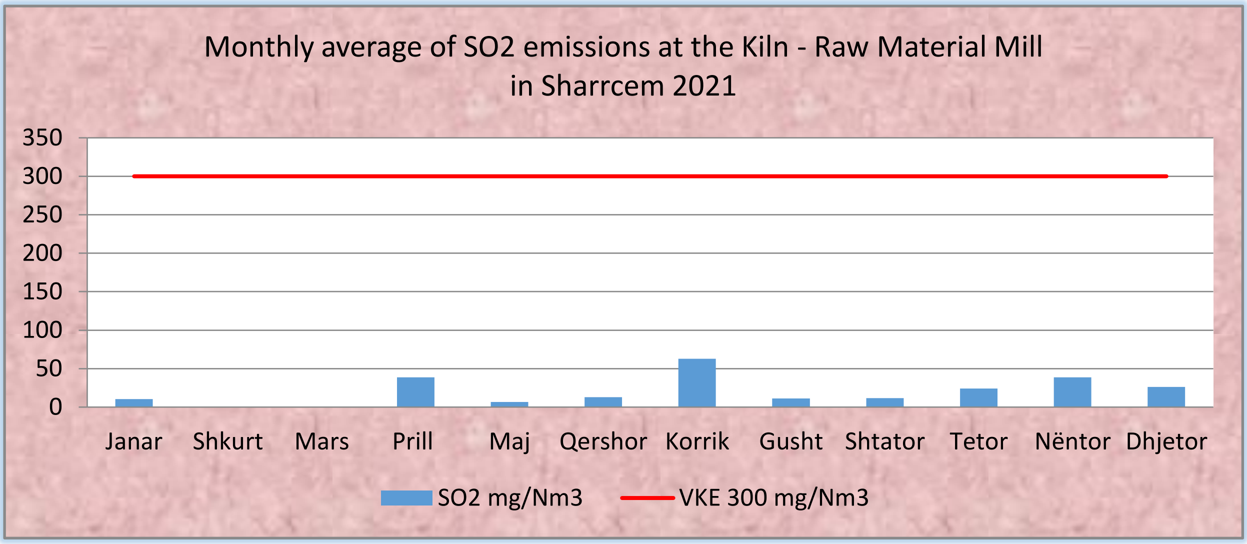

Fig. 41. SO_2 emissions in the kiln - raw mill in Sharrcem January-December 2021

NOx emissions in the kiln - raw material mill

Figure 42 shows the average monthly values of NOx emissions in the furnace - Raw Material Mill. Average NOx values have reached the allowable threshold values. The highest NOx emission values were reached during January, April and August - values exceeding 500 mg / Nm3.

