Interreg - IPA CBC

CCI 2014 TC 16 I5CB 009

TRAP

Air Quality Plan for Bitola

TRAP

Transboundary Air Pollution Health Index Development and Implementation

[June, 2021]

CONTENTS

ACRONIMS AND ABREVATIONS

TRAP	Transboundary Air Pollution Health Index Development and Implementation
MOEPP	Ministry of Environment and Physical Planning
EU	European Union
SO_2	sulfur dioxide
NO_x	nitrogen oxides
PM	particulate matter
NMVOC	Non-methane volatile organic compounds
NH_3	ammonia
IPPC	Integrated pollution prevention and control
NERP	National emission reduction plan
O_3	ozone
VOCs	Vaporized organic compounds
PAHs	polycyclic aromatic hydrocarbons
HM	heavy metals
km	kilometer
km^2	square kilometers
m	Meter
%	percentage
SSO	State Statistical Office
°C	degree Celsius
mm	millimeter
‰	per mille
m/s	meters by second

ppm	parts per million
MEIC	Macedonian Environmental Information Center
N	north
E	east
$\mu g/m^3$	micrograms per cube meter
WHO	World health organization
IARC	International Agency for Research on Cancer
AOT40	Accumulated Ozone exposure over a Threshold of 40 ppb
CET	Central European Time
LV	limit value
B1	Bitola 1
B2	Bitola 2
CLRTAP	Convention on transboundary air pollution
IIR	Informative Inventory Report
TSP	total suspended particles
Cd	Cadmium
Pb	lead
Hg	mercury
MW	megawatts
GW/h	Giga watts per hour
LHV	Lower heating value
kJ/kg	kilojoules per kilogram
t	tons
PCB	polychlorinated biphenyl
EEA	European Environment Agency

LPG liquid petroleum gas

GB Guidebook

EF emission factor

RES renewable energy sources

LIST OF TABLES

LIST OF FIGURES

1. Introduction

1.1 Project Overview

Information on real time air pollution levels is now more necessary than ever before. At present, air pollution is one of the most significant factors posing threat to the health of individuals worldwide. It is associated with a range of diseases, symptoms and conditions that impair health and quality of human life. According to the WHO, outdoor air pollution was responsible for the deaths of some 3.7 million people under the age 60 around the world in 2012 , representing 6.7% of the global disease burden while outdoor air pollution combined are among the largest risks to health worldwide. Apart from habitants air quality impacts natural environment and biodiversity. The main sources of air pollution at both countries are mainly caused by industrial activities, transportation and heating.

Air Pollution has been recognized as of the most pressing problems in both Greece and the Former Yugoslav Republic of Macedonia, following the economic and social development of the two countries the sources of air pollution are mainly industrial activities, transport and central heating. The major challenges of transport in urban areas are the rising number of vehicles, their increased average age and traffic congestion. Air quality problems from industrial sources mainly concern areas with thermos-electrical power stations and industrial units located close to residential areas. Air quality is strongly influenced by pollutants trapped due to thermal inversions caused by from land local breezes and thermal internal boundary layers.

TRAP developed on the necessity for developing ICT applications in environmental protection, monitoring and management of the eligible areas. Environmental initiatives is a privileged field for developing cooperation in the cross-border area contributing significantly to economic and social development of the population and public health, therefore, the opportunity for mutual cooperation and understanding between public authorities, scientific institutions and residents of the area. The major challenge is the development of an integrated approach including air quality monitoring with providing health indicator for vulnerable groups of the population. TRAP project addresses a series of issues, such as:

- Identification of the emission sources and development of regional and CB emission for vulnerable groups of the population
- Assessment of each emission source
- Development of air quality plans
- Monitoring data, validation and analysis
- Basic demographic, health and public health profile

- Air quality and Health Indicators
- Joint CB comparative analysis
- Capacity Building at user level (Health and authority stakeholders)
- Air quality and health sensitization campaigns
- Protection of human health
- Citizen involvement
- Implementation of air quality directives

Partners aim to improve management and protection of areas in both countries by establishing air quality monitoring networks. The measurements of all station in areas involved in this project will create a system that will display real-time measurements through the internet. Moreover, epidemiological indicators and indicators of air quality, based on the effects of air pollution on human health, will be calculated and displayed on the web. The best way for someone to use an Air Pollution Health Indicator (APHI) is to regularly check the current index value, to pay attention to personal symptoms and self –calibrate to personal symptoms and self-calibrate to the report current APHI value. Therefore, the strategic objective of TRAP project is the creation of an ICT application integrating Air Quality Monitoring with Air Pollution Health Indicator) (APHI) in CB area.

The specific sub-objectives of the project are to:

- Develop and evaluate emission inventories at partner areas
- Assess the health risk related to air quality measurements
- Create integrated ICT tool including air quality information correlated to possible health impacts and providing emergency mechanism to policy makers and vulnerable groups
- Evaluate the CB conditions regarding air quality and transported pollution in CB areas
- Engage relevant stakeholders in order to inform them on the created tool operation and indexes
- Disseminate and communicate the project results to key stakeholders as well as to the general public and vulnerable groups

TRAP project results will positively affect and contribute to the programmes result indicator for ecosystems with improved protection status for the eligible areas of Florina, Bitola and Gevgelija where the monitoring stations will be placed. The innovative character of TRAP is served by its approach that favours the interaction and exchange of ideas as well as the knowledge diffusion and integration among the targeted stakeholders. Many of the projects activities will be jointly implemented creating unified framework for problem resolutions and providing added value to the CB area as a total. The expected results are focused on the development of an ICT tool for better air quality monitoring in CB area integrated with Air pollution Health Indicator.

1.2 Purpose of this deliverable

Preparation of the document "Air quality plan for Bitola" is one of the activities within the project "Transboundary Air Pollution Health Index Development and Implementation" with project acronym "TRAP". The Project is implemented by the Ministry of environment and physical planning of the Republic of North Macedonia, Centre for climate change - Gevgelija, Environmental center of Western Macedonia in Florina, Greece, Municipality of Florina, Greece and European regional framework for cooperation Thessaloniki, Greece.

Thus, the scope of the document is to develop air quality plan for Bitola, necessary for further planning and implementation of air quality measures, as part of the legal requirement of the local self-government concerning detected high air quality pollution levels.

The company Tehnolab was engaged by the Centre for climate change – Gevgelija for preparing the Air Quality Plan for Bitola according to Service contract for European Union external actions No. TRAP-F1-S.O.23-SC30/TD03.

The Air Quality Plan for Bitola is prepared according to Rulebook on the detailed content and the manner of preparing the plan for improving the ambient air quality (Official Gazette of RM No.148/2014).

According to the Project Terms of references, this document fully integrates previously developed chapters of Air Quality Improvement Plan by MOEPP.

2. LEGAL FRAMEWORK

2.1 EU legislation on air quality

Air pollution has adverse impact on human health and the environment as a whole. Due to this, EU has developed and implemented instruments that require coordinated efforts at national, regional and local level. The EU air policy is based on the following instruments:

1. The Ambient Air Quality Directives:

- Directive 2008/50/EC on ambient air quality and cleaner air for Europe which set air quality standards and requirements to ensure that Member States adequately monitor and/or assess air quality on their territory, in a harmonized and comparable manner.

- Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air (Fourth Daughter Directive).

- Directive 2015/1480/EC amending several annexes to Directives 2004/107/EC and 2008/50/EC laying down the rules concerning reference methods, data validation and location of sampling points for the assessment of ambient air quality, and

- Commission Implementing Decision 2011/850/EU laying down rules for Directives 2004/107/EC and 2008/50/EC as regards the reciprocal exchange of information and reporting on ambient air quality.

2. The National Emission Ceilings Directive (2016/2284/EC) requires national emission inventories and sets national emission reduction targets to limit transboundary pollution for the most important transboundary air pollutants (SOx, NOx, $PM_{2.5}$, NMVOC, and NH_3);

3. Source-specific regulatory approaches: These include several Directives regulating different emission sources such as: Directive 2010/75/EC on industrial emissions, the Directive 2009/125/EC establishing a framework for the setting of eco-design requirements for energy-related products (Eco-design directive), Directive (EU) 2016/802 relating to a reduction in the sulfur content of certain liquid fuels (Sulfur Directive), Directive 2009/30/EC (Fuel Quality Directive addressing air pollution from the road transport setting additional fuel quality parameters), Regulation (EU) 2019/631 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles, Regulation (EU) 2016/1628 on requirements relating to gaseous and particulate pollutant emission limits and type-approval

for internal combustion engines for non-road mobile machinery and Directive 2006/32/EC on energy end-use efficiency and energy services.

4. Monitoring and reporting requirements and requirements related to public information about the emissions and (actual and expected) air quality.

1.1. National legislation on ambient air

1.1.1. Law on ambient air quality

The Law on ambient air quality (Official Gazette No. 67/04, 92/07, 35/10, 47/11, 59/12, 163/13, 10/15, 146/2015, 151/2021) regulates the measures to avoid, prevent or reduce the harmful effects of air pollution on human health and the environment as whole, by setting limit and targets values of ambient air, alert thresholds and thresholds for informing, limit and target values for emissions, establishment of a unique ambient air quality monitoring and control system and monitoring of emission sources, a comprehensive system for management of ambient air quality and emission sources as well as other protection measures and activities of legal entities and individuals who have direct or indirect impact on ambient quality air.

The main principles upon which the Law is based are the principle of careful and responsible behavior from everyone in order to avoid and prevent ambient air pollution, principle of time perspective meaning fulfillment of the timeframes in plans, programs and decisions related to ambient air quality and the principle of caution which means keeping the air emissions within the prescribed emission limit values without incurring unnecessary costs. However, beside these main principles in the protection of the ambient air quality, the principles established in the Law on Environment also apply.

For the zones and agglomerations where there is a risk the levels of pollutants to exceed one or more of the alert thresholds, the Law puts obligation on the mayor of the municipality and the mayor of the City of Skopje to prepare an air quality improvement plan. The plan must be prepared according to the Rulebook on detailed content and manner of preparation of Air quality improvement Plan (Official Gazette No. 148/14) and must be based on an integrated approach which means taking into consideration regulations in the area of environmental protection, health care as well as other relevant regulations. In the process of preparation, the municipality has to cooperate with the bodies of the state administration, scientific and professional organizations including legal entities and individual owners. In parallel, in the preparation and adoption of the plan, the municipality is obliged to provide access to information and participation of the public. For the implementation of the plan, the municipality is obliged to submit annual report to the Administration of environment.

Beside the abovementioned rulebook, in the preparation of the plan itself it is worth mentioning the Rulebook for criteria, methods and procedures for assessment of ambient air quality (Official Gazette No. 169/13) and the Decree on limit values for levels and types of pollutants in ambient air and alert thresholds, deadlines for reaching limit values, margins and tolerance for limit value, target values and long-term goals(Official Gazette No. 50/05, 183/17) as well as other bylaws regulating the management of ambient air quality.

The latest amendment of the Law on ambient air quality (Official Gazette No. 151/2021) further regulates the procedure of preparation of Air Quality plans and defines the authorities involved in adoption and implementation of the prepared plan.

1.1.2. Law on environment

The Law on environment (Official Gazette No. 53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/13, 187/13, 42/14, 44/15) as horizontal law regulates all the media and area of the environment among which the protection of ambient air quality. As per the Law the municipalities and the City of Skopje are responsible for issuing approval /permits for different types of activities (installations under elaborates and B-IPPC) which may have impact on the ambient air quality. In parallel, they are obliged to provide access to information and participation of the public in the decision making process. Regarding the ambient air quality, the Law gives an opportunity to the municipalities and the city of Skopje to establish local monitoring network.

1.1.3. Plans, Programs and Reports

At national level, achievement of the set goals for ambient air quality is regulated with several planning documents such as: National Environmental Protection Plan, Plan for improving the quality of the ambient air, Short-term action plan for protection of the ambient air, and the National program for gradual reduction of the quantities of emissions of certain pollutants at national level. The purpose of these planning documents is to achieve integrated approach to ambient air quality protection, water and soil, protection of human health in working and living environment as well as to avoid negative effects on the environment of neighboring or other states. In the process of preparation of the short-term action plan for Bitola should be taken into consideration the following documents:

National plan for clean air and programs with defined measures for 2019, 2020 and 2021

The program identifies the priority areas and activities that should be financed in the short term period in order to achieve certain target of pollution reduction. The program identifies the following main areas: air monitoring, inspection, raising public awareness, revision of legislation and the most critical pollution sources (domestic heating, transport, industry, construction, urban greenery and waste).

National Plan for protection of ambient air quality in the Republic of Macedonia for the period 2013 – 2018

The National plan for protection of ambient air quality outlines the state of emissions of pollutants and the air quality, defines measures to improve air quality on the entire territory of the country and identifies the institutions responsible for implementing measures aimed at improving the air quality in the 5-year period. The plan also provides assessment of the financial means for implementation of the measures with inclusion of modernization of processes, introduction of measures for energy efficiency and use of renewable sources, introduction of the best available techniques, improving fuel quality and con- ducting campaigns for raising public awareness about air quality. The new five-year plan will be prepared in IPA 2 project Support for implementation of air quality directives that is planned to start at the end of the year.

National Program for gradual reduction of the quantities of certain pollutants in Republic of Macedonia for the period 2012-2020

The main aim of the Program is progressive reduction of the quantities of air emissions in relation to the upper limits - ceilings of the quantities of emissions of certain pollutants according to the requirements set out in the Rulebook on the quantities of the upper limits-ceilings of pollutants through established projections for the period 2020 which refer to the reduction of quantities of emissions of pollutants per year. The new program will be prepared in IPA 2 project Support for implementation of air quality directives that is planned to start at the end of the year.

National emission reduction plan (NERP) of Sulphur dioxide (SO_2), nitrogen oxides (NOx) and dust from existing large combustion plants of Republic of Macedonia

The National emission reduction plan defines national ceilings for 8 LCP for the period 2018-2027. The plan was prepared in TAIEX expert mission and it was approved by Energy community and adopted by the government of Republic of North Macedonia in 2017.

Pilot Program for improvement of air quality in Bitola

This pilot program was prepared in 2012 within the Twinning project "Strengthening the capacities of local and central level for environmental management in the field of air quality” funded by the European Union. The purpose of the pilot program was to achieve pollution reduction and improvement of ambient air quality in the city of Bitola. The report provides information about the critical air emission sources, an assessment of the air quality by analyzing the basic pollutants NO_2, SO_2, CO, O_3 and PM_{10} and proposes short- and long-term measures for improving the ambient air quality in the city.

Air quality assessment reports

The air quality monitoring in the country has been carried out since 1965. During the years, the monitoring system was modernized and now provides data from continuous measurements of sulfur dioxide (SO_2), nitrogen oxides (NOx / NO_2), suspended particles (PM_{10} and $PM_{2.5}$), carbon monoxide (CO) and ozone (O_3) at seventeen meteorological locations in different parts of the country. Vaporized organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs) and heavy metals (HM) are measured through short-term measurement campaigns. Calculations of dispersion modeling have also been developed that have been used to assess air quality compared to limit values. The results from the measurements were published in the following reports:

- Air quality assessment report in Republic of Macedonia for the period 2005 – 2015;
- Air quality assessment report or concentration of sulfur dioxide, nitrogen dioxide, nitrogen ox- ides, carbon monoxide, suspended particles, ozone, lead, arsenic, nickel and cadmium in the Republic of Macedonia, 2012.
- Upgraded report for preliminary quality assessment of air for sulfur dioxide, nitrogen dioxide, nitrogen oxides, carbon monoxide, suspended particles and ozone in the Republic of Macedonia, 2008.

1.1.4. Connection with other strategic and planning documents

Following strategic and planning documents will be taken into consideration during the preparation of the Air Quality plan for Bitola:

- Strategy for environment and climate change 2014 – 2020
- Third National Plan for Climate Change, 2013;
- Strategy for Energy Development in Republic Of North Macedonia Until 2040
- Strategy for promotion of energy efficiency by 2020;
- National Waste Management Plan (2009-2015) and Draft National waste management plan (2020 – 2026);
- National Transport Strategy 2018-2030
- National Action Plan for ratification and implementation of Heavy Metal Protocol, Protocol for POPs and the Gothenburg Protocol to the Convention for long distance cross-border air pollution, 2010.
- Program for Development of Pelagonija Planning region 2020-2024
- Action Plan for realization of the Program for Development of Pelagonija Planning region in 2021

2. BASIC INFORMATION ON THE STATE OF THE ENVIRONMENT

2.1. Geographical position

Municipality of Bitola is one of the nine municipalities located in the Pelagonija region which is the largest region covering 18.9% of the total area of the country (app.4.717 km^2). It covers the city of Bitola and 65 villages in the surrounding. With its 794,53 km^2 Municipality of Bitola is the largest municipality in the Pelagonija region. Further the City of Bitola is the second largest city in the county, located in the south-western part of the Republic of North Macedonia, at the foot of Baba Mountain with the peak Pelister (2.601 m), a distance of 13 km from the border with Republic of Greece.

To the west, the municipality borders with the Municipality of Resen, where the border between the two municipalities passes through Mountain Baba. The southern border is the state border with Republic of Greece. To the east and northeast, the municipality of Bitola borders with the Municipality of Novaci and the Municipality of Mogila, while to the north it borders with the Municipality of Demir Hisar.
Municipality of Novaci covers an area of 773 km^2 and municipality of Mogila covers an area of 251 km^2.

The figure below presents the geographical location of the Municipality of Bitola and its borders.

Figure 1 – Location of Municipality of Bitola, Novaci and Mogila

The city of Bitola extends to the following coordinates: from 21°18'20" to 21°22'11" east to the Green house Meridian and from 41°00'00" to 41°03'20" north of the equator.

2.2. Demographic characteristics

Following the new territorial division of the Republic of North Macedonia from 2004, the area of the Municipality of Bitola is determined by law and covers the city of Bitola and 65 villages as follows: Bareshani, Bistrica, Bratin Dol, Brusnik, Bukovo, Velushina, Gabalavci, Gopesh, Gorno Egri, Gorno Orizari, Graeshnica, Dihovo, Dolenci, Dolno Egri, Dolno Orizari, Dragarino, Dragozani, Dragosh, Drevenik, Gjavato, Zabeni, Zlokukjani, Kazani, Kanino, Karamani, Kishava, Kravari, Krklino, Kremenica, Krstoar Kukurechani, Lavci, Lazec, Lera, Lisolaj, Logovardi, Lopatica, Magarevo, Malovishte, Metimir, Medzitlija, Nizepole, Novo Zmirnevo, Oblakovo, Oleveni, Opticari, Orehovo, Ostrec, Poeshevo, Porodin, Ramna, Rastani, Rotino, Svinishte, Sekirani, Snegovo, Sredno Egri, Srpci, Staro Zmirnevo, Strezevo, Trn, Trnovo, Capari, Crnobuki and Crnovec.

According to the 2002 census, there are 95.385 inhabitants in the municipality of Bitola, of which 74.550 live in the city of Bitola, while 20.835 in the 65 villages. The population density is 788 inhabitants per km^2.

The total number of the households in Bitola is 28.942 of which 23.010 are in Bitola and 5.932 in the villages, and the number of dwellings (all types of living quarters) is 37.225, of which 28.155 are in the city of Bitola and 9.070 are in the villages.

According to the ethnic affiliation, the population of Macedonian nationality is the largest, followed by the Albanians, Rhomas, Turks, and Vlachs etc. In more details, the numbers of the population by ethnic affiliation is presented in the table below.

Table 1 - Population in Municipality of Bitola by ethnic affiliation

Ethnic affiliation	**Total**	**Share (%)**
Macedonians	84.616	88,7
Albanians	4.164	4,36
Turks	1.610	1,69
Rhomas	2.613	2,73
Vlachs	1.270	1,34
Serbs	541	0,57
Bosniaks	21	0,03
Other	550	0,58

Source: State Statistical Office, Census 2002

Concerning the distribution of the population by sex in the Municipality of Bitola, 46.969 are male and 48.416 are females.

Taking into the consideration that the last census was conducted in 2002, State statistical office is preparing reports with estimation of the population in order providing updated data about the population in the country. Therefore, according to the last issued report for the estimation of the population on 31.12.2015 according to gender and age, by municipalities and by statistical region, the total number of citizens in Bitola was 92.203 inhabitants of whom 45.351 are male and 46.852

are female. *(Source: Population estimates on 30.06.2015 and 31.12.2015 by gender and age, by municipalities and statistical regions (NTES 3 - 2007) - State Statistical Office)*

From the economical point of view, in the table below are presented data in relation to the total population in the municipality at 15 years of age and over, according to the activity.

Table 2 - Population in Municipality of Bitola by activity

Municipality	**Total**	**Economically active**			**Economically non active**
		All	Employed	Unemployed	
Bitola	78.929	43.278	29.251	14.027	35.651

Source: State Statistical Office, Census 2002

According to the 2002 census, municipality of Novaci has total population of 3549 and 1125 households, and municipality of Mogila has population of 6710 and 1851 households.

2.3. Climate characteristics

The climate in Bitola region is characterized by moderate - continental climate with expressed seasons, while in the mountains there is a mountain climate. Winters are wet and cold, while summers are hot and dry.

According to the last issued report by the state statistical office “North Macedonia in numbers 2020” the average annual temperature in the area of Bitola for the year 2019 was 12.9 °C, the average annual rainfall was 576.4 mm, the number of days with rain was 101, number of days with snow was 17 and number of days with fog was 212. Source of the data is National Hydro meteorological Service of the Republic of North Macedonia.

2.3.1. Temperatures

The average annual temperature in the area of Bitola (Bitola field) is 11.3°C. The coldest month is January, with an average monthly temperature of -0.3 °C. The warmest month is July with an average monthly temperature of 21.6 °C. The average annual temperature oscillation is 21°C. Autumn is warmer than spring, with an average temperature difference of 0.9 °C. The local continental feature of the Pelagonija Valley is expressed by an absolute minimum temperature (29.4 °C).

On the figure below are presented data for the average temperature by month in the area of Bitola.

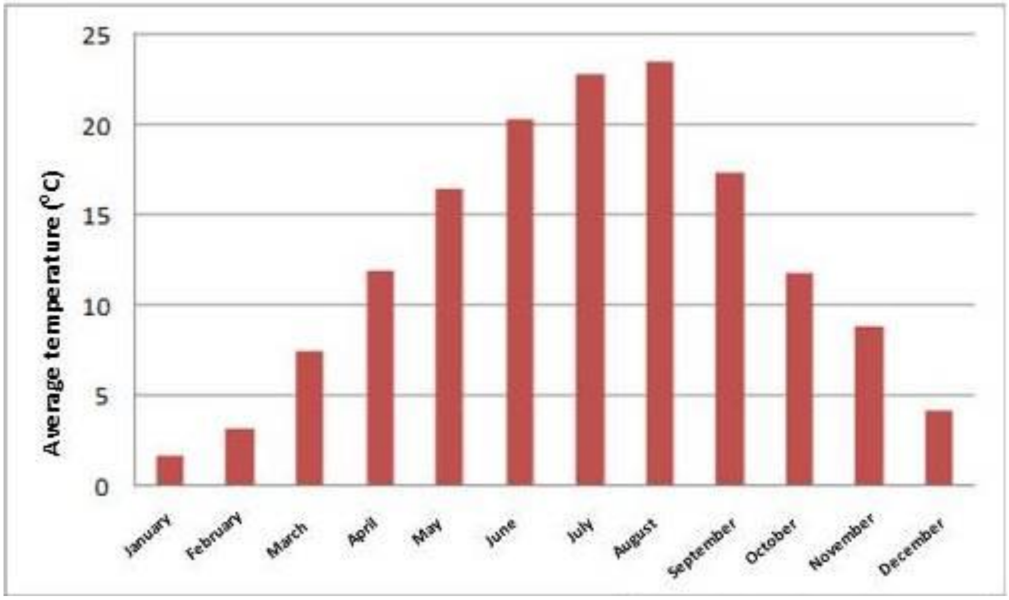


Figure 2 -Average temperature by month in the area of Bitola

2.3.2. Rainfall

The average annual rainfall is 598 mm. In certain years, the annual value varies from 359 mm to 818 mm. During the year, the rainfall is unevenly distributed. The main maximum is in November, with an average monthly value of 72 mm or 12% of the average annual value. Taking in consideration the rainfall by seasons, it is rainiest in the fall with an average seasonal value of 171 mm, and the least rainfall falls in the summer, averaging 106 mm.

The precipitation in the Pelagonija valley is mostly from rain and snow and occurs during the winter months. As an annual average, there are 34 to 36 days with snow cover. The Pelagonija Valley is characterized by a high frequency of dry periods. During the year, the dry periods are more intense in summer and autumn. Of the total number of dry periods, 61% are in these seasons and the other 39% in winter and spring. Summer droughts are 34%, autumn 27%, while winter droughts are 23%, and spring droughts are 16%.

The average annual solar radiation in the Pelagonija valley is 2,321 hours of solar radiation, or 6 hours per day on average. The maximum is in July, with a monthly average of 336 hours, or 10.8 hours per day on average.

2.3.3. Humidity

The average annual relative humidity is 70%, with a gradual decrease throughout the year from January to August, and then rapidly increasing from September to December. The highest monthly value of relative humidity occurs in January and ranges between 82% and 84%, while the lowest is in August with 57% and 56%. The Pelagonija Valley is characterized by an annual average of 25 days of fog. It is most common during the winter.

2.3.4. Winds

In the Pelagonija valley, dominant are the winds from the north and south. In the Bitola field, the north wind is dominant with an average annual frequency of 189 ‰, an average annual speed of 2.2 m/s and a maximum speed of 15.5 m/s.

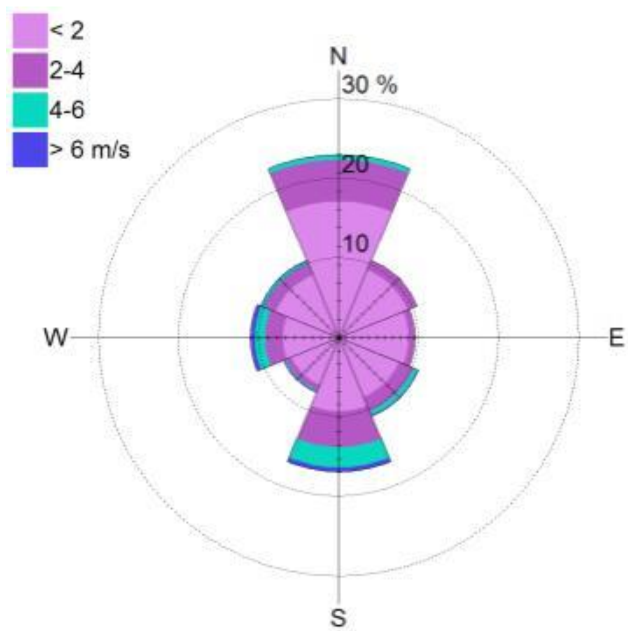


Figure 3 - Wind rose

The wind rose represents the average speed and wind direction in Bitola in the period 2008-2010. The data are based on synoptic meteorological observations from the HMS station in Bitola. The wind rose represents in percent (%) the average wind sectors (from where the wind blows) and the average wind speed (m/s) as a percentage (%) of each sector.

2.4. Topographic characteristics

Municipality of Bitola to the north is surrounded by four connected hills, with a height of 640 to 890 m, called Bair, which are part of the Oblakovsko - Snegovska Mountain (1.430 m). From the

south, the city is surrounded by the 744 m high hill Tumbe Cafe, which is a branch of the higher mountain site Neolica, and it is part of the vast Baba Mountain. To the east, Bitola is wide open to the valley bottom of Pelago- nija, and to the west, to the fluvioglacial deposits of the river Dragor, the wide Gjavato partition valley and the high Pelister.
(Source Local Environmental Action Plan of Bitola, 2016)

Hence, the relief of the municipality of Bitola is characterized by mountainous and lowland part, where on the western side stretches Baba Planina, and on the eastern side it occupies the central part of the valley bottom of Pelagonija.

The terrain on which Bitola lies is sloped from 715 to 585 m, from west to east, i.e. from Pelister and Baba Mountain to the Pelagonija valley, from 710 to 590 m, which means that the city has an average altitude of 650 m. These height differences significantly affect the appearance of the city and the structure of the cityscape. On one hand, the city is located on the plain, and on the other - on hilly land and floodplain terrain. Bitola is located in a zone where two different agricultural units are affected, agricultural - horticultural in the east, northeast and southeast and orchard-horticultural and livestock zone in the west and southwest.

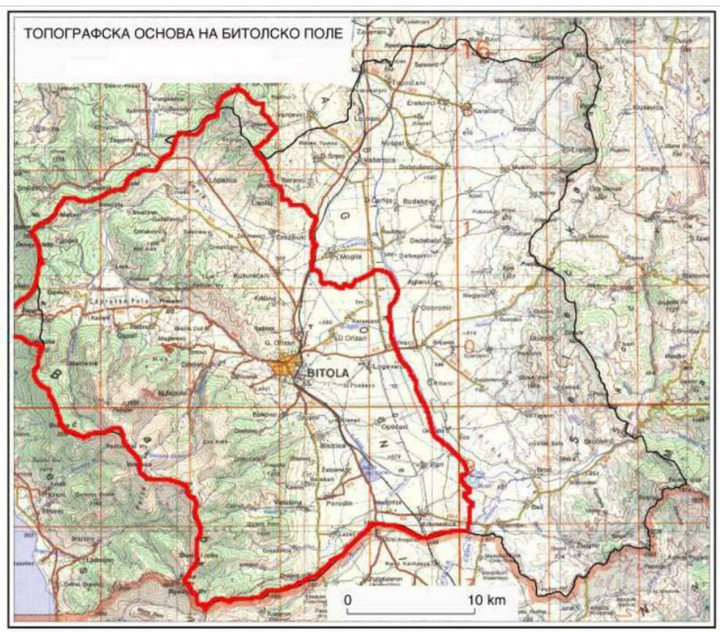


Figure 4 - Topographic map of the Bitola field

3. AIR QUALITY OF MUNICIPALITY OF BITOLA

3.1. Introduction

Ambient air is the outside air in the lower part of the troposphere, with the exception of the air in the working environment. Ambient air quality is the state of ambient air displayed through the degree of pollution. The main constituents of atmospheric air are nitrogen (78.08%), oxygen (20.95%) and argon (0.93%). Other components that are significantly present in the atmospheric air are water vapor and carbon dioxide (360 ppm).

The exponential growth of human activities, the development of technology, the increasing presence of various types of pollutants in the air that adversely affect human health, lead to damage to natural eco-systems, reduction of stratospheric ozone, visible degradation of the biosphere and modification of the weather and climate. In the air in urban and industrial environments are present a large number of pollutants, which can be classified in different ways (according to the chemical nature, origin, effects on the environment, etc.).

In the Republic of North Macedonia, the Ministry of Environment and Physical Planning (MOEPP) has set up an automatic network for monitoring the quality of ambient air through the Macedonian Environmental Information Center (MEIC).

On the figure below is provided the map of the State automatic monitoring system for monitoring ambient air quality.

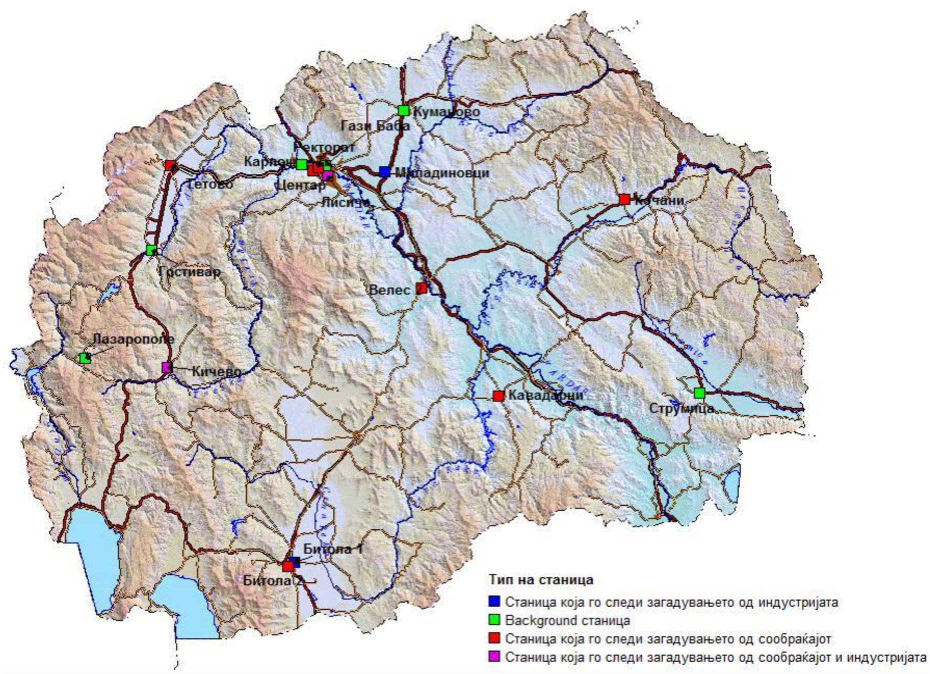


Figure 5 - State automatic monitoring system for monitoring ambient air quality

The monitoring of the ambient air quality in the Pelagonija region is conducted through two monitoring stations located in the municipality of Bitola. Both stations were set up in 2004.The first monitoring station (Bitola 1) is located at the site of meteorological station next to the Zlaten dab warehouse, at the entrance to the city of Bitola and covers the industrial part of the city(41°02’30,04 N 21°21’11,93E). This station monitors the following parameters: O_3, NO_2, SO_2, CO and PM_{10}. The second monitoring station (Bitola 2) is located in the center of the city in front of the administrative building of PUE "Strezevo" next to the Police station and covers the urban area of the city (41°01’55,48 N 21°20’00,38 E). This station monitors the following parameters: O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$. *(Source: http://airquality.moepp.gov.mk/).* Beside the parameters mentioned above, both stations monitor me- teorological parameters such as: wind speed and direction, temperature, pressure, humidity and global solar radiation. Locations of the monitoring stations are presented on the following figure.

Figure 6 - Location of monitoring stations Bitola 1 and Bitola 2

3.2. Data analysis from the measurement of the ambient air quality in Bitola

Analysis of the ambient air quality in Bitola is based on the available data from the air quality monitoring stations Bitola 1 and Bitola 2 in the period of 2015 – 2019. In the analysis were used criteria, methods and procedures specific for each of the basic pollutants prescribed in the Rulebook for criteria, methods and procedures for assessment of ambient air quality (Official Gazette No. 169/13). For the pollutants for which data are available, a comparison is made with the limit values prescribed in the domestic legislation, while for those for which no data are available, assumptions of their concentration level is made.

Sulfur dioxide is invisible gas with sharp smell. It reacts with other substances and forms harmful substances such as acids and sulfate particles. The largest source of sulfur dioxide in the air (app. 99%) comes from industrial activities for generation of electricity from coal, oil or gas that contain sulfur and other industrial facilities. Smaller sources of sulfur dioxide are industrial processes for extraction of mineral ores which contain sulfur, natural sources (volcanoes), vehicles and heavy equipment that burn fuel with high sulfur content. Sulfur dioxide can harm both human health and the environment. Exposure to this gas can harm human respiratory system and is especially harmful to children and people with asthma. Height concentrations of SO_2 in the air lead to formation of other sulfur oxides which can react with other compounds in the atmosphere and form particles which contribute to PM pollution. Beside health, SO_2 at high concentrations can harm trees and plants by damaging foliage and de- creasing growth.

National air legislation is regulating this parameter with two limit values (hourly and daily) for health protection as well as a limit value for protection of ecosystems. The limit values for SO_2 are presented on the following Table.

Table 3 - Limit values for SO_2

Average period	Limit values for health protection	Number of allowed exceedances	Alert threshold	Limit value for protection of ecosystem
Hour	350 µg/m³	24times within one calendar year		
Day	125 µg/m³	3 times within one calendar year		
3 consecutive hours			500 µg/m³	
1 year				20 µg/m³

Calculated values of data coverage in the period 2015 - 2019 for both monitoring stations are presented on the following Table.

Table 4 - SO_2 Data coverage

	2015	2016	2017	2018	2019
Bitola 1	65%	91%	54%	86%	98%
Bitola 2	0%	64%	88%	83%	86%

From the Table above it is evident that the required minimum data coverage of 90% is achieved only for Bitola 1 in 2016 and 2019 while for Bitola 2 it is not achieved at all. However, due to the relatively high data coverage for both locations the analysis will be performed on the data with data coverage of 75%.

The average annual concentration of SO_2 for the period 2015 - 2019 can be seen on the following figure.

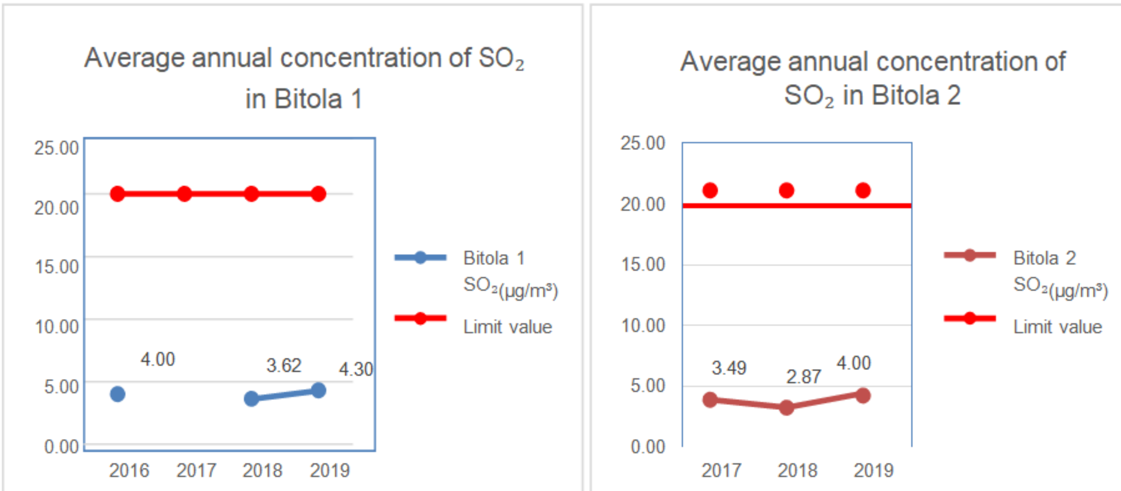
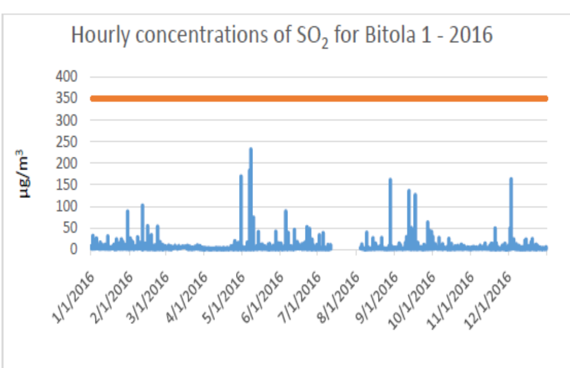
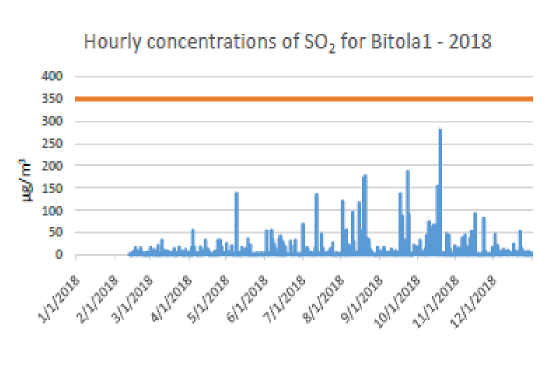


Figure 7 - Average annual concentration of SO_2 in Bitola 1 and Bitola 2

Data from the both monitoring stations show that the average annual concentration of SO_2 are in the range of 2,87 to 5,46 μg/m^3 in the whole analyzed period and are far below the prescribed limit for protection of vegetation (20 μg/m^3).

Hourly concentrations of SO_2 for Bitola 1 in 2016, 2018 and 2019 are presented in the following diagrams.





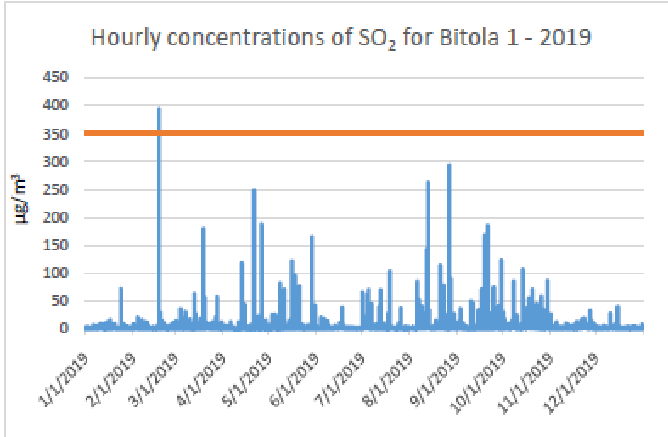
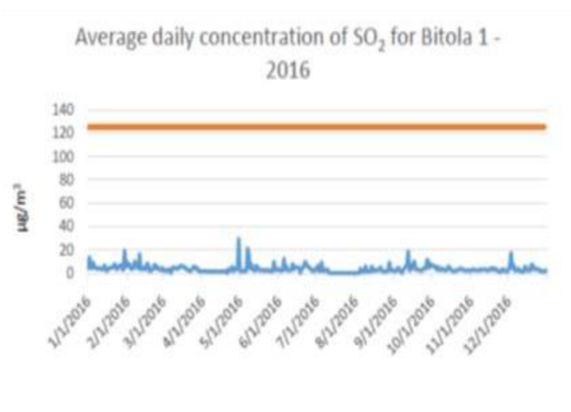
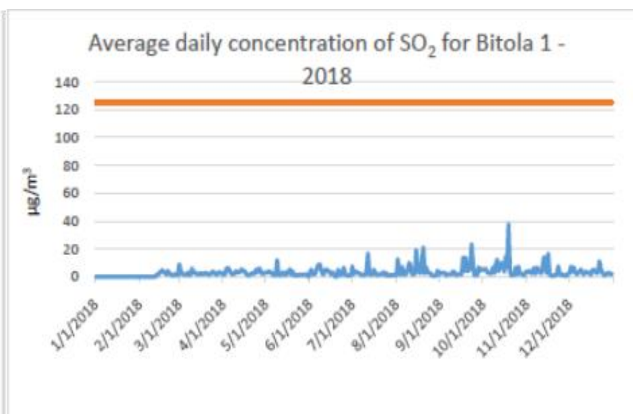


Figure 8 - Hourly concentrations of SO_2 for Bitola 1 in 2016, 2018 and 2019

From the above diagrams can be seen that the hourly concentration of SO_2 in the analyzed years is exceeded only once in 2019 with measured concentration of 393;20 µg/m^3. As the number of exceedances is below the allowed number of exceedances in one calendar year it means that the concentration of SO_2 is within the prescribed limit value.

Average daily concentration of SO_2 for location Bitola 1 for the above mentioned years is presented on the following diagrams.