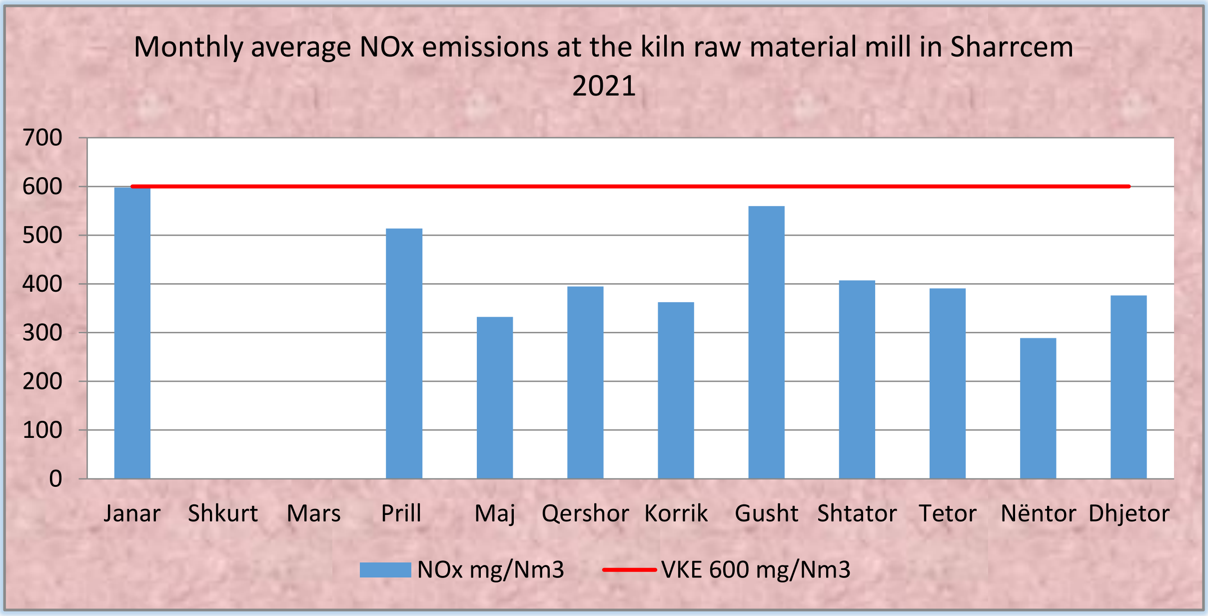

Fig. 42. NOx emissions in the Kiln - Raw Mill, January - December 2021

4. Effects of air pollution on health

The population of the Western Balkans region, including Kosovo, is exposed to high concentrations of air pollution compared to other countries in Europe. It is estimated that these concentrations are up to five times higher than the levels of national and EU guidelines.
Energy, industry, transport, agriculture, waste and solid fuel consumption along with adverse meteorological conditions for the distribution of pollutants emitted into the ambient air, especially during the autumn-winter seasons, and frequent smog builds in this period, have been identified as the main factors of air pollution in the environment of Kosovo. Less than 23% of Kosovo's population perceive ambient air quality as poor and this is much higher among Pristina's agglomeration population, especially Obiliq, due to its proximity to power plants and urban life.

Air pollution is one of the main factors for the occurrence of respiratory diseases, premature deaths, loss of years of life, etc. Short-term and long-term exposure to polluted air can lead to reduced lung function, respiratory infections and severe asthma, cancer, etc. Maternal exposure to air pollution is associated with adverse effects on fertility, pregnancy, as well as in new-borns and children. There is also new evidence that exposure to air pollution is associated with new type 2 diabetes in adults and may be associated with obesity, systemic inflammation, Alzheimer's disease, etc.

The effects of air pollution on health depend not only on exposure but also on people sensitivity. Sensitivity to the effects of air pollution may increase as a result of age, pre-existing health conditions, eating habits, physical activity, smoking, etc. In the general sphere, a large number of evidences show that people with low socio-economic well-being tend to live in environments with poor air quality.[3] New evidence suggests that increased long-term exposure to air pollution (especially PM2.5) increases the risk of serious complications of COVID-19 due to its impact on respiratory and cardiovascular diseases.

Tab.19. Reference values for air quality from WHO acceptable for health impact

Air quality guidelines from the World Health Organization (WHO) and estimated reference levels			
Pollutants	Average period	Reference level	Comments
PM10	1 day Year	50 µg/m3 20 µg/m3	99% (3 days per year)
PM2.5	1 day Year	25 µg/m3 10 µg/m3	99% (3 days per year)
O3	Maximum 8-hour daily average	100 µg/m3	-
NO2	1 hour	200 µg/m3 40 µg/m3	-
SO2	1 minute 1 day	500 µg/m3 20 µg/m3	-
CO.	1 hour Maximum 8 hours a day	30 µg/m3 10 µg/m3	-

[3] *Air quality in Europe — 2020 report/ EEA Report No 09/2020*

The most harmful pollutants to health closely related to excessive premature mortality are the fine particles $PM_{2.5}$ that penetrate deeply into the lungs, enter the bloodstream and reach the organs, causing systemic damage to tissues and cells. Clinical and experimental studies suggest that fine airborne particles increase the risk of cardiovascular disease by promoting arteriosclerosis, increasing oxidative stress, increasing insulin resistance, promoting endothelial dysfunction, and increasing the propensity for coagulation.
According to the report published in 2021 by MFK/MCC entitled *"Air pollution and impact on health in Kosovo"*, it is estimated that for current exposures (compared to the limit value of 2.4 µg/m^3) and then, the assessment of the exposure of limit value according to the WHO for the concentration of $PM_{2.5}$ (10 µg/m^3),the results show that 1150 deaths per year (121/100 000 inhabitants) are attributed to the current level of $PM_{2.5}$ in Kosovo, which represents 12.1% of total mortality, from all causes of natural death, see table 20.

The estimated number of attributable deaths that can be avoided (annually), if WHO limit values are met, is 758, representing 7.97% of total (natural) mortality in the age group of 30 years and older. An average of 80 deaths, calculated as the norm per 100,000 inhabitants at risk, are attributed to the cause of exceeding the limit value of this pollutant. The results show that 758 premature deaths each year that are caused by long-term exposure to $PM_{2.5}$, can be avoided if limit values are met according to WHO standards.