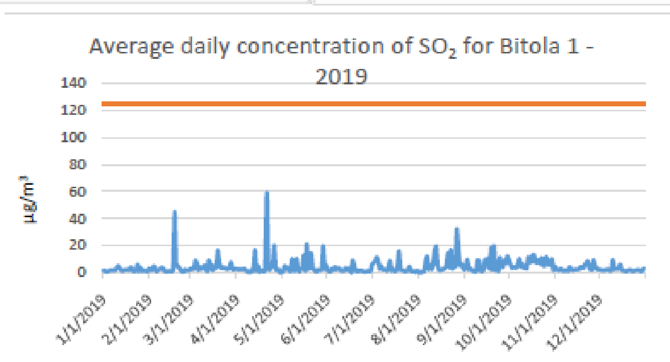


Figure 9 - Average daily concentration of SO_2 for location Bitola 1

From the above diagrams it is evident that there is no ecxeedance of the average daily concentration of SO_2 for location Bitola 1in all analyzed years.

Regarding monitoring station Bitola 2, the hourly concentrations of SO_2 for the period 2017– 2019 are presented on the following diagrams.

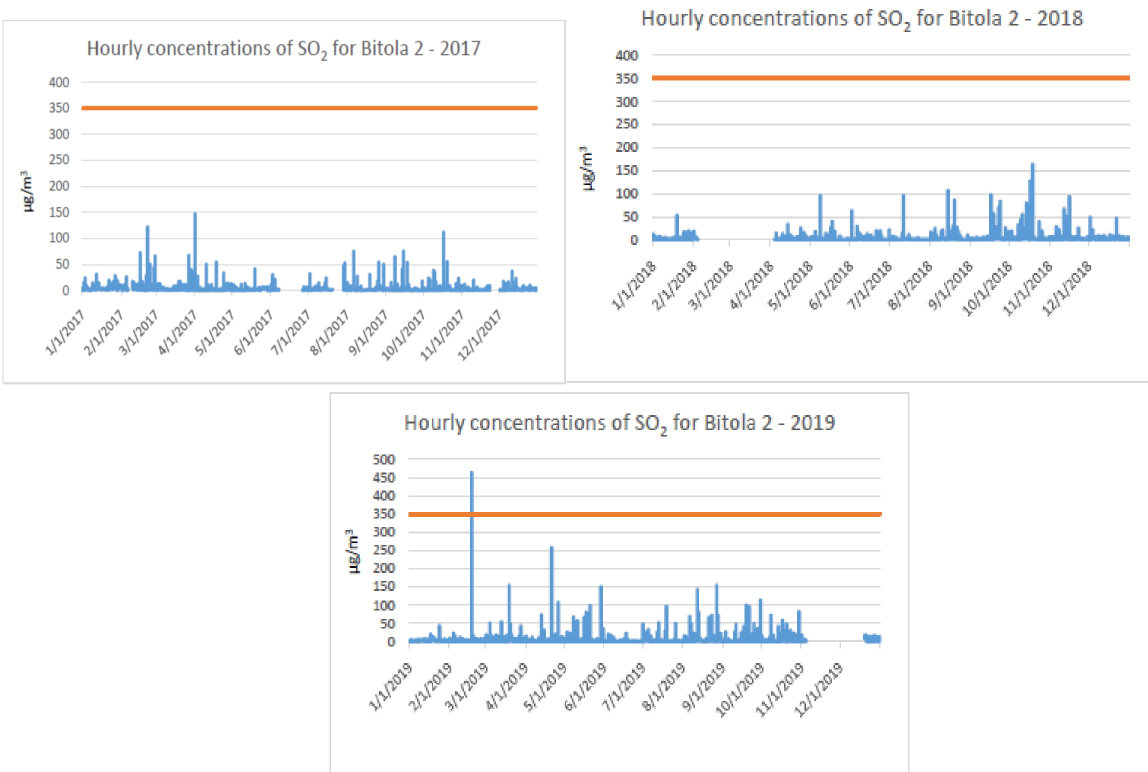


Figure 10 - Hourly concentrations of SO_2 for location Bitola 2 for the period 2017– 2019

Hourly concentrations of SO_2 for location Bitola 2 presented above clearly show that there is only one exceedance of the hourly limit value in February 2019 as it was the case for location Bitola 1 when it were measured 463,30 µg/m^3. However, as mentioned also above, the exceedance of the hourly concentration happened only once in a calendar year which means that the concentration of SO_2 is within the prescribed limit value.

Average daily concentration of SO_2 for Bitola 2 in the period 2017– 2019 is presented in the following diagrams.

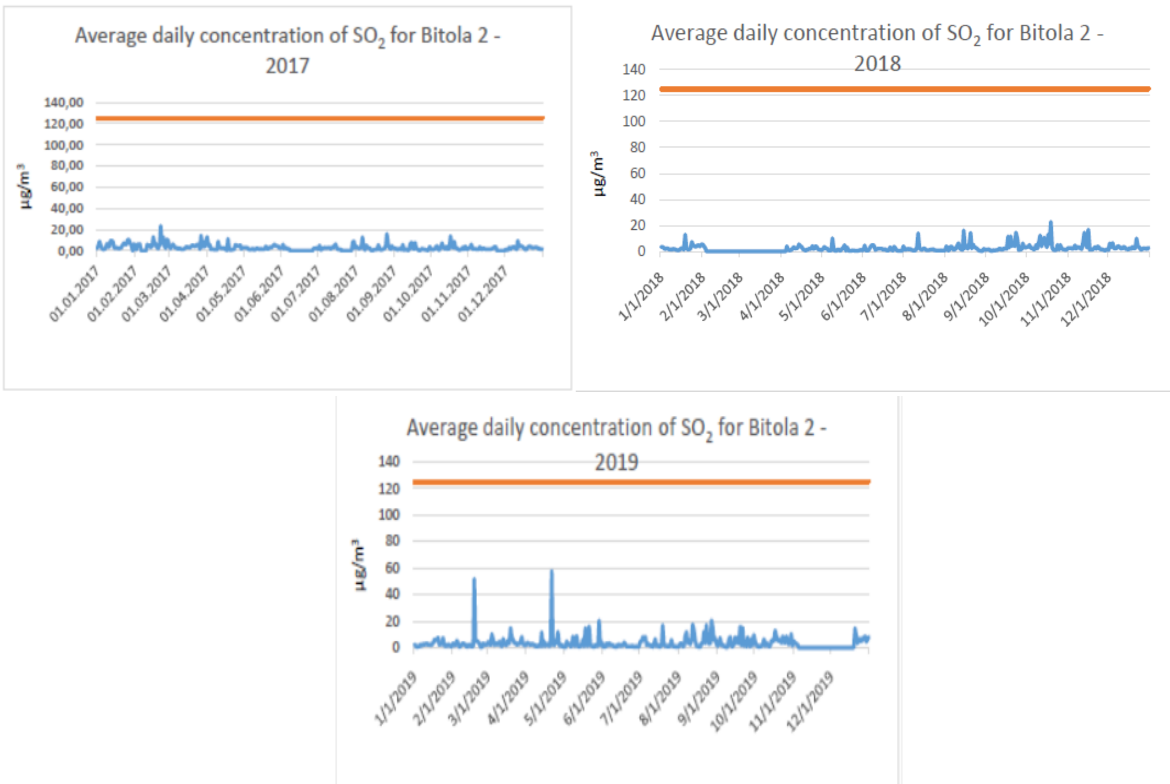


Figure 11 - Average daily concentration of SO_2 for Bitola 2 in the period 2011– 2019

From the above diagrams it is evident that the average daily concentration at Bitola 2 location is bellow the prescribed limit value of 125 µg/m^3 in the whole analyzed period.

Taking into consideration all the above diagrams it can be summarized that the hourly concentration of SO_2 is exceeded only once (in February 2019) at both locations from the allowed number of exceedances which is 24 within one calendar year. On the other hand, the average daily concentration of SO_2 is within the prescribed limits for both locations in the whole analyzed period. Based on this can be concluded that SO_2 is not a critical pollutant for Bitola.

<u>Nitrogen oxide (NOx)</u>

Nitrogen oxides are a group of seven gases and compounds composed of nitrogen and oxygen, some- times collectively known as NOx gases. The two most common and hazardous oxides of nitrogen are nitric oxide and nitrogen dioxide. Nitrous oxide, commonly called laughing gas, is a greenhouse gas that contributes to global warming. The major sources of NOx are vehicles, burning of coal, oil, diesel fuel and natural gas especially from electric power plants. They are also emitted by cigarettes, gas stoves, kerosene heaters, wood burning, and silos that contain silage. Nitrogen oxides can create environmental health hazards when they react with sunlight and other chemicals to form smog. Nitrogen oxides and sulphur dioxide react with substances in the atmosphere to form acid rain. Elevated levels of NOx can damage human respiratory system and cause respiratory infections and asthma. Long-term exposure to this gas can cause chronic lung disease. High levels of NOx are also harm for the environment causing damage of foliage, decrease growth or reducing crop yield.

According to national legislation, concentration of NO_2 is regulated with limit values presented in the following Table.

Table 5 - Limit values for NO_2

Average period	Limit values for health protection	Number of allowed exceedances	Alert threshold	Limit value for protection of ecosystem
Hour	200 µg/m^3	18		
Annual	40 µg/m^3	0		
3 consecutive hours			400 µg/m^3	
1 year				30 µg/m^3

The calculated values of data coverage for concentration of NO_2 measured on both locations in the period 2015 – 2019 are presented on the following Table.

Table 6 - NO_2 Data coverage

	2015	2016	2017	2018	2019
Bitola 1	0%	0%	44%	57%	61%
Bitola 2	0%	64%	92%	85%	91%

Data presented in the above table show that the required minimum of 90% is achieved only for location Bitola 2 for 2017 and 2019. As there is a lack of additional data for NO_2 concentration, analysis will be performed on the data with data coverage of at least 75%. The annual average concentration of NO_2 and exceedances of the daily and annual limit value of NO_2 in the period 2017- 2019 for Bitola 2 is presented on the Figure 12 below.

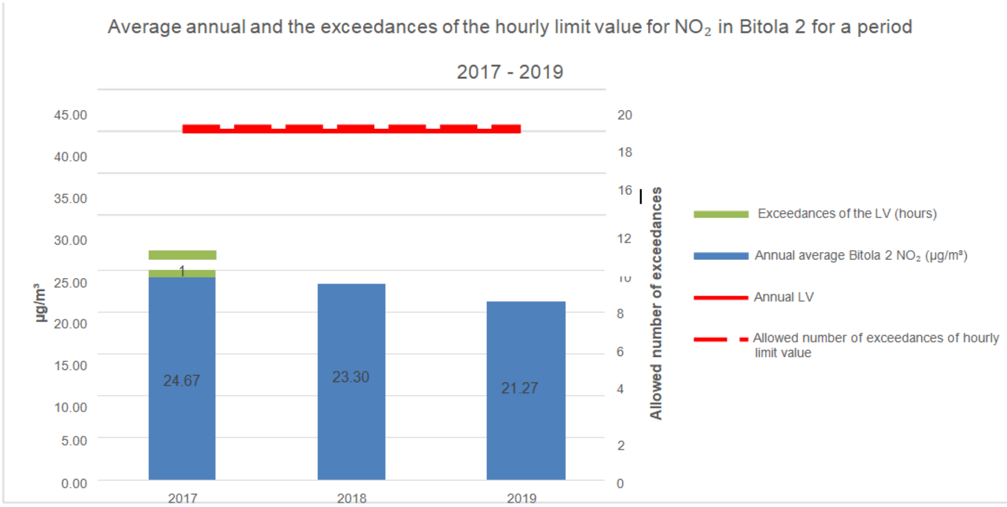


Figure 12 - Average annual and exceedance of the hourly limit value for NO_2 in Bitola 2 in the period 2017 -2019

From the above diagram it can be seen that there is one exceedance of the hourly limit value which happened in 2017 and no exceedance of the annual average in the whole analyzed period for NO_2.

Hourly concentrations of NO_2 for Bitola 2 in the period 2017-2019 are presented in the following figure.

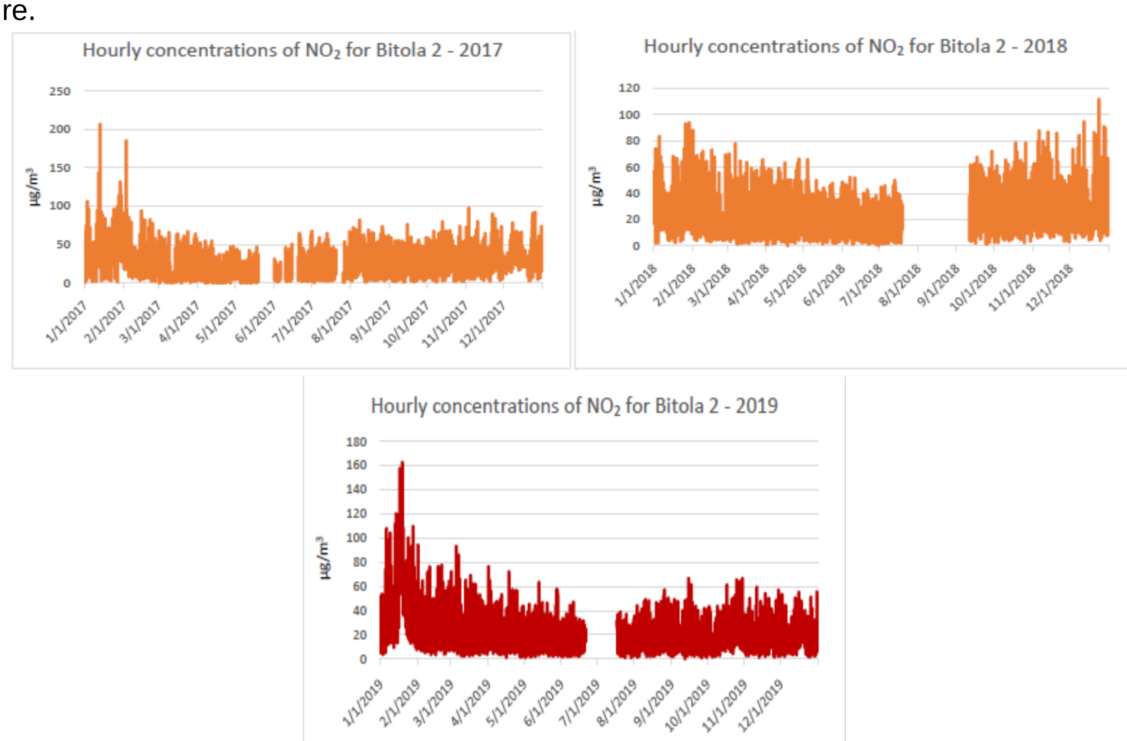


Figure 13 - Hourly concentration of NO_2 measured on location Bitola 2 in the period 2017-2019

On the diagrams presented above can be seen that there is one exceedance of the hourly limit value of NO_2 on this location in January 2017 with measured concentration of 206,50 μg/m^3. However, the number of exceedances is far below the allowed number of 18 exceedances per year.

The average daily variation of the concentration of NO_2 for the whole analyzed period is presented on the diagrams presented in the following figure.

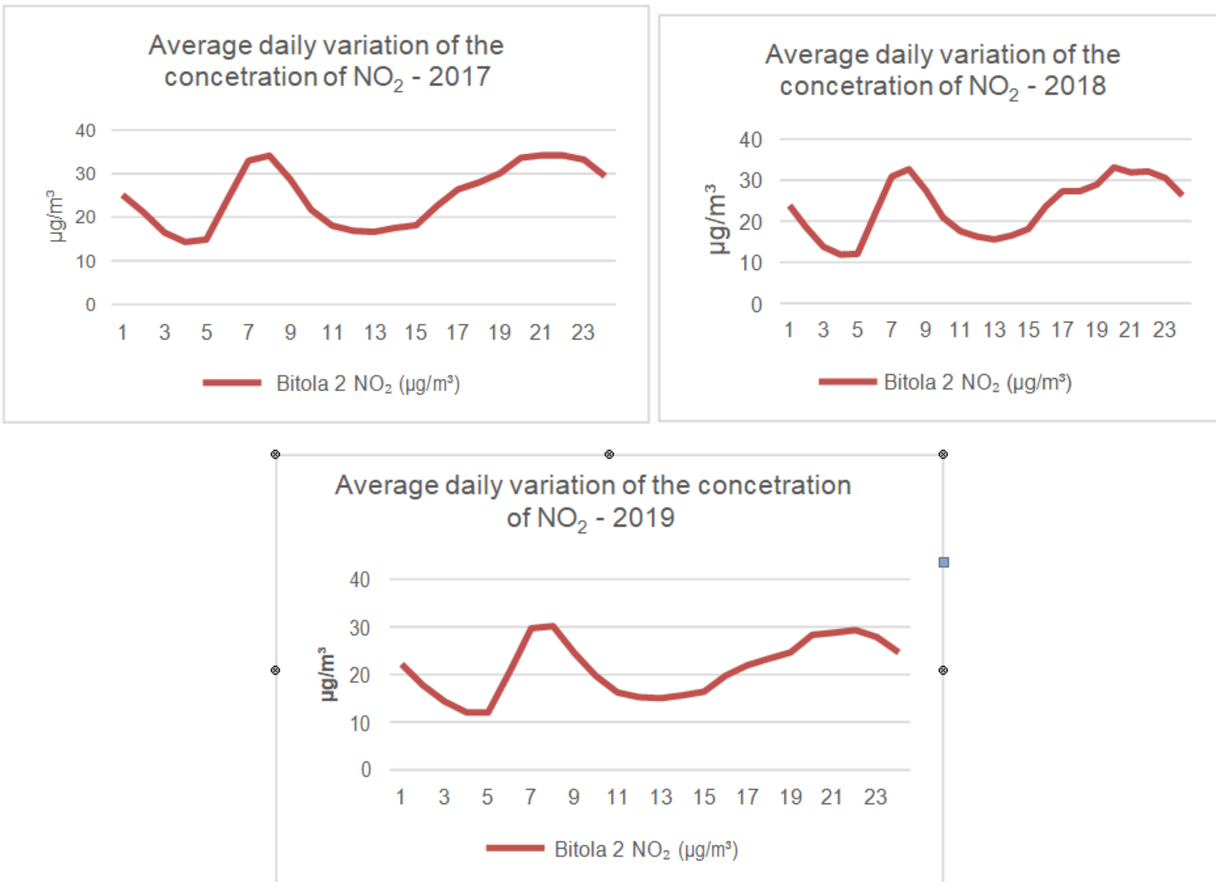


Figure 14 - Average daily variation of the concentration of NO_2

As it can be seen on the diagrams presented above there are two peaks on each diagram presenting the daily concentration of NO_2 at around 8 o'clock in the morning and at 21:00 in the evening. As the major sources of this parameter are vehicles and burning of fuels the morning high value of NO2may be due to the rush hour when inhabitants are travelling to work. On the other hand, the higher concentration of NO_2 in the evening, at around 21:00 is after the usual rush hour when inhabitants are returning from work and needs further assessment in order to determine the source of this increase. However, based on the results presented above can be concluded that NO_2 is not a critical parameter for Bitola.

<u>Particulate matter PM</u>

Particulate air pollution is a mixture of solid, liquid or solid and liquid particles suspended in the air and these vary in size, composition and origin. While some particles, (such as dust, dirt, soot, or smoke) are large or dark enough to be seen with the naked eye, others are so small that can only be detected using an electronic microscope. Particle pollution includes: PM_{10} with diameters that are generally 10 micrometers and smaller and $PM_{2.5}$ with diameters that are generally 2.5 micrometers and smaller.

Most particles form in the atmosphere as a result of complex reactions of chemicals such as sulfur dioxide and nitrogen oxides, which are pollutants emitted from power plants, industries and incinerators. PM can absorb and transfer multitude of pollutants which results in its composition variation. However, PM mainly comprises of ions, reactive gases, organic compounds, metals, and particle carbon core.
The size, surface, number and composition of the particles play an important role in the strength and type of health effects they cause. The part of respiratory system affected by PM depends upon the size of particle. The upper respiratory tract is affected by PM_{10} while lung alveoli are affected by ultrafine particles (0.1 mm diameter). Regarding to mortality, respiratory and cardiovascular effects it can be concluded that finer particles are more hazardous to human health than the coarser ones. Particulate matter can cause premature mortality in patients suffering from lung or heart disease, nonfatal heart at- tacks, aggravate asthma, reduced lung functionality, irritation in airways, coughing difficult breathing etc. In 2013, it was classified as a cause of lung cancer by WHO's International Agency for Research on Cancer (IARC). It is also the most widely used indicator to assess the health effects from exposure to ambient air pollution.

Beside human health, particulate matter pollution has also negative impact on the environment causing acid rain and climate change. In addition, it can also change weather patterns, cause drought, contribute to global warming, and cause acidification of the oceans.

Particulate matter PM_{10}

As a pollutant with severe effect on human health, particulate matter PM_{10} is regulated in the national legislation with limit values presented in the following table.

Table 7 - Limit values for PM_{10}

Average period	Limit values for health protection	Number of allowed exceedances	Alert threshold	Limit value for protection of ecosystem
24 h	50 µg/m³	35 times in one calendar yean	100 µg/m³ and forecast for stable weather (consecutive 2 days)	
Annual	40 µg/m³	0		

2 consecutive days			200 µg/m^3 and forecast for stable weather (2 consecutive days) (information threshold)	

Calculated values of the data coverage for concentrations of PM_{10} for both locations in the period 2015-2019 are presented on the following Table.

Table 8 - PM_{10} Data coverage

	2015	2016	2017	2018	2019
Bitola 1	94%	77%	99%	92%	48%
Bitola 2	84%	97%	81%	84%	48%

Data presented in the above table show that fulfillment of the required minimum of 90% data coverage is achieved for Bitola 1 for 2015, 2017 and 2018 while for Bitola 2 only in 2016. Taking into consideration the relatively high data coverage for both locations, the analysis was performed on all data with data coverage of 75%. Therefore, data for 2019 will not be taken into consideration in the further analysis for both locations.

The annual average concentration of PM_{10} and the exceedance of the daily limit values for Bitola 1 in the period 2015-2018 are presented on the following figure.

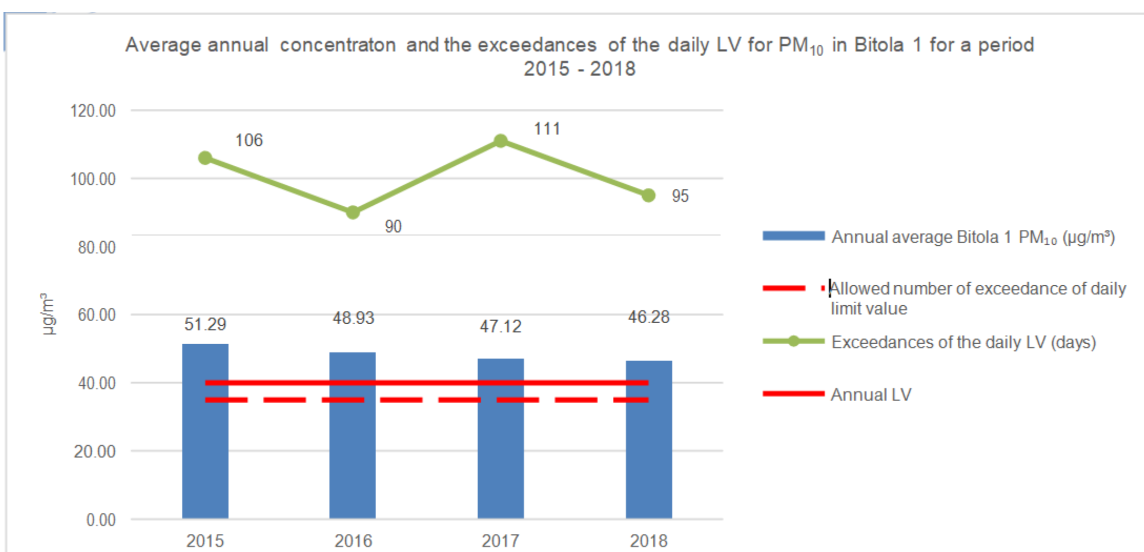


Figure 15 - Average annual concentration of PM_{10} and exceedance of the daily limit value for Bitola 1 for a period 2015 – 2018

From the above figure can be seen that the annual average value for protection of human health and the daily limit value for health protection are exceeded in the whole analyzed period.

The annual average concentration of PM_{10} and the exceedance of the daily limit values for Bitola 2 in the period 2015-2018 are presented on the following figure.

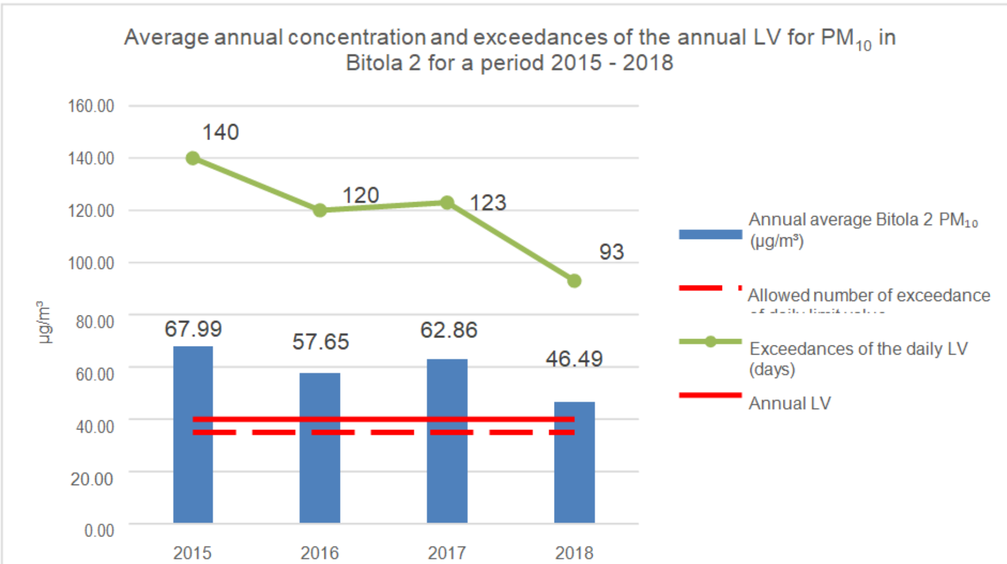


Figure 16 - Average annual concentration of PM_{10} and exceedance of the daily limit value in Bitola 2 for a period 2015 - 2018

For Bitola 2, the diagram above shows that both values (the annual average and the daily limit value for health protection) are exceeded in the whole analyzed period.

The average daily concentration of PM_{10} for the period 2015 – 2018 for both locations is presented on the figures below.

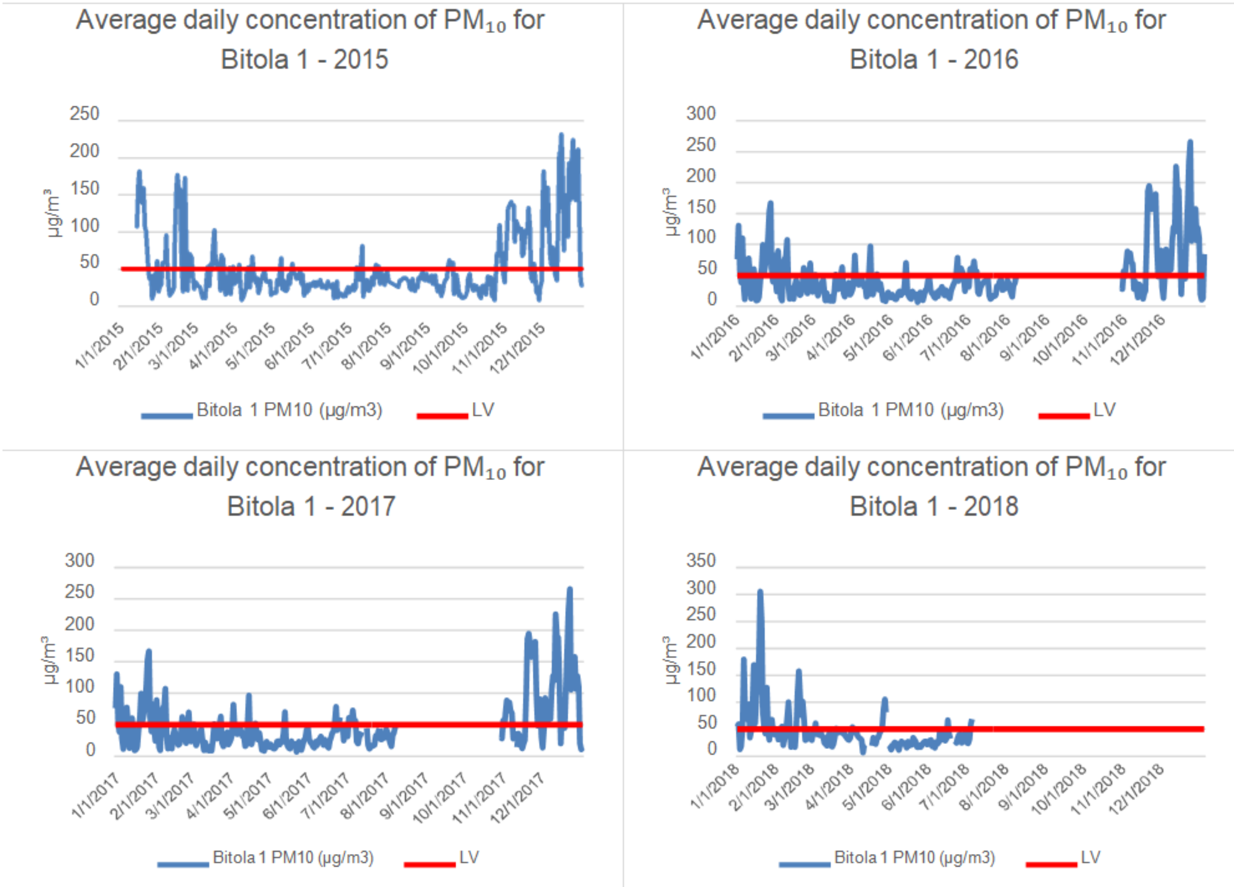


Figure 17 - Average daily concentration of PM_{10} for Bitola 1

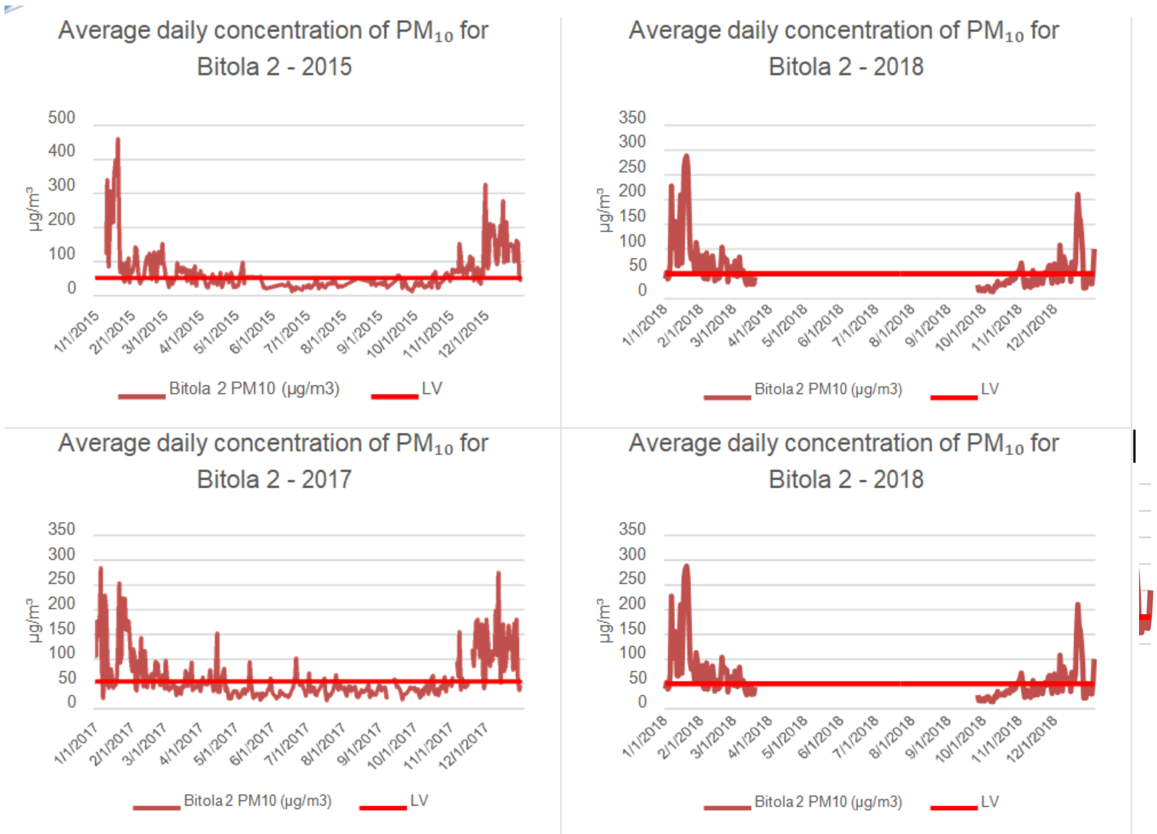
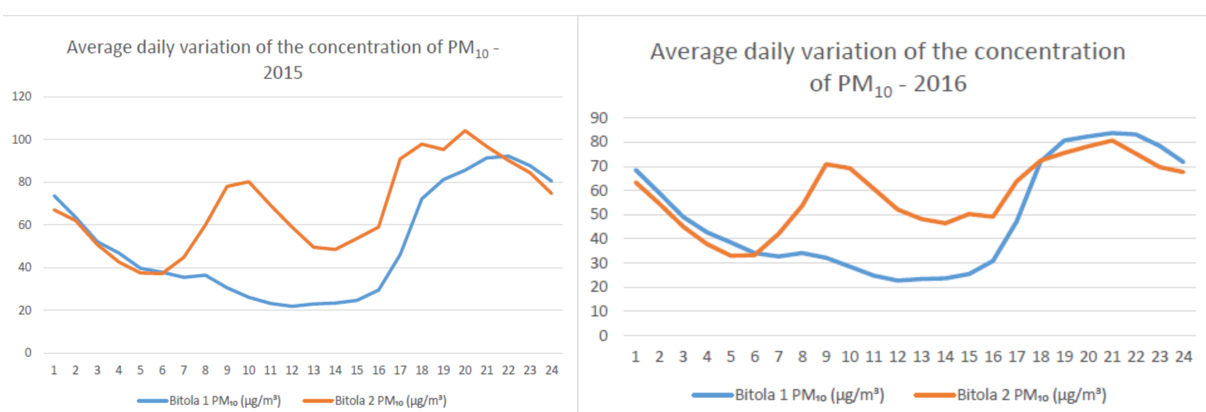


Figure 18 - Average daily concentration of PM_{10} for Bitola 2

The variation of the daily concentrations is very similar on both locations during the whole analyzed period. As it can be seen from the above diagrams, the concentrations of PM_{10} are highest in the winter period. However, a lot of exceedances of the daily limit values can be seen on both locations also in the summer period during the whole analyzed period.

Comparison of the daily variation of the concentration of PM_{10} for both locations in the analyzed period is presented on the diagrams bellow.



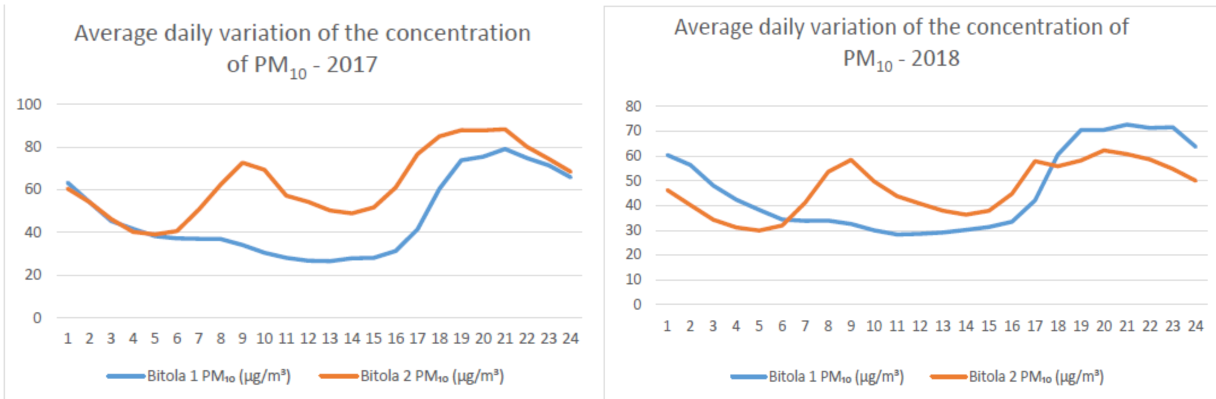


Figure 19 - Daily variation of the concentration of PM_{10} in the analyzed period at Bitola 1 and Bitola 2

From the above figures it can be concluded that in the whole analyzed period the average daily concentration of PM_{10} measured on the measurement point Bitola 2 located in the center of the city are higher than those measured in Bitola 1 located at the entrance of the city. The reason for this difference may be the impact from the traffic in the center of the city which causes higher concentrations at around 09.00 in the morning and 19.00 in the evening. On the other hand, highest PM_{10} concentrations at Bitola 1 are measured in the period 20.00 – 03.00 which indicates on impact from industrial source as this monitoring station is located in the industrial part of the city.

The analysis presented above clearly shows that PM_{10} is a critical parameter for the city of Bitola.

Particulate matter ($PM_{2.5}$)

Limit values for $PM_{2.5}$ set in the national legislation are shown in the following table.

Table 9 - Limit values for $PM_{2.5}$

Average period	Limit values for health protection	Number of allowed exceedances	Alert threshold	Limit value for protection of eco-system
Annual	25 µg/m^3	0		

Calculated values of the data coverage for concentrations of $PM_{2.5}$ for both locations in the period 2015-2019 are presented on the following Table.

Table 10 - $PM_{2.5}$ Data coverage

	2015	2016	2017	2018	2019
Bitola 1	0	0	0	0	0
Bitola 2	0	0	43%	84%	48%

Concentration of $PM_{2.5}$ is measured only in monitoring station Bitola 2. Taking into consideration that the data coverage for 2017 and 2019 is below 75% in the analysis will be included only data for 2018. The annual average and the exceedance of the annual limit value for $PM_{2.5}$ in Bitola 2 for 2018 are presented on the following diagram.

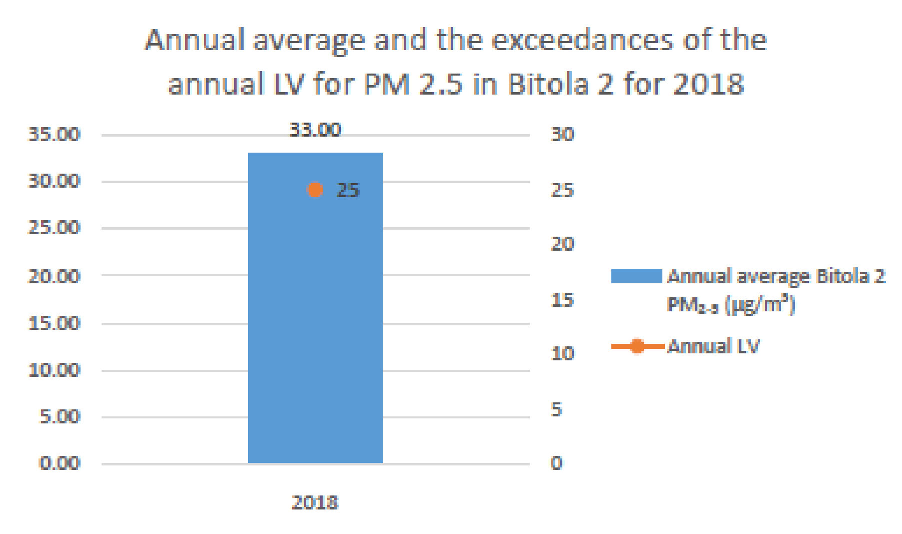


Figure 21 - Annual average and the exceedance of the annual limit value for $PM_{2.5}$ in Bitola 2

From the diagram above it is evident that the annual average concentration of $PM_{2.5}$ is exceeding the annual limit value. This is not unusual taking into consideration that the concentration of $PM_{2.5}$ is around 70-80% of the concentration of PM_{10}. Taking into consideration that the average annual concentration of PM_{10} is above 46 µg/m^3, it is expected this trend to be followed by $PM_{2.5}$ which makes it a critical pollutant for Bitola.

<u>Ozone (O_3)</u>

Ozone is a gas composed of three atoms of oxygen (O_3) which occurs both in the Earth's upper atmosphere and at ground level. It can be good or bad, depending on where it is found. Good ozone (stratospheric ozone), occurs naturally in the upper atmosphere, where it forms a protective layer that shields us from the sun's harmful ultraviolet rays. This ozone has been partially destroyed by manmade chemicals, causing what is sometimes called a "hole in the ozone". Bad ozone or the one at the ground level is a harmful air pollutant, because of its effects on people and the environment. This ozone is the main ingredient in “smog".

Tropospheric, or ground level ozone, is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC). This

happens when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources chemically react in the presence of sunlight.
The level of ozone is most likely to increase on hot sunny days in urban environments and reach unhealthy levels. However, it can reach high levels even during colder months. Ozone can also be trans- ported long distances by wind, so even rural areas can experience high ozone levels.
Increased ozone levels can impact human health. It can irritate the nose and lungs. People exposed to enough ozone might feel some pain in their ears, eyes, nose and throat. People with asthma might have more attacks and athletes might find it harder to perform as well as usual.
In the national legislation ozone is regulated with target values, presented in the following table.

Table 11 - Target value for ozone, O_3

Average period	Target value for health protection	Number of allowed exceedances	Information threshold	Alert threshold	Target value for protection of vegetation
Maximum daily 8h mean concentration	120 µg/m³	25 days within a calendar year with mean value measured within 3 years	180µg/m³ (one hour average)	240 µg/m³ (one hour average)	
AOT40, calculated from 1 h values for the period May - July					18000 µg/m³h calculated average for period of 5 years

	Parameter	Long term target
Long term target for health protection	Maximum daily 8hours mean value of the concentration during a calendar year	120 µg/m³
Long term target for protection of vegetation	AOT40, calculated from 1 h values for the period May - July	6000 µg/m³h

Calculated values of the data coverage for concentration of ozone for both locations in the period 2015-2019 are presented on the following Table. According to legislation the needed minimum data coverage for ozone is 75% for the winter period (January – March, October – December) and 90% for the summer period (April - September). Data coverage for both locations (Bitola 1 and Bitola 2) is presented on the following tables.

Table 12 - O_3 Data coverage for Bitola 1

	2015	2016	2017	2018	2019

Data coverage in winter period	93%	80%	100%	100%	100%
Data coverage in summer period	100%	90%	99%	98%	71%

Table 13 - O_3 Data coverage for Bitola 2

	2015	2016	2017	2018	2019
Data coverage in winter period	94%	97%	99%	96%	94%
Data coverage in summer period	87%	97%	87%	89%	100%

From the above tables can be seen that the required data coverage is achieved in Bitola 1 for the period 2015 – 2018 while for Bitola 2 for the whole period 2015 - 2019.