Table 20. Estimated disease burden and impact assessment of current air quality in Kosovo

3-year average PM2.5 (µg/m3)	Limit value (µg / m3)	Total mortality, from all (natural) causes 30+ years old	Mortality rate* (per 100,000)	Estimated attributable deaths					
				#	95% CI	% of total mortality (attributable proportion)	95% CI	Attributable cases* (per 100,000)	95% CI
23.8	2.4	9,518	998.9	1150	766-1493	12.1	8.1-15.7	120.7	80.4-156.7
23.8	10.0	9,518	998.9	758	501-992	7.97	5.3-10.4	79.6	52.6-104.1

According to the European Environment Agency, the rate of premature deaths attributed to air pollution (PM2.5) were the highest in 2018 in Central and Eastern European countries, reaching up to 120-180 deaths per 100,000 inhabitants in: Bulgaria, Hungary, Poland , Romania and Croatia. The death toll was lowest in the Nordic countries, with rates about six times lower, 20-30 deaths per 100,000 inhabitants[4].

The impact on health and the burden of disease due to air pollution in Kosovo together with the associated economic costs are significant for the country's economy and are directly related to coal burning and emissions from transport. According to the World Bank, the estimated economic cost associated with mortality from exposure to air pollution in Kosovo is 160-310 million USD, equivalent to 2.5% -4.7% of gross domestic product (GDP) in 2016. The economic costs related to health damage are on average 240 million USD, equivalent to 3.6% of GDP in 2016.

[4]*European Environment Agency (2020), Air Quality in Europe - 2020 Report. Accessible at https://www.eea.europa.eu/publications/air-quality-in-europe-2020.*

5. Investments in the air sector

Investments in the air sector are not in proportion to air pollution which comes from multiple sources. During 2021, investments in the air sector were limited. Investments from the public budget in the air sector for 2021 are oriented for the supply and maintenance of air quality monitoring stations that are under the management of KEPA (tab.21).

Donor investments in the air sector for 2021 were low. In this regard, foreign investments are valued more in terms of air assessment and monitoring, and impact on health. Projects from donors that are related to the air sector are presented in Table 22.

Tab.21 Investments from the public budget in the air sector for 2021

Type of investment	Value	Year
Supply and Maintenance of Network of Stations for Air Quality Monitoring	99,669.00	2021

Table 22: Some of the donor projects related to the air sector 2017-2021

Project name	Donor	Project value	Implementation period
Improving the environmental performance of the "Kosova B" power plant	EU-IPA	76.400.000.00 €	2019-2022
Project “Capacity development for air pollution control”	JICA-Japanese Government	4,000,000.00 $	2017 - 2021
Environmental Data Collection (MCC's Threshold Program)	MCC - USA	3,000,000.00 $	2017-2021
Investing in energy efficiency in the household sector (MCC's Threshold Program)	MCC - USA	20.700.000.00 $	2017-2021
Investment in district heating system (MCC's Threshold Program)	MCC - USA	10,900,000.00 $	2017-2021
Capacity building for the use of environmental data. Cooperation project between KEPA and the Swedish Environmental Protection Agency	AIDS	2.262.400.00 SEK (Swedish Krona)	2020-2023
Strengthen the registry of PRTR environmental pollutants in the Balkans and Moldova.	German Government	355,301 EUR	2021-2023
Participation in the work and program of the European Environment Agency (Regional project)	EU-IPA	EU IPA - Multi-beneficiary IPA Fund 2,480,202.00 €	2018-2022
Transition towards low emissions and climate-resilient economy in the Western Balkans (TRATOLOW)	EU-IPA	EU IPA - Multi-beneficiary IPA Fund	2021-2022