The maximum daily average 8-hours value of O_3 which is a long term target for health protection at locations Bitola 1 and Bitola 2 for the period 2015 -2019 is presented on the following diagrams.

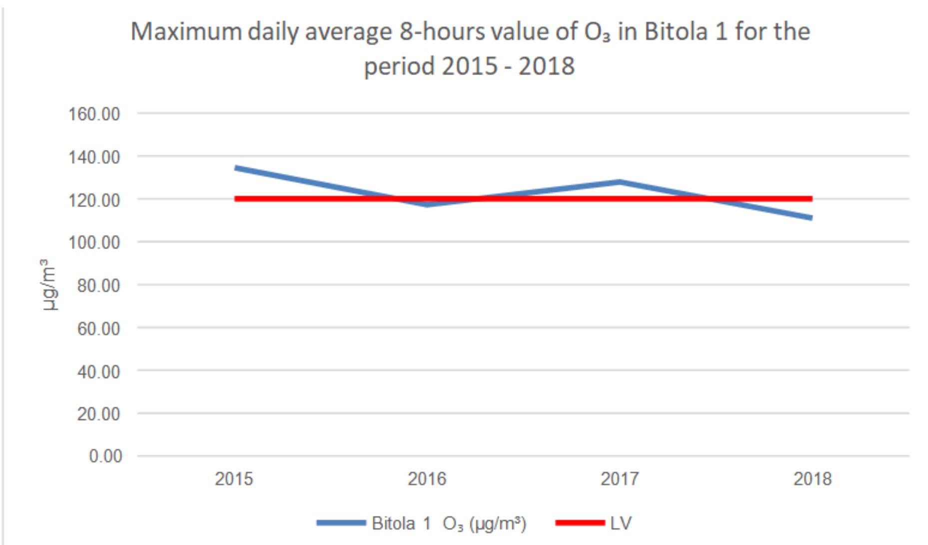


Figure 22-The maximum daily average 8-hours value of O_3 at Bitola 1 for the period 2015 -2018

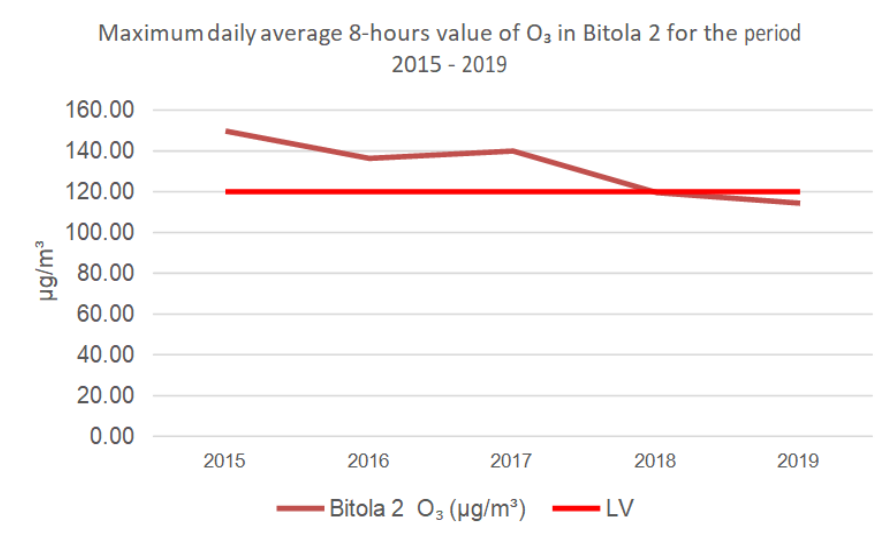


Figure 23 - The maximum daily average 8-hours value of O3 at Bitola 2 for the period 2015 -2019

From the above diagrams can be seen that the maximum daily average 8-hours mean value is exceeding the long-term target of 120 µg/m^3 for health protection in Bitola 1 in 2015 and 2017 while in Bitola 2 in 2015, 2016 and 2017.

The number of exceedances of the target value for O_3 at both locations is presented on the following tables.

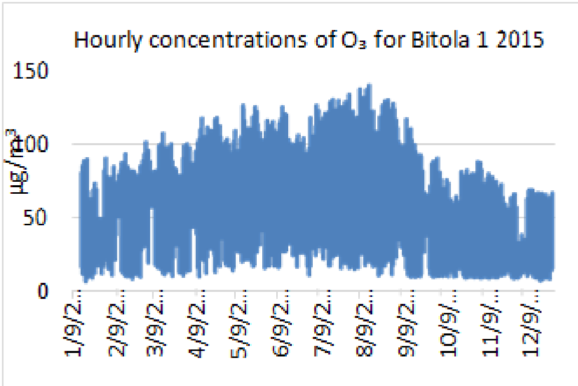
Table 14 - Number of exceedances of the maximum daily 8 hours mean value for health protection on both locations per year

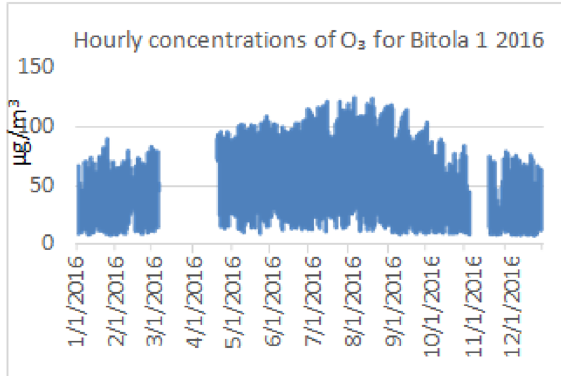
Bitola 1	2015	2016	2017	2018
Number of exceedance per calendar year	17	0	16	0

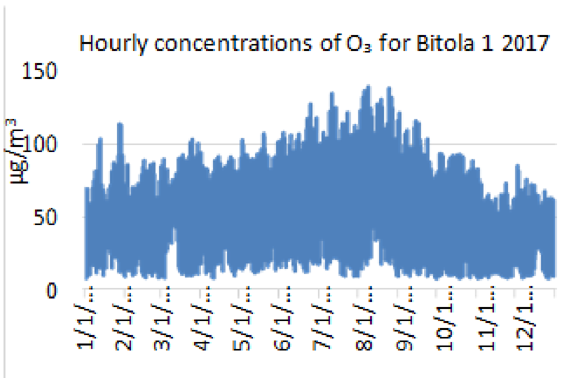
Bitola 2	2015	2016	2017	2018	2019
Number of exceedance per calendar year	75	40	28	0	0

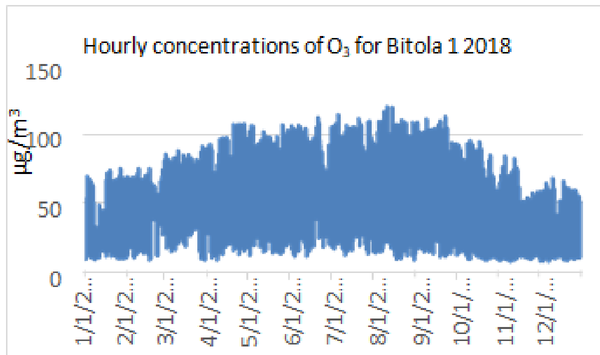
From the tables above it is evident that the allowed number of exceedance which is 25 per calendar year this limit value is exceeded only for Bitola 2 in the period 2015-2017.

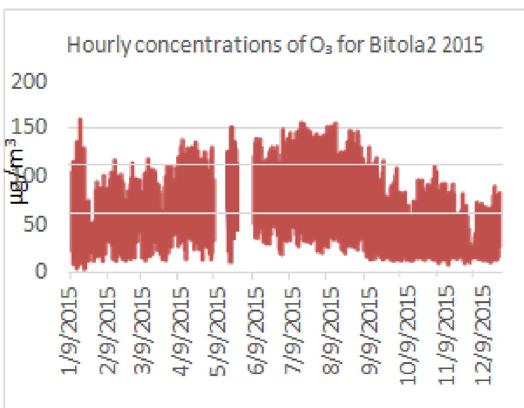
The hourly measurement of the concentration of O_3 for the analyzed period at both locations is presented on the following diagrams.

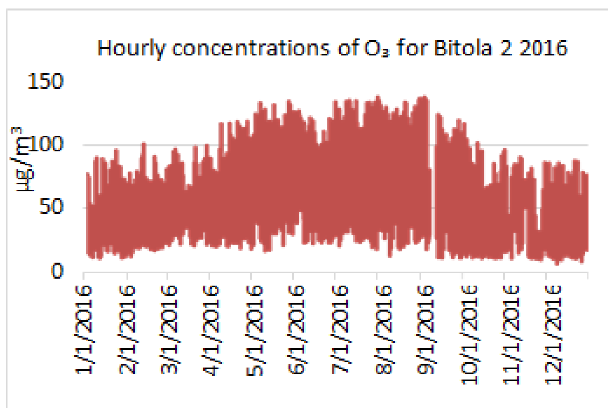

Hourly concentrations of O₃ for Bitola 1 2015
µg/m³
150
100
50
0
1/9/2…
2/9/2…
3/9/2…
4/9/2…
5/9/2…
6/9/2…
7/9/2…
8/9/2…
9/9/2…
10/9/…
11/9/…
12/9/…


Hourly concentrations of O₃ for Bitola 1 2016
µg/m³
150
100
50
0
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016


Hourly concentrations of O₃ for Bitola 1 2017
µg/m³
150
100
50
0
1/1/…
2/1/…
3/1/…
4/1/…
5/1/…
6/1/…
7/1/…
8/1/…
9/1/…
10/1…
11/1…
12/1…


Hourly concentrations of O₃ for Bitola 1 2018
µg/m³
150
100
50
0
1/1/2…
2/1/2…
3/1/2…
4/1/2…
5/1/2…
6/1/2…
7/1/2…
8/1/2…
9/1/2…
10/1/…
11/1/…
12/1/…


Hourly concentrations of O₃ for Bitola2 2015
µg/m³
200
150
100
50
0
1/9/2015
2/9/2015
3/9/2015
4/9/2015
5/9/2015
6/9/2015
7/9/2015
8/9/2015
9/9/2015
10/9/2015
11/9/2015
12/9/2015


Hourly concentrations of O₃ for Bitola 2 2016
µg/m³
150
100
50
0
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016

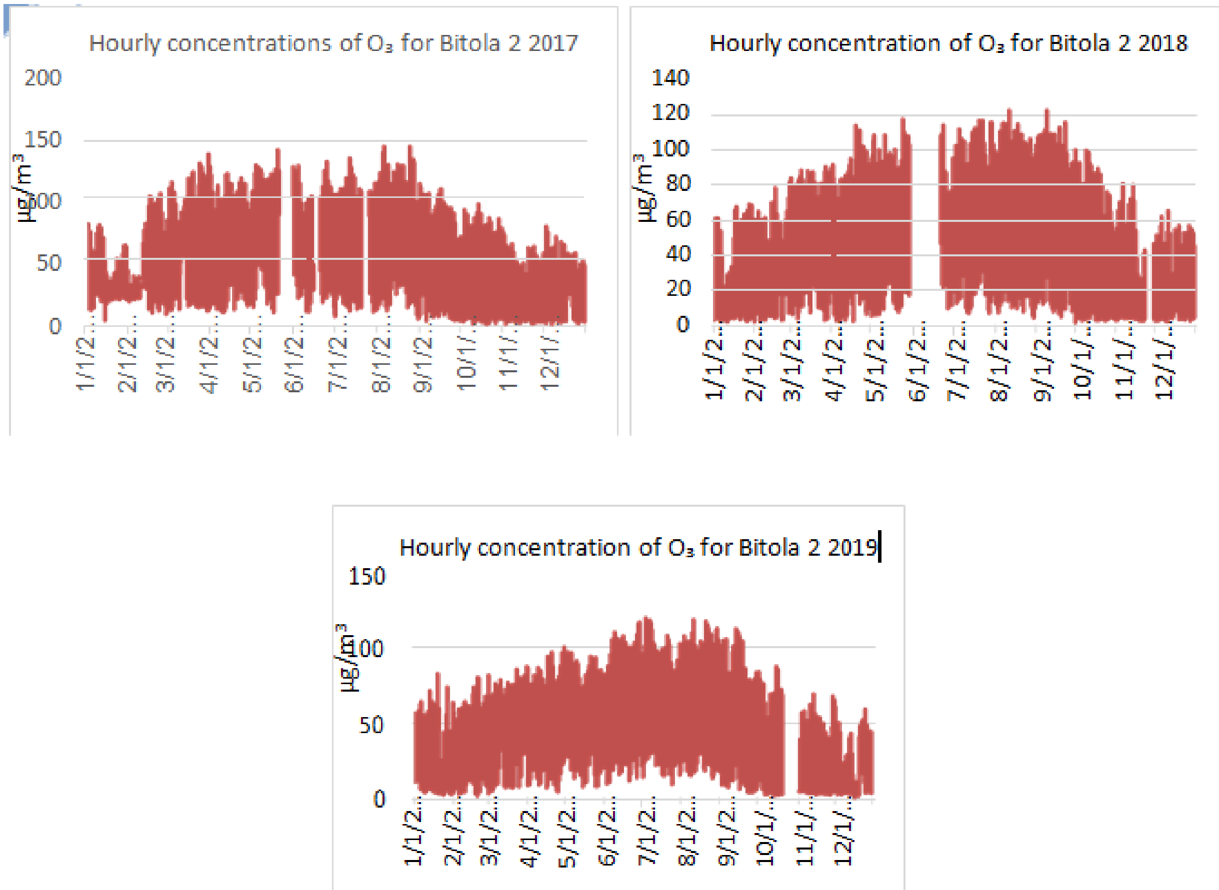


Figure 24 - Hourly measurement of the concentration of O_3 for the analyzed period at both locations for the period 2015-2019

From the above diagrams it is evident that there is no exceedance of the hourly concentrations of O_3 within 3 consecutive hours above the information and alarm threshold in the entire period of analysis.

Annual variation of the concentration of O_3 on both locations for the period 2015-2019 is presented on the following diagrams.

Figure 25- Annual variation of the concentration of O_3 on both locations for the period 2015-2019

From the above diagrams can be concluded that mutual for all of them is the trend of the ozone concentrations which are highest in the summer period of the year and lowest in the winter period. This trend is expected due to the influence of the direct sunlight which is highest in summer months.

Beside the limit value for health protection our national legislation is prescribing the AOT40 which is identified as an excess indicator for the protection of vegetation. AOT40 (Accumulated Ozone exposure over a Threshold of 40 ppb (=80 µg/m³) for vegetation is the accumulated excess of hourly ozone concentrations above 80 µg/m³ between 8:00 and 20:00 CET (Central European Time = Universal Time (UT) + 1) in the months of May, June, July (growth season). This indicator is designed for the protection of crops and (semi) natural vegetation. The AOT40 quantifies only ozone exposure, i.e. not the effective ozone uptake by (and therefore damage caused to) vegetation. The target value for this indicator is 18000 (µg/m³) h averaged over 3-5 years. The long-term objective is 6000 (µg/m³). The data coverage of AOT40 for both locations is presented on the following table.

Table 15 Data coverage of AOT40 for Bitola 1 and Bitola 2

	2015	2016	2017	2018	2019
Bitola 1	100%	100%	100%	97%	75%
Bitola 2	74%	100%	74%	79%	100%

Taking into consideration that the needed data coverage of 90% for the period between 08:00 and 20:00 CET within consecutive 3-5 years is achieved only for Bitola 1 in the period 2015-2018 on the following diagram is presented the exceedance of this target value only for this location.

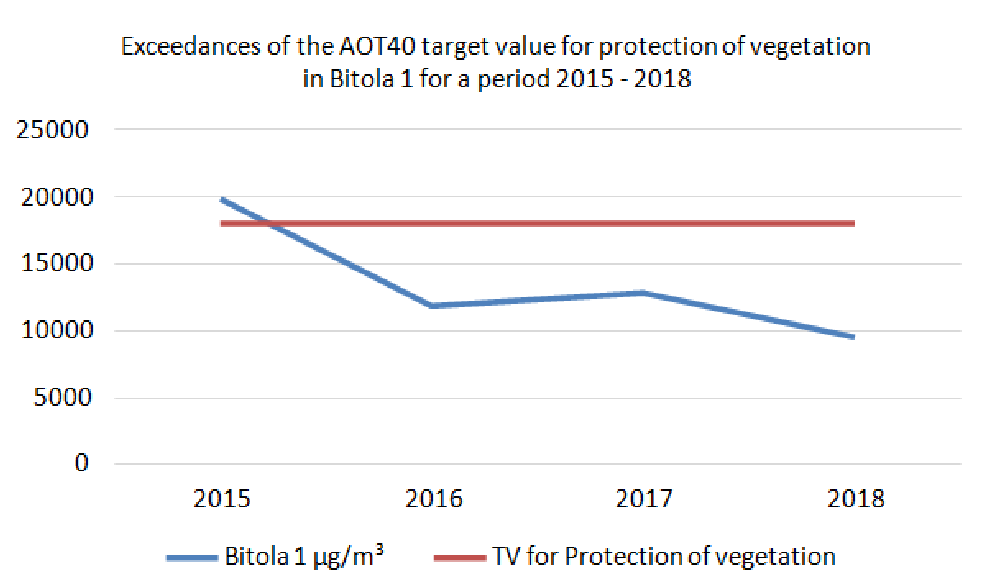


Figure 26 - Exceedances of AOT40 in Bitola 1 (2015 -2018)

From the above diagram it is evident that the long-term target value for protection of vegetation is exceeded only in 2015.

Carbon monoxide (CO)

Carbon monoxide is a colorless, odorless, tasteless and toxic air pollutant. It is produced as a result of incomplete combustion of fuels that contain carbon (natural gas, coal, oil, gasoline and wood). Natural sources of carbon monoxide include volcanoes and bushfires. The main sources of additional carbon monoxide are motor vehicles and some industrial activities, such as steel production. Topographical and meteorological conditions of sites can contribute toward increased concentration of CO into the ambient air. For example, strong temperature inversions or existence of high hills that inhibit the wind flow can limit the dispersion of the air pollutants. Due to the limited dispersion, many of these sites can have high (unhealthy) concentrations of ozone and particulate matter. Also, low temperatures can contribute toward high concentrations of CO into the ambient air. This is caused because engines and vehicles operate less efficient when is cold so air to fuel ratio is lower, combustion is less complete and catalysts take longer to become fully operational. The result is incomplete combustions causing higher emissions of CO as well as CO_2. Carbon monoxide can also occur naturally in the environment. The main natural sources of CO into the atmosphere are volcanoes as they erupt, from the smoke of forest fires, from the natural gases in coal mines, and even from lightning.

CO affects human health and the environment. Increased levels of CO reduce the amount of oxygen carried by hemoglobin around the body in the red cells. Due to this, the vital organs such as brain, nervous tissues and heart do not receive enough oxygen to work properly. Exposure to CO can cause headache, dizziness, vomiting and nausea. In case of exposure to moderate and high levels of CO for longer period can cause heart disease. High concentrations of CO can cause death.

Carbon monoxide emitted into the atmosphere effects the amount of greenhouse gases, which are linked to climate change and global warming. This means that land and sea temperature increases changing to ecosystems, increasing storm activity and causing other extreme weather events. In the national legislation carbon monoxide is regulated with limit values, presented in the following table.

Table 16 - Limit values for CO

Average period	Target value for health protection	Number of allowed exceedances	Information threshold	Alert threshold	Target value for protection of eco-system
Maximum daily 8h average concentration	10 mg/m^3	0			

Calculated values of the data coverage for concentration of carbon monoxide for both locations in the period 2015-2019 are presented on the following Table.

Table 17 - CO Data coverage

	2015	2016	2017	2018	2019

Bitola 1	58%	62%	41%	31%	93%
Bitola 2	73%	96%	89%	98%	94%

According to legislation the needed data coverage is 90%. From the table above it is evident that the required minimum is achieved in Bitola 1 only for 2019 while for Bitola 2in 2016, 2018 and 2019. Still, due to the lack of other data for measurement of concentration of CO for location Bitola 1, in the analysis below will be presented concentration of CO in the years where data coverage is at least 75% for both locations.

The maximum daily 8-hours mean value of CO for the analyzed period in both locations is presented on the following figures.

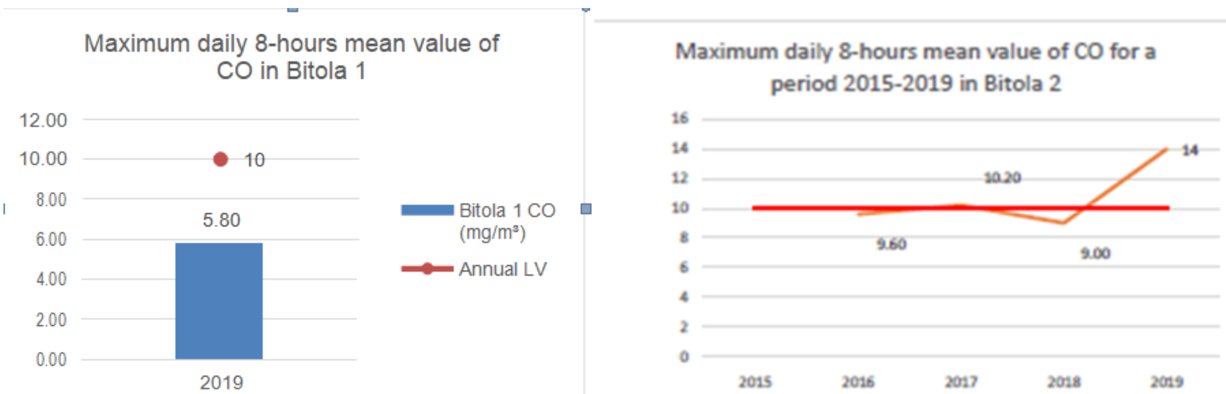


Figure 27 - Maximum daily 8-hours mean value of CO in Bitola 1 and Bitola 2

From the above figure can be concluded that the maximum daily 8-hours mean value of CO is exceeded only on location Bitola 2 in 2019.

In order to see in more detail, the variation of hourly and daily concentrations of CO in a calendar year, on the figures below are presented diagrams for both locations for the years with data coverage of at least 75%. The hourly concentration of CO measured at Bitola 1 for 2019 is presented on the following diagram.

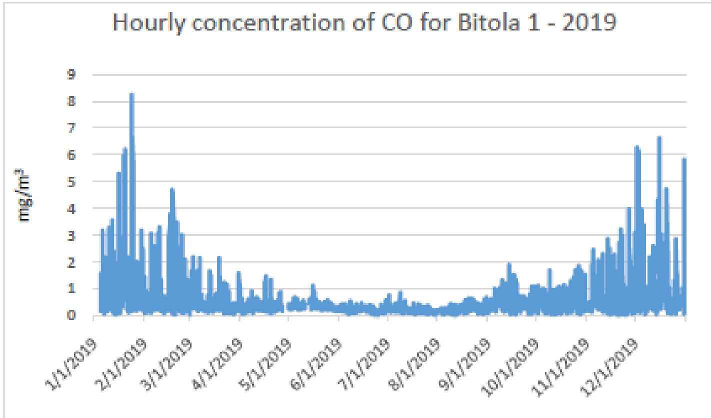


Figure 28 - Hourly concentration of CO in Bitola 1

The hourly concentrations of CO measured in location Bitola 2 in the analyzed period 2016, 2018 and 2019 are presented on the following diagrams.

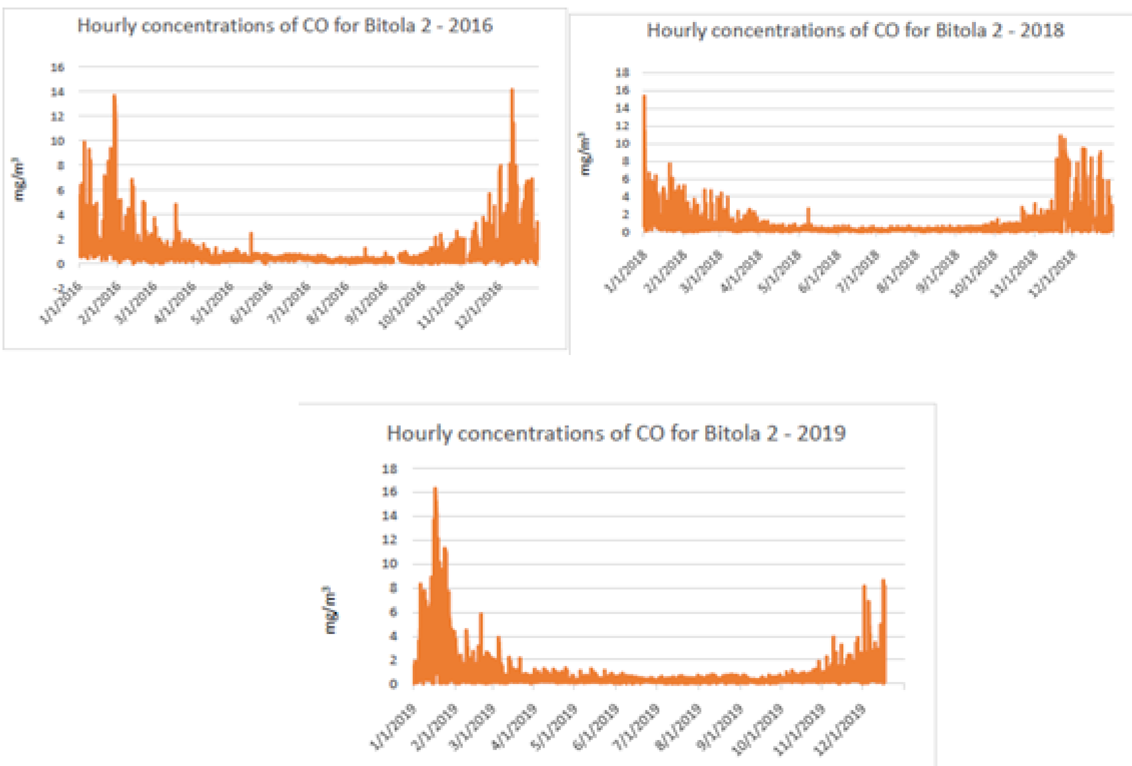


Figure 29 - Hourly concentration of CO for Bitola 2

From the above diagrams for hourly concentrations of CO at both locations for the analyzed period can be concluded that the highest concentrations are in the winter period.

The maximum daily 8-hours mean concentration of CO for Bitola 1 and Bitola 2 for the analyzed period is presented on the following figures.

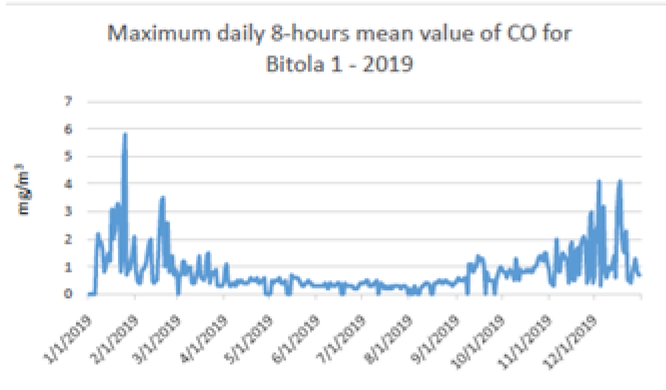


Figure 30 - Maximum daily 8-hours mean concentration of CO for Bitola 1

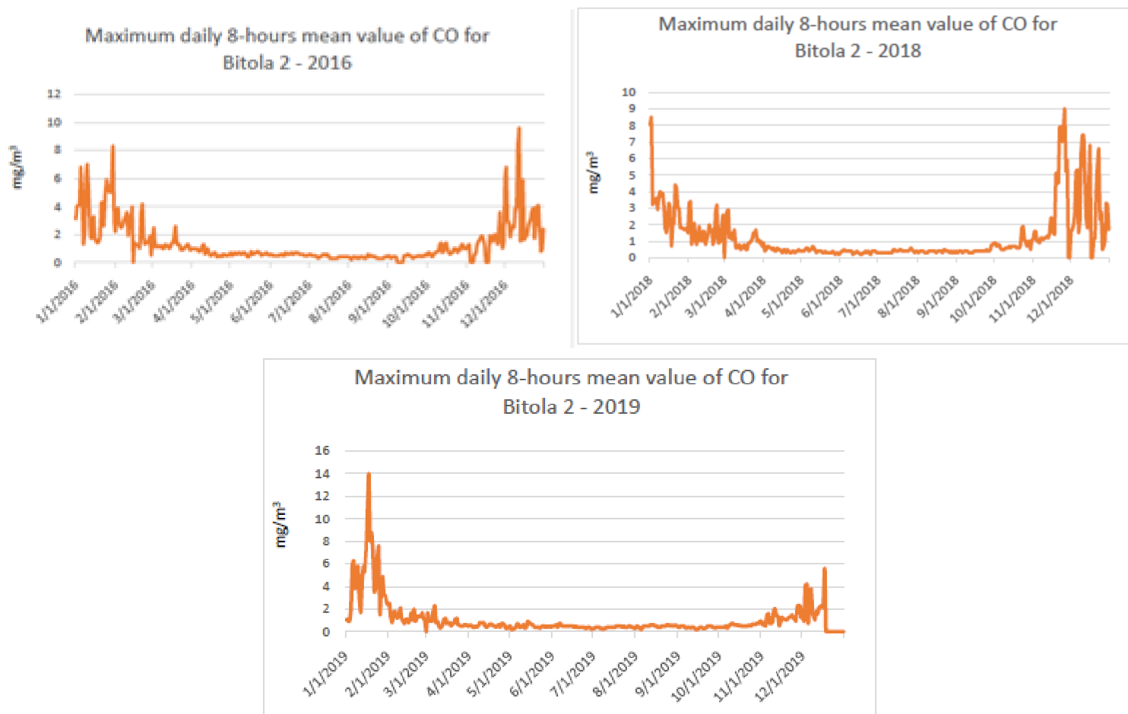


Figure 31 - Maximum daily 8-hours mean concentration of CO for Bitola 2

From the data of the maximum daily 8-hours mean concentration of CO for both locations presented in the above figures can be concluded that there are two exceedances of the limit value for location Bitola 2 in January 2019.

4. SUMMARY OF THE AIR QUALITY ASSESSMENT IN BITOLA

The analysis of the ambient air quality in Bitola is based only on the data obtained from the monitoring stations Bitola 1 and Bitola 2 which are part of the state monitoring network. The reason for this is the unavailability of other data from measurements of the concentration of pollutants in the air. The data from the monitoring stations were analyzed taking into account the data coverage for each of the parameter and for each location separately. Although the legally prescribed data coverage is not fulfilled for all the parameters and all locations still the data taken into consideration are with high enough quality to be used to assess the ambient air quality in Bitola.

The assessment of the air quality in Bitola is prepared in compliance with the requirements of the Rulebook on criteria, methods and procedures for assessment of ambient air quality (Official Gazette of RM No. 169/13) and the Decree on limit values for levels and types of pollutants in ambient air and alert thresholds, deadlines for reaching the limit values, tolerance margins for the limit value, target values and long-term goals (Official Gazette of RM No. 183/17).

In order to present the assessment of the concentration of all the parameters visually the following legend is used.

Below the AQ standards	Above the AQ standards	No measurements	Insufficient data coverage

Taking into consideration the above legend, the table below presents the compliance/non-compliance of each of the parameters with the air quality standards prescribed in the national legislation. Thus, the concentrations of pollutants that are within these standards are marked in green, while those that are above the prescribed standards are marked in red. Pollutants that do not have sufficient data coverage are marked blue, while those for which there is no measurement in a certain period of time are marked gray.

Table 18 Review of the ambient air quality in Bitola 1 (B1) and Bitola 2 (B2) for the analyzed period 2015-2019

Polutant	AQ standards (LV - Limit Value, TV - Target Value)		2015		2016		2017		2018		2019	
			B1	B2	B1	B2	B1	B2	B1	B2	B1	B2
SO_2	Hourly LV	350 µg/m³, not to be exceeded more than 24 times per year										
	Daily LV	125 µg/m³, not to be exceeded more than 3 times per year										
	Alert threshold	500 µg/m³, 3 consecutive hours										
	Critical level for vegetation protection	20 µg/m³, annual concentration										

NO_2	Hourly LV	200 µg/m³, not to be exceeded more than 18 times per year
	Daily LV	40 µg/m³
	Alert threshold	400 µg/m³,3 consecutive hours
PM_{10}	Daily LV	50 µg/m³, not to be exceeded more than 35 times per year
	Annual LV	40 µg/m³
$PM_{2,5}$	Annual LV	25 µg/m³
O_3	TV	120 µg/m³ max daily 8-th hour mean not to be exceeded more than 25 days per calendar year averaged over three years)
	Long term objective	120 µg/m³ max daily 8th hour mean
	Information threshold	180 µg/m³, 3 consecutive hours
	Alert threshold	240 µg/m³, 3 consecutive hours
CO	LV	10 mg/m³, max daily 8th hours mean

It is clear from the table above that the main critical air pollutant in Bitola is PM_{10}. Measurements from both measuring stations show that at both locations during the period 2015 - 2019 the daily limit value of 50 µg/m³ has been exceeded more than 35 times during one calendar year. Also, the annual limit value of 40 µg/m³ for both locations is exceeded in the same time period.

The air legislation defines an information threshold which means exceeding of the daily concentration of 100 µg/m³ and alert threshold which means exceeding of the daily concentration of 200 µg/m³ in two consecutive days and a forecast for a stable weather. In case of exceeding the alert threshold, it is necessary to take immediate steps to improve air quality.

In addition to the primary emissions of PM_{10} that are emitted directly into the air by natural and anthropogenic sources, parameters such as SO_2, NOx, NH_3 and VOC have a significant impact on the increased concentration of this parameter. These are the so-called secondary sources of PM_{10} which are mainly derived from anthropogenic sources. Therefore, in the measures that will be taken to reduce the concentration of PM_{10}, it is necessary to include measures to reduce the

concentration of these pollutants also.
The annual limit value has been exceeded for $PM_{2.5}$ for the only year in which the requirement for mini- mum data coverage is met, which is expected. Given that this pollutant is part of the PM_{10} it can be considered potentially critical.

The target value of 120 μg/m³ for ozone is exceeded only at the measuring station Bitola 2 in the period 2015 – 2017. Regarding the long-term target, the measurements show exceeding of O_3 in Bitola 1 in 2015 and 2017 while in Bitola 2 in the period 2015-2017. The measurement of the hourly concentrations at both locations shows that there is no exceedance of the information and alert thresholds. The data also show exceedance of the long term target value for protection of vegetation in 2015 for Bitola 1 measuring station. Given that ozone is a secondary air pollutant, it is necessary to take measures to re- duce concentrations of pollutants such as NOx and VOC.

The limit value of 10μg/m³ of CO has been exceeded only in 2019 for Bitola 2. The table clearly shows the insufficient data coverage in 2015, 2016, 2017 and 2018 for Bitola 1 and in 2015 for Bitola 2. The data from the measuring station Bitola 2 in 2016, 2017 and 2018 shows that they are within the prescribed limit value.

The only parameters for which no exceedances of the limit values were measured at the two measuring stations are SO_2 and NO_2. Regarding SO_2 measurements were not performed in 2015 at the measuring station Bitola 1 while there is insufficient data coverage in 2015 and 2016 in Bitola 2 and in 2017 in Bitola 1. Concentrations of SO_2 measured in 2016, 2018 and 2019 at the measuring station Bitola 1 as well as in the period 2017- 2019 in Bitola 2 are within the prescribed limit values (hourly and daily). Regarding the NO_2, limit values are within the prescribed for location Bitola 2 in the period 2017- 2019 while for location Bitola 1 it is evident that either there is no data or there is insufficient data coverage. Although these pollutants are not critical for Bitola, it is still necessary to monitor and take measures for reduction due to their contribution to increasing the concentration of PM_{10} and O_3.

5. KEY EMISSION SECTORS AND IDENTIFICATION OF EMISSION SOURCES

In general, high industrialization level and regular human activities are inevitably causing emission of air pollutants. Emission sources are usually analyzed according to the activities that produce air emission of pollutants. Major activities considered as key emission sectors are: energy and combustion facilities, industry, domestic heating, transport, waste and agriculture.

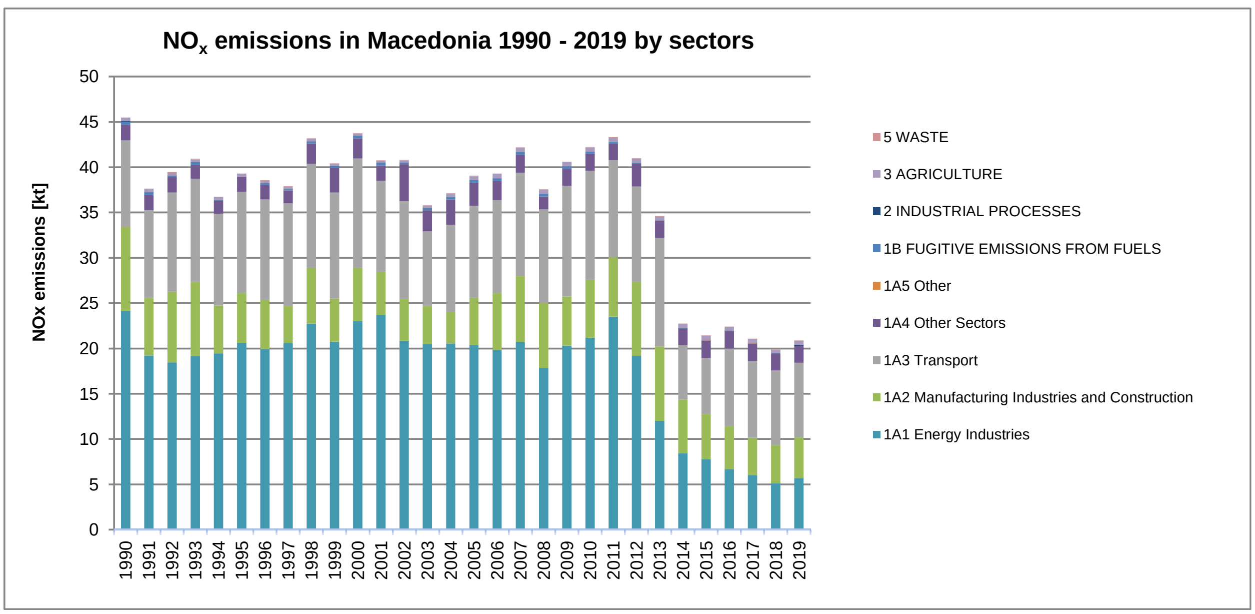
According to the Law on ambient air quality, Republic of North Macedonia has an obligation for emission inventory reporting toward ratified Convention on transboundary air pollution (CLRTAP) and its eight protocols.

The methodology used for calculation of emissions and selection of emission factors depends on availability of activity data. Having into consideration all the difficulties on obtaining data for activity rates and the fact that Republic of North Macedonia does not have national emission factors for all emission source categories, calculations are performed using Tier 1 methodology and relevant emission factors from EMEP/EEA air pollutant emission inventory guidebooks including its last version from 2019.

In 2021 the MOEPP has issued the Informative Inventory Report 1990-2019 (IIR 2019) where calculation data with introduced emission factors from the EMEP/EEA air pollutant emission inventory guidebook 2019 are presented according to NFR categories. This report is based on input activity data obtained from following relevant sources:

- Statistical Yearbooks of Republic of North Macedonia 1990-2019;
- MAKSTAT DATABASE from SSO
- Publications published by SSO in different areas (Transport, Industry in the Republic of North Macedonia, Industry and Energy, Livestock, Agriculture and Forestry);
- Energy Balance of the Republic of North Macedonia by Ministry of economy
- Measurements data from the industrial operators and waste incineration plant
- International web page databases (FAO, Eurostat and etc.)
- Data from relevant national ministries and agencies (MOD, PEMF, MAFWS and others)

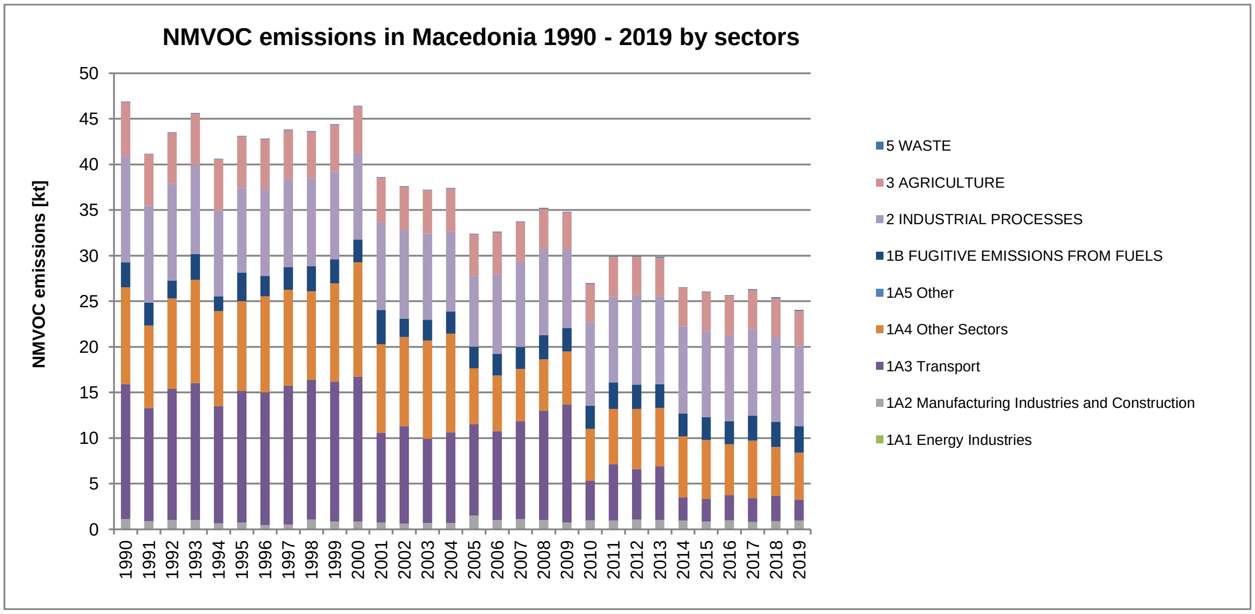
On the following figures data for the emission of the air pollutants by sectors in Republic of North Macedonia are presented.