6. Conclusions and recommendations

6.1. Conclusions

- Air quality in the territory of Kosovo is monitored through systematic measurements of the network of monitoring stations managed by KEPA/KHMI and consists of 12 static stations and 1 mobile station.
- Monitoring data indicate exceedances of the maximum values permitted for some parameters and in particular for PM10 and PM2.5, mainly during the winter season.
- It was found that in the Agglomeration Area (AKS1), 144 days were recorded with exceedances of values for PM_{10}, while in ZKS1 155 days were recorded with exceedances. The number of days with exceedances of PM_{10} during 2021, compared to the previous year (2020), for both monitoring areas has decreased.
- In the Agglomeration Area (AKS1), PM_{10} values with exceedances were recorded at Rilindja and KHMI stations during February, while with higher values of $PM_{2.5}$ were recorded at KHMI, Rilindje, Obiliq and Dardhishte stations, during the months January, February, March, November and December.
- In ZKS1 area, values with exceedances of PM_{10} were recorded only at the station of Gjilan during February, while values above exceedances for $PM_{2.5}$ were recorded at stations of Drenas, Mitrovica, Peja, Prizren and Gjilan during January, February, March, November and December.
- The trend of annual concentration of monitored parameters shows a significant decrease in the concentration of pollutants in 2021 compared to 2020.
- Monitoring of Benzene, Toluene, Ethylbenzene and Xylene (BTEX) was carried out for the first time in Kosovo, and according to local legislation, these monitoring parameters are within the allowed values of 5 µg/m^3.
- The process of identifying sources of pollution, indicates that the largest emissions for PM_{10} and $PM_{2.5}$ come from the small combustion sector and industry, the largest emissions for NO_X, come from the industry and transport sector, while the largest emissions for SO_2 come from industry.
- Pollutant emissions emitted by industrial operators show that the largest dust emissions are released from TPP B, where they are recorded with higher values during 2021, despite TPP A where dust values are recorded with allowable values according to the standard. SO_2 and NO_X emissions from TPP A and TPP B during 2021 have been above the allowable value.
- Pollutant emissions of SO_2 and NO_X, CO from the Ferronickel Plant during 2021, have been below the allowed value.
- Also, the dust emissions into the air, SO_2 and NO_X, from Sharrcem Cement Factory during 2021 have been below the allowed values.
- Although by 2021 there are 18 operators equipped with Integrated Permits, only two of them report monthly data to KEPA for emissions of pollutants into the air.
- The low-level of the implementation of laws, bylaws and policies for the air sector has also been noted, as is the case with policies for the control of emissions from mobile sources and those for the control of oil quality.
- The low level of implementation of legal requirements is also at the local level, although the Law

on Air Quality requires the drafting of Local Action Plans for air quality. So far only a few municipalities in Kosovo have drafted and approved such a document.

6.2. Recommendations

Although in 2021 there is an improvement of air condition compared to previous years, in order to improve air quality, actions are still required to achieve the standards allowed for better health for the population.

Recommendations needed to improve the air condition at the national level include the following actions;

- Approving and implementing the Strategy for Protection and Sustainable Development of the Environment 2022-2030, which includes the air sector, from where it should be drafted Air Quality Action Plan.
- Increase in the efficiency of the implementation of environmental legislation, through complementary mechanisms and instruments.
- Strengthening the technical and human institutional capacities for the maintenance of the air quality monitoring network, the servicing and calibration of the equipment as well as the accreditation of the laboratories.
- Operators provided with environmental permits should be supervised by the environmental inspectorate regarding the regular monitoring of air quality and air emissions, should respect the standard norms of air emissions and should report their data to the responsible institutions;
- Improving the cooperation between monitoring institutions and operators, especially in the process of information flow, processing, reporting and more efficient information of the public on air quality.
- Developing favourable policies for the use of fuels that have lower emissions into the environment and for the application of clean technologies in production processes;
- Favouring the use of alternative transport that has lower emissions into the air and apply a time limit for the use of obsolete vehicles and those without catalytic converters.
- Implementing sub-legal acts on permitted rates of air emissions from mobile and stationary sources.
- Municipalities should draft local plans for air protection from pollution for their territory and implement measures to reduce air pollution;
- Investing in increasing green areas in urban areas;
- Funding more from the public budget for the implementation of projects that will focus on improving the air quality in the country.

7. List of abbreviations, figures, tables, photos

7.1. List of abbreviations

MESPI - Ministry of Environment, Spatial Planning and Infrastructure;

KEPA - Kosovo Environmental Protection Agency;

KHMI - Kosovo Hydrometeorological Institute;

MCC - Millennium Challenge Corporation;

MFK - Millennium Foundation Kosovo;

TPP A – Thermal Power Plant Kosovo A;

TPP B – Thermal Power Plant Kosovo B;

AQI - Air Quality Index;

BTEX - Benzene, Toluene, Ethylbenzene and Xylene;

VOC - Volatile Organic Compounds;

USEPA- US Environmental Protection Agency;

EU - European Union;

WHO - World Health Organization;

GDP - Gross domestic product.

7.2. List of figures

Fig. 42. *NOx emissions in the kiln - raw material mill, January - December 2021.*

7.3. List of tables

7.4. List of photos

State of the Air Report in Kosovo 2021

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