Source: Republic of North Macedonia, Informative Inventory Report 1990-2019

Figure 32 NOx emissions in North Macedonia 1990-2019 by sectors

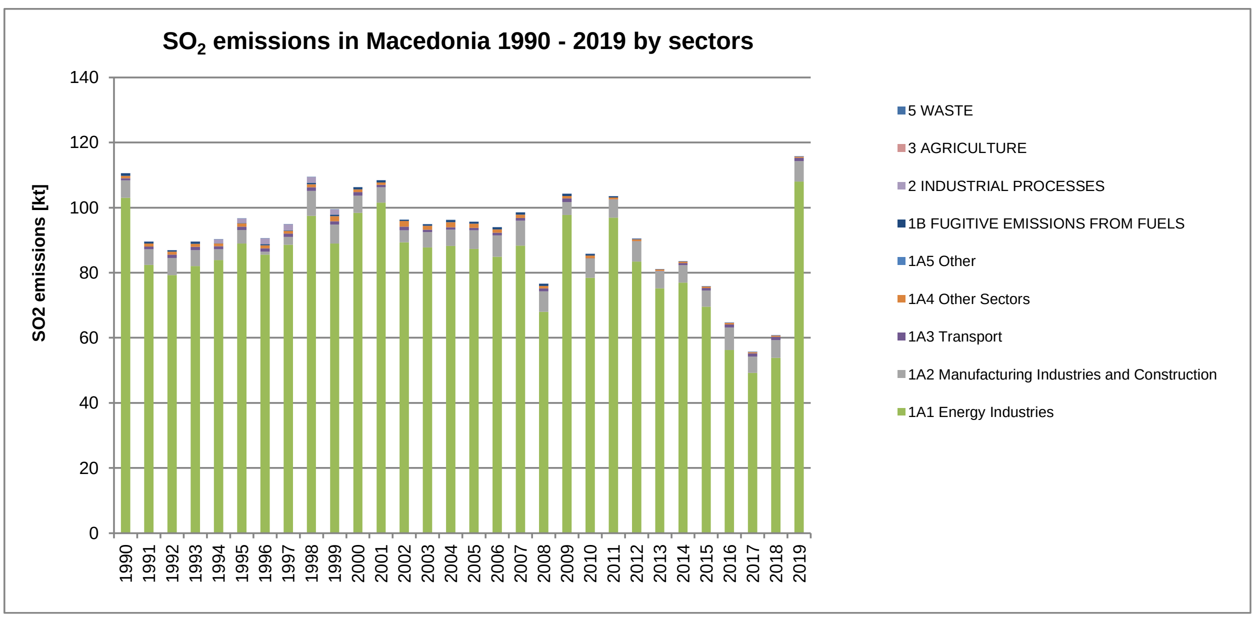
Presented data are showing that after 2012 most NOx emissions are coming from the sector transport and sector Energy Industries.



Source: Republic of North Macedonia, Informative Inventory Report 1990-2019

Figure 33 NMVOC emissions in North Macedonia 1990-2019 by sectors

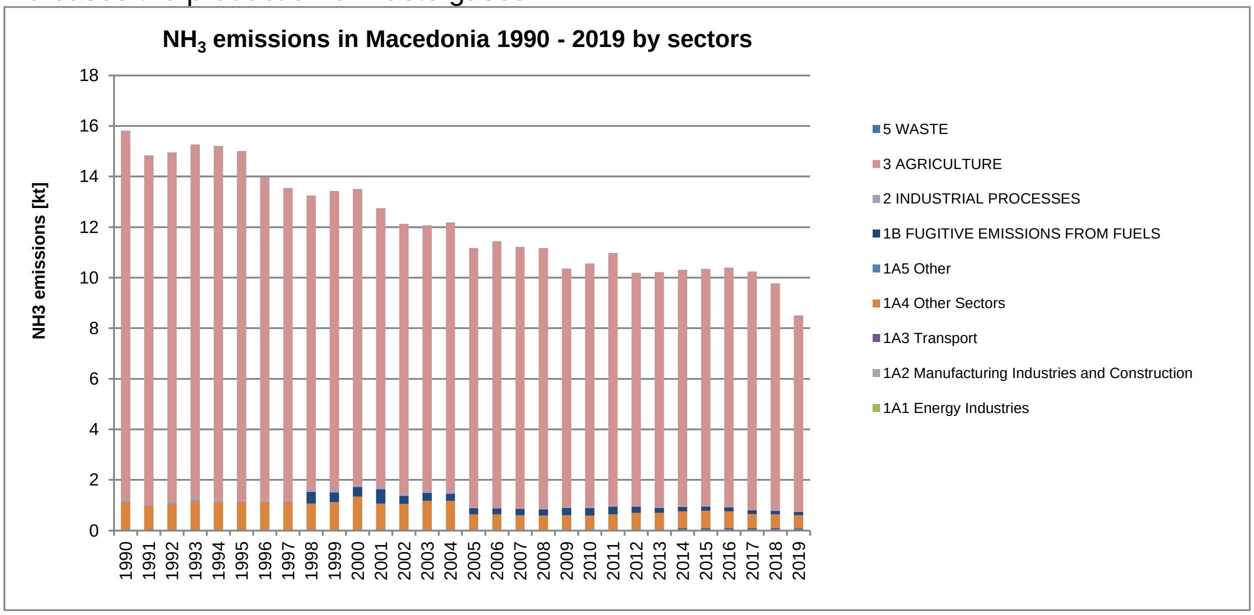
Largest share in emissions of NMVOC has the sector Industrial processes. There is decreasing trend starting from 2000.



Source: Republic of North Macedonia, Informative Inventory Report 1990-2019

Figure 34 SO_2 emissions in North Macedonia 1990-2019 by sectors

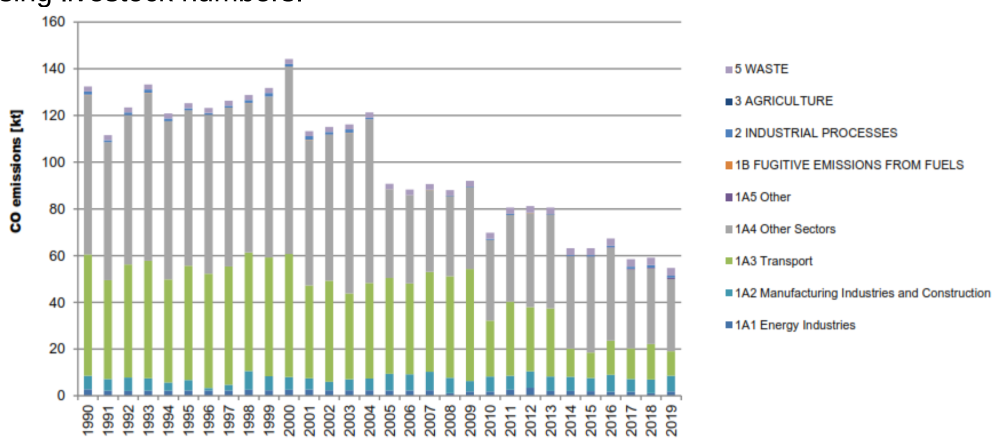
As presented in the Figure 34, the biggest share in emission of SO_2 has sector- Energy Industries. There was decreasing trend from 2012, however in 2019 there is a sharp increase. The reason for these results according to the report from REK Bitola is the content of sulfur in the coal and fuel oil that were burned (due to a problem with the implementation of the public procurement for analysis of annual coal test for 2018, it was not done, for 2019 a sample is sent for analysis). In 2018, compared to 2019, the total operating time of the units is lower by about 16%, the production of electricity is lower by 19.72%, a smaller amount of coal is burned by 18.38% and fuel oil by 19.92%. The coal that burned in 2018 has a lower thermal power of 1609 kcal / kg, while in 2019 1566 kcal / kg, consequently the consumption of coal is higher per unit of energy obtained, which increases the production of waste gases.



Source: Republic of North Macedonia, Informative Inventory Report 1990-2019

Figure 35 NH_3 emissions in North Macedonia 1990-2019 by sectors

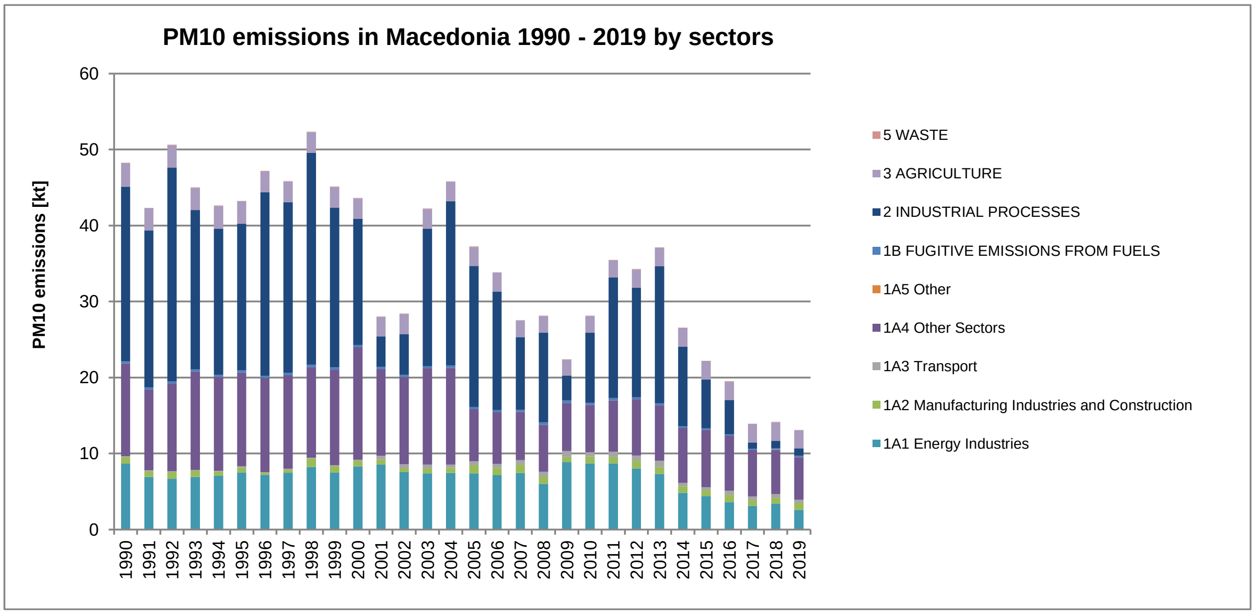
Figure 35 is showing that emissions of NH_3 generally are coming from agriculture sector. Main reasons for the decline are decreasing emissions from Agriculture (Manure Management) related to decreasing livestock numbers.



Source: Republic of North Macedonia, Informative Inventory Report 1990-2019

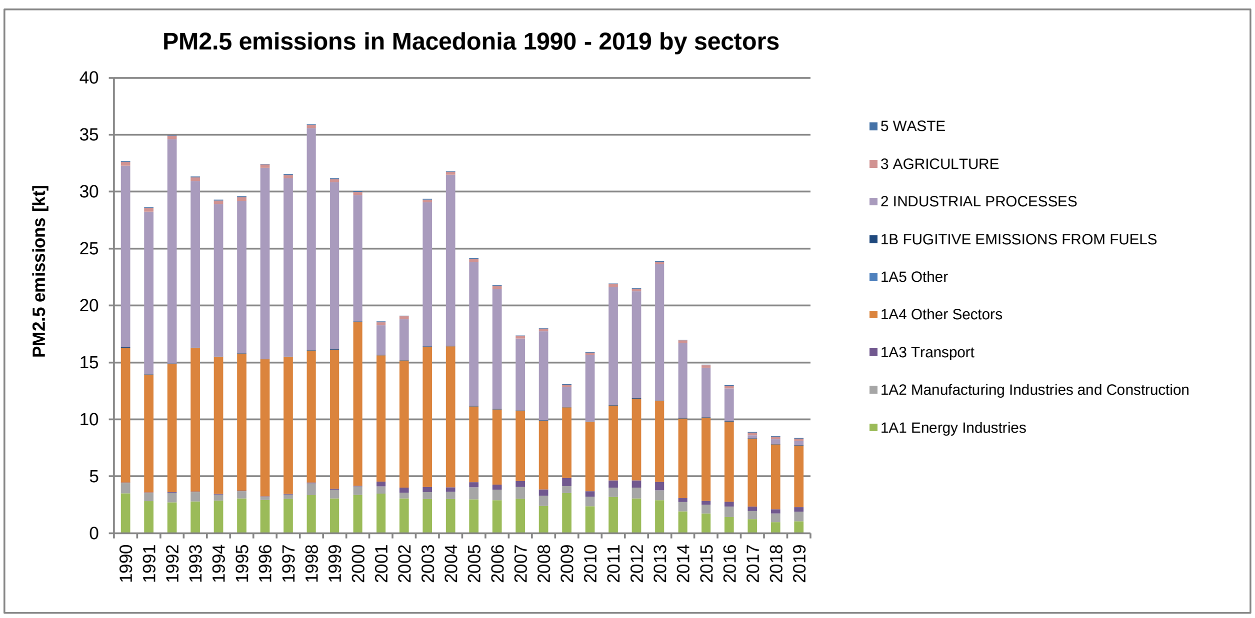
Figure 36 CO emissions in North Macedonia 1990-2019 by sectors

Emissions of CO mostly come from other sectors where small combustion in residential and commercial facilities is included. The decreasing trend started in 2000 and could be attributed to lower solid fuel consumption in 1.A.4 sector, but the trend is not stable.



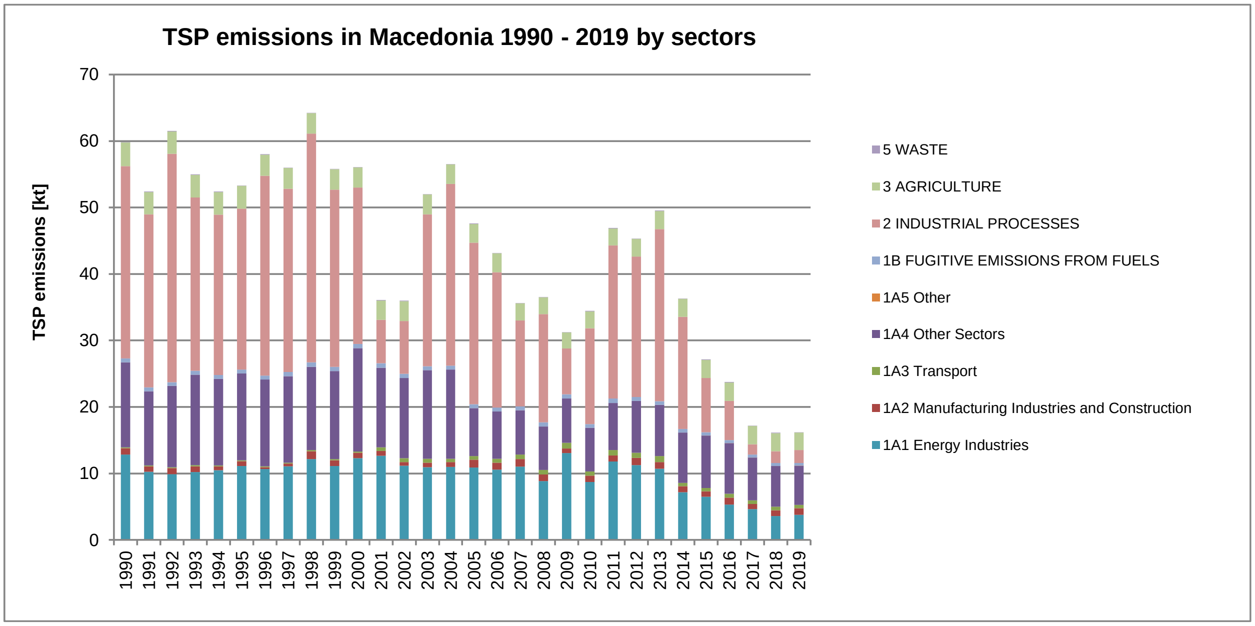
Source: Republic of North Macedonia, Informative Inventory Report 1990-2019

Figure 37 PM_{10} emissions in North Macedonia 1990-2019 by sectors



Source: Republic of North Macedonia, Informative Inventory Report 1990-2019

Figure 38 $PM_{2,5}$ emissions in North Macedonia 1990-2019 by sectors

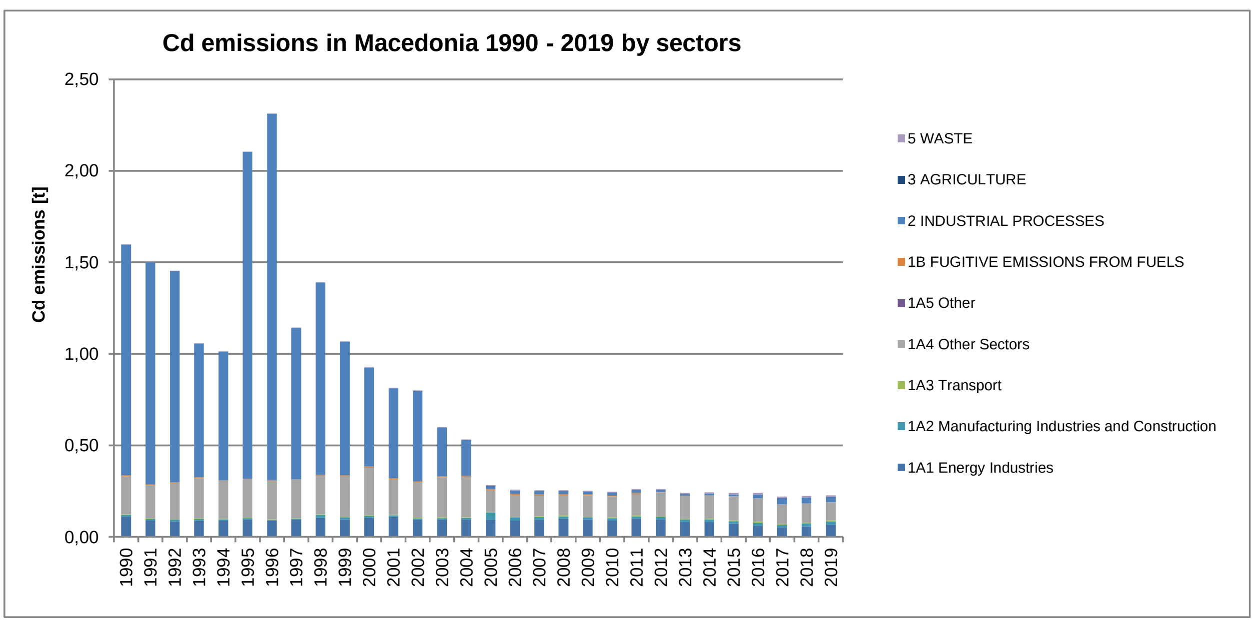


Source: Republic of North Macedonia, Informative Inventory Report 1990-2019

Figure 39 TSP emissions in North Macedonia 1990-2019 by sectors

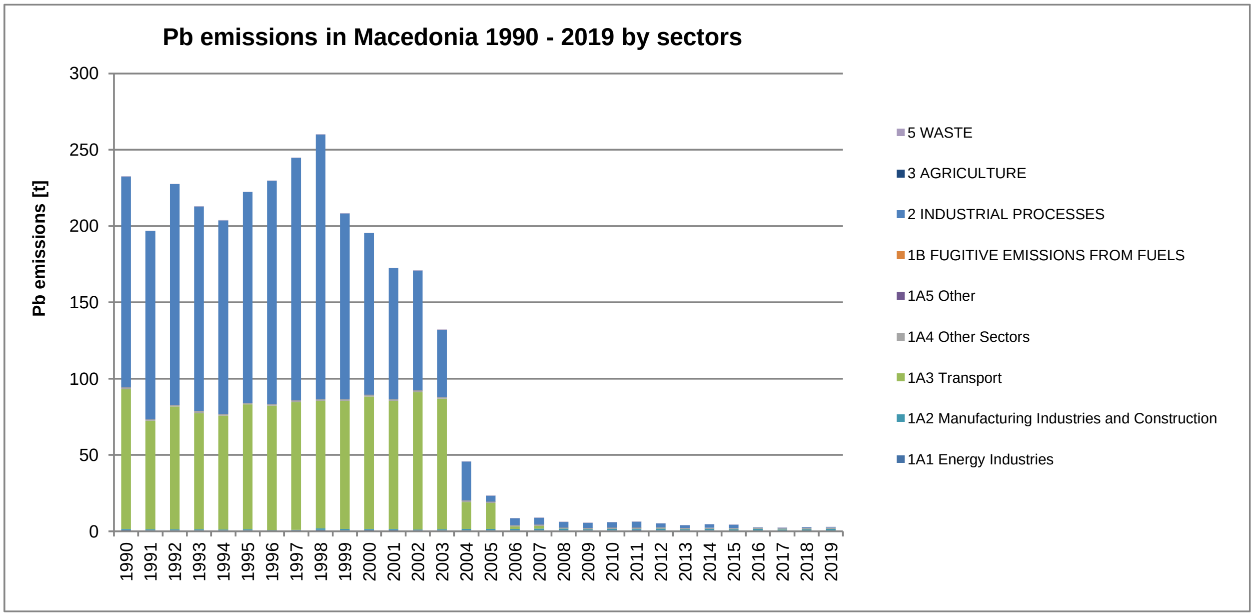
Emissions of PM_{10}, $PM_{2,5}$ and TSP from industrial processes are significantly reduced in the period 1990-2019, so those emissions in recent years generally are coming from other sector which includes households and combustion of fuels in administrative capacities.

Emissions of the heavy metals by sectors in Republic of North Macedonia are presented in following figures.



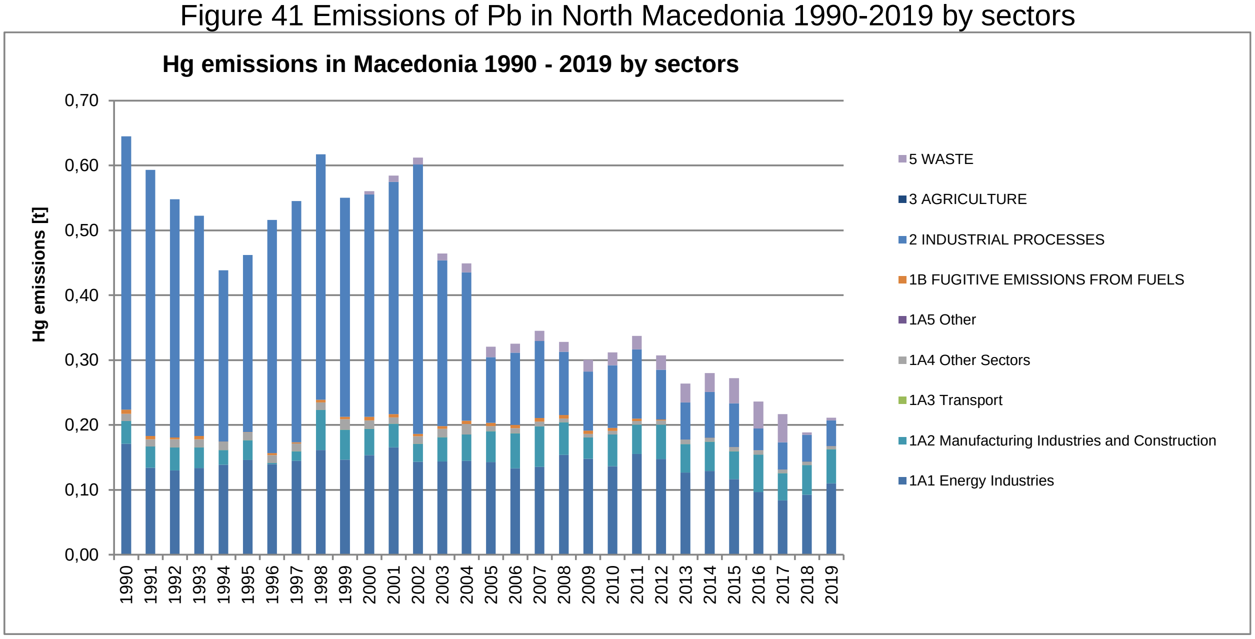
Source: Republic of North Macedonia, Informative Inventory Report 1990-2019

Figure 40 Emissions of Cd in North Macedonia 1990-2019 by sectors



Source: Republic of North Macedonia, Informative Inventory Report 1990-2019

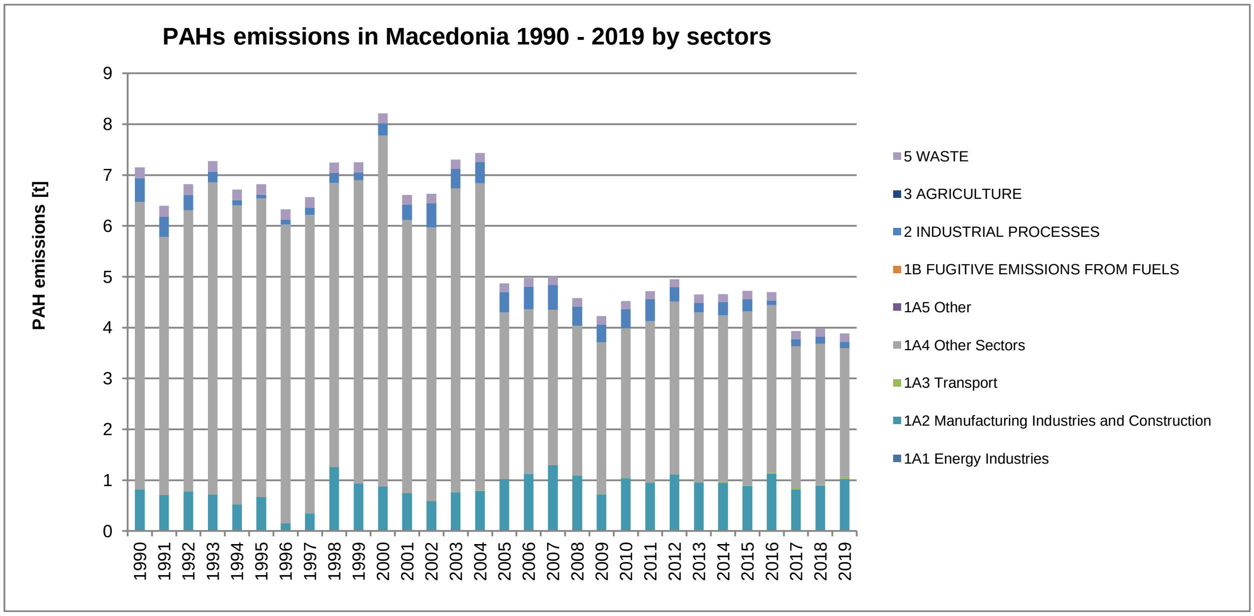
Figure 41 Emissions of Pb in North Macedonia 1990-2019 by sectors



Source: Republic of North Macedonia, Informative Inventory Report 1990-2019

Figure 42 Emissions of Hg in North Macedonia 1990-2019 by sectors

It can be concluded that emissions of heavy metals have decreasing trend. In the past the major source of emissions was industry while in the last year the major source is industry.
On figure 43 emissions of PAH by sectors in Republic of North Macedonia 1990-2019 are presented.



Source: Republic of North Macedonia, Informative Inventory Report 1990-2019

Figure 43 Emissions of PAH-4 in North Macedonia 1990-2019 by sectors

As in the case of particulates the most important emission source in 2019 of PAHs is NFR sector 1 - Energy. Within the Energy sector the main contributor in 2019 is 1.A.4 Other Sectors (residential heating and combustion of fuels in the administrative capacities).

6. TOTAL EMISSION CALCULATION DATA FOR THE CRITICAL AMBIENT AIR POLLUTANTS BY EMISSION SECTORS

According to available data emissions of air pollutants from the identified emission sectors are calculated for each identified emission sector except for the Energy industry sector where data from emission measurement are also used. Emission factors used for the calculation are according EMEP/EEA guidebook 2019, national emission inventory and Informative inventory reports prepared by MOEPP. Selection of emission factors tier level is made according to the available activity data and prior expert knowledge of the technology used in facilities and plants relevant for each emission sector. Emission sectors covered with this report are: Energy, Industrial processes, energy small combustion at residential and commercial objects, transport, waste and agriculture. Activity data for emission calculation was obtained from available relevant official data sources such as: data provided by MOEPP, Municipality of Bitola, Municipality of Novaci and Municipality of Mogila; MAKSTAT database; Statistic yearbook of the Republic of North Macedonia 2020 and other official reports from the State statistical office.

Total annual air pollutant emission from the identified emission sectors for base year 2019 are presented in following chapters.

6.1. ENERGY Sector

6.1.1. Energy production

Emissions of air pollutants emitted from energy production industries are included in Energy sector. Energy sector is major contributor to air pollutant emissions in the Republic of North Macedonia. Emissions from this sector arise from energy production fuel combustion and fugitive emissions from fuels. In region of Bitola, Novaci and Mogila power plant REK Bitola is the only installation for energy production. Thermal Power Plant Bitola is located in Municipality of Novaci and it is the biggest energy production facility in Republic of North Macedonia. Three energy generating block are operating in Thermal Power Plant Bitola each with capacity of 233MW. Annual energy production of Thermal Power Plant Bitola is 1.200GW/h. Fuels used in Thermal Power Plant Bitola are lignite with an average LHV of 6528 kJ/kg and water content up to 60% and heavy fuel with (Lower heating value) LHV of 40.563 kJ/kg. Lignite used as energy production source in Thermal Power Plant Bitola is surface excavated from Pelagonija basin coal mines Suvodol and Brod-Gneotino.

Activity data for fuel consumption have been provided by the plant operator in tones per month converted in tones per year. For 2019 Power plant REK Bitola reported use of 5.559.991 tons of lignite and 12.037 tons of heavy fuel.

Total annual air pollutant emissions from Thermal Power Plant Bitola are obtained by using reliable data provided by stack emission monitoring during 2019 and by calculations using emission factors from EMEP/EEA guidebook 2019 and National emission factors.

Tier 3 meaning measurement data as well as Tier 1, default emission factors were used for calculation of emissions coming from this sector. Installation REK Bitola in its monthly reports is reporting on NOx, CO, TSP and SOx measurements. For 2019 for these pollutants, the measurements received were converted to yearly emissions.

Implied emission factors for PM2.5 and PM10 are derived as 68% and 27% from TSP. These emission factors were calculated with the support of Austrian energy expert in the Twining project “Further strengthening the capacities for effective implementation of the acquis in the field of Air Quality” that has been carried out in the period 2015-2017 in the Ministry of environment and physical planning as explained in the IIR, 2019 published by MOEPP.

Total annual emission of main pollutants from Thermal Power Plant Bitola, measured and calculated, is presented in Table 19.

Table 19 Total annual emission of main pollutants from Thermal Power Plant Bitola

	pollutant						
	NOx	**CO**	**NMVOC**	**SOx**	**TSP**	**PM10**	**PM2.5**
	Unit Mg(t)						
Energy production	**5.280,45**	**1.664,82**	**51,03**	**105.431,34**	**3.596,24**	**2.428,23**	**983,59**

Total annual emissions of heavy metals, PAHs, HCB and PCBs relevant for sector energy production, emitted from Thermal Power Plant Bitola are shown in Table 20.

Table 20 Total emissions of heavy metals, PAHs, HCB and PCBs emitted from Thermal Power Plant Bitola in 2019

	pollutant											
	Pb	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**	**PAHs**	**HCB**	**PCBs**
	Unit Mg(t)										Unit kg	
Energy production	0,55	0,07	0,11	0,52	0,33	0,04	0,48	1,64	0,36	0,002538	0,000244	0,00012

6.1.2. Fugitive emission from solid fuels: coal mining and handling

Fugitive emission arises from coal mining, production, distribution, storage and distribution of oil products and in this section fugitive emission from coal mining and handling at mines Suvodol and Brod-Gneotino are calculated.

Activity data for those calculations is obtained from quantity of coal mined in 2019 as reported in monthly reports toward MOEPP. Calculations were done using Tier 2 methodology to the fact that all coal mines are categorized as open mines.

Fugitive emissions of NMVOC and particulates calculated from this category are presented in the following table.

Table 21. Calculated Fugitive emission from solid fuels: Coal mining and handling

	Pollutant			
	NMVOC	**TSP**	**PM_{10}**	**$PM_{2,5}$**
	Unit t/year			
Fugitive emission from solid fuels: Coal mining and handling	1.112,00	455,92	216,84	33,36

6.1.3. Transport

Sector transport covers the emissions from road transport as well as gasoline evaporation and tire and break ware and road dust. No aviation or lake transport is carried out in Bitola region.

Road transport

According to the EEA emission estimation guidebook, the classification of the exhaust emissions categories of road vehicles are the following:

- Passenger Cars;
- Light Duty Vehicles;
- Heavy Duty Vehicles;
- Buses;
- Motorcycles.

Tier 2 approach allows to estimate the emission for a given vehicles fleet, when the information concerning the number of vehicles classified by categories, fuel and emission standards is known. The calculation includes emissions from passenger cars, light duty vehicles, heavy-duty vehicles and busses, motorcycles and gasoline evaporation from vehicles.

According to the methodology, tier 2 approach considers the fuel used by different vehicle categories and their emission standards that are multiplied by the appropriate emission factor, which depends on the type of the fuel and type of technology of combustion in stationary sources and the type of mobile equipment and machinery, respectively.

Concerning the annual average mileage of a vehicle category, data available from the national statistics are referring to the total annual mileage of a certain vehicle, without considering the different regimes of circulation (urban, interurban, highway).

The information related to the vehicles fleet for Bitola region (for 2019) was retrieved from the Ministry of environment received previously by the Ministry of Interior due to MOU between institutions. No raw data are used for calculation.

According to the vehicle fleet data available for 2019 from the Ministry of Interior there are 28.723 vehicles registered in Bitola, Novaci and Mogila. The data for the driven kilometer per type of vehicle has been calculated.

The chart in Figure 44 presents the composition of the vehicle fleet by different vehicle categories, whereas the chart in Figure 45 presents the classification of each vehicles category by Euro standard classes.

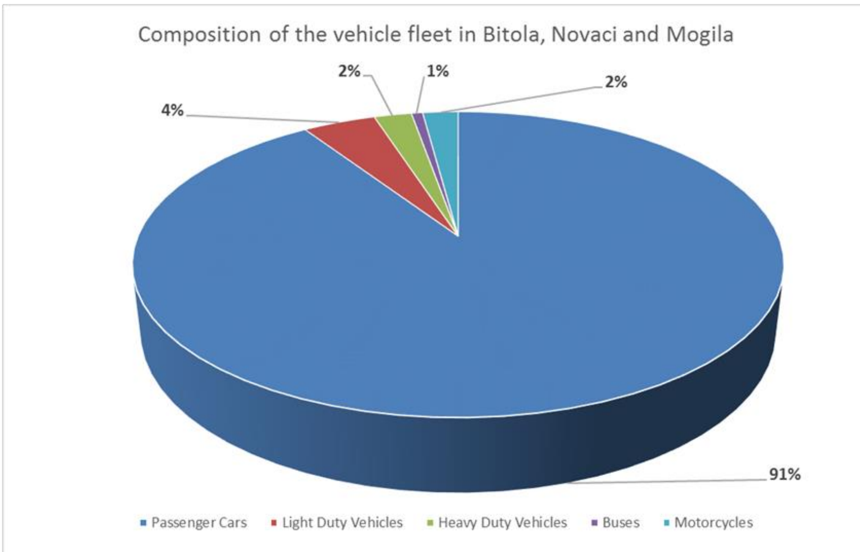
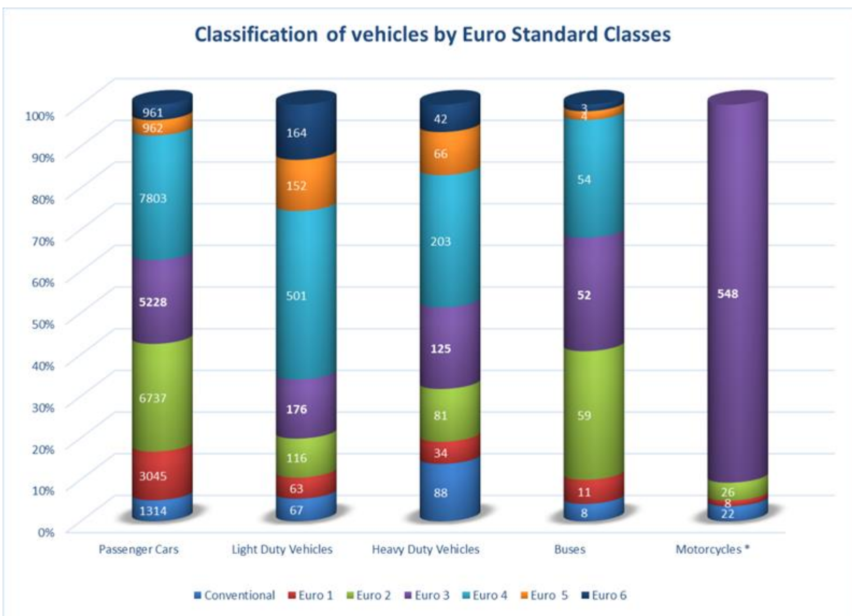


Figure 44. Composition of the vehicle fleet in Bitola Region by type of vehicle

Vehicle fleet in Bitola region is mainly consisted of passenger cars (91%), whereas the Light duty vehicles represent approximately 4% of the fleet.



*According to Euro Standards, motorcycles are classified up to Euro 3 class. Euro 4 and Euro 5 classes are not defined.

Figure 45. Classification of vehicles in Bitola region by euro standard classes

As presented in the figure above dominant Euro standard class for vehicles registered in Bitola region is Euro 4 with 29,8% of the total vehicle fleet, except for the motorcycle category where dominant Euro standard category is Euro 3.

The Light duty vehicles is the category with the highest percentage of new vehicles; on the contrary 13,7% of the heavy-duty vehicles are old, classified as conventional or Euro 1. The motorcycles category is differently classified compared to the other vehicle categories (Euro 4 and Euro 5 standards have not been regulated yet for this category). Motorcycle category is mainly composed of Euro 3 vehicles that are considered as relatively environmentally friendly. Concerning the PM10 pollutant emissions, the oldest classes of vehicles (conventional, Euro 1 and Euro 2) contribute to almost 70% to the total emissions from passenger vehicles. For CO and NOx, the conventional technology class represents the most polluting class.

Most of the passenger vehicles in the Region of Bitola use gasoline as fuel (52%). Approximately 47% of the passenger cars use diesel and only minor part of the fleet is fueled with LPG (1%).

Light duty vehicles in the Region of Bitola mostly use diesel as fuel (86%), 13% are using gasoline and only 1% are using LPG as fuel.

Regarding Heavy duty vehicles, most of the vehicles registered are using diesel as fuel no matter the range of registered load capacity, only 6% of this category of vehicles are using gasoline as fuel.

For this sector, emission factors for CO, NH_3, NMVOC, NOx, lead, PAHs, DIOX, PCBs, Particulate Matter (PM) are available. Default emission factors for the basic pollutants were taken from Guidebook 2019 –Tier 2 emission factors. Concerning particulate matter, the guidebook assumes that the amount of total suspended particles is equivalent to the PM_{10} and $PM_{2,5}$.

Railway

Air emissions from railway are calculated according from the EMEP/EEA air pollutant emission inventory guidebook 2019 – Update Oct. 2020 / 1.A.3.c Railways 2019, using Tier 1 methodology. Railway diesel consumption for Bitola, Novaci and Mogila is calculated as percentage from the total railway diesel consumption for North Macedonia in 2019 (the percentage is calculated as mean from: 5,17% of turnover of goods and 8,87% of turnover of passengers on train station in Bitola). This data is used as activity data for calculation of air emissions from railway.

Gasoline evaporation

Most evaporative emissions of VOCs emanate from the fuel systems (tanks, injection systems and fuel lines) of petrol vehicles. Evaporative emissions from diesel vehicles are considered negligible, due to the presence of heavier hydrocarbons and the relatively low vapor pressure of diesel fuel and can be neglected in the calculations.

For calculation of NMVOC, emission factors for gasoline fueled road vehicles, when daily temperature range is around 10 to 25°C, were considered. This emission factor was chosen because calculated average annual temperature was 13.7ºC, according to the automatic meteorological station under responsibility of HMA – Hydro Meteorological Administration.

Road vehicle tire and brake wear

This technical chapter of EMEP/EEA air pollutant emission inventory guidebook 2019 covers the emissions of particulate matter (PM) which are due to road vehicle tire and brake wear and road surface wear. PM emissions from vehicle exhaust are not included. The focus is on those particles emitted directly because of the wear of surfaces — and not those resulting from the re-suspension of previously deposited material.

The activity data on the number of vehicles for the category have been taken from MOI and Yearly mileages per vehicle category were calculated as average between urban and total mileage. Relevant emission factors from the EMEP/EEA air pollutant emission inventory guidebook 2019 were used for calculation.

Summary of total emissions from transport sector by each category contributing to this sector is presented in following table.

Table 22 Summary of total emissions from transport sector

Transport NFR Category	NOx t	CO t	NMVOC t	SO2 t	TSP t	PM10 t	PM2.5 t	NH3 t	Pb t	PAHs t	PCDD +PCDF g-I-TEQ	PCB kg
passengers cars	95,58	372,65	36,96	30,74	3,87	3,87	3,87	5,78	0,003	0,0007	0,0007	0,000001
light weight vehicles	28,25	27,64	3,14	1,68	1,68	1,68	1,68	0,16	0,0001	0,00007	0,001	0,0000003
heavy duty vehicles	120,98	136,88	16,52	2,87	3,09	3,09	3,09	0,15	0,0003	0,0005	0,002	0,0000007
buses	108,48	24,17	4,78	2,91	2,53	2,53	2,53	0,04	0,0002	0,0002	0	NA
motorcycles	0,42	9,50	2,35	0,36	0,05	0,05	0,05	0,004	0	0,000002	0,00003	0
gasoline evaporation	0	0	151,60	0	0	0	0	0	0	0	0	0.00
road vehicle tyre and brake	0	0	0	0	5,94	4,35	2,57	0	0	0	0	0
road surface wear	0	0	0	0	5,03	2,52	1,37	0	0	0	0	0
railway	9,40	1,92	0,83	0,02	0,001	0,27	0,26					
Total	363,11	572,76	216,18	38,58	22,19	18,36	15,42	6,13	0,004	0,001	0,009	0,00002

Distribution of emissions of different pollutants in all vehicle categories is shown on the figures below. Emissions from trains are not presented because they have insignificant share in total emissions.

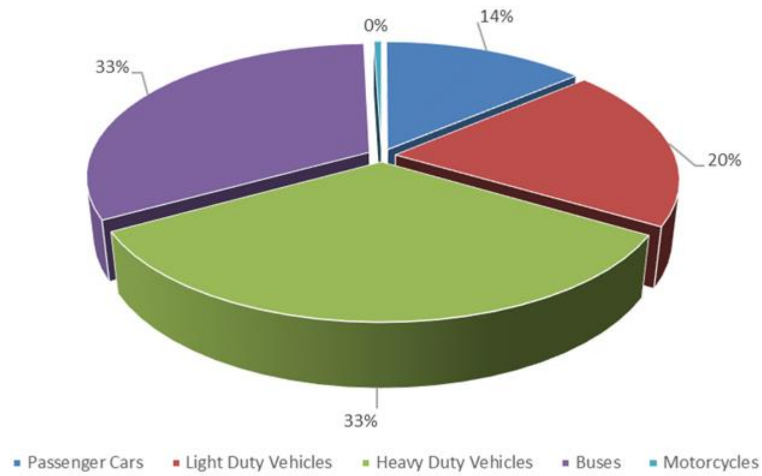


Figure 46. Distribution of PM10 traffic emission in all vehicle categories

As presented above, buses and heavy duty vehicles contribute with 33% each in total emissions of PM_{10}. This is due to the fact that those categories of vehicles mostly use diesel as fuel and large percent of registered buses by Euro standards are classified up to Euro 3.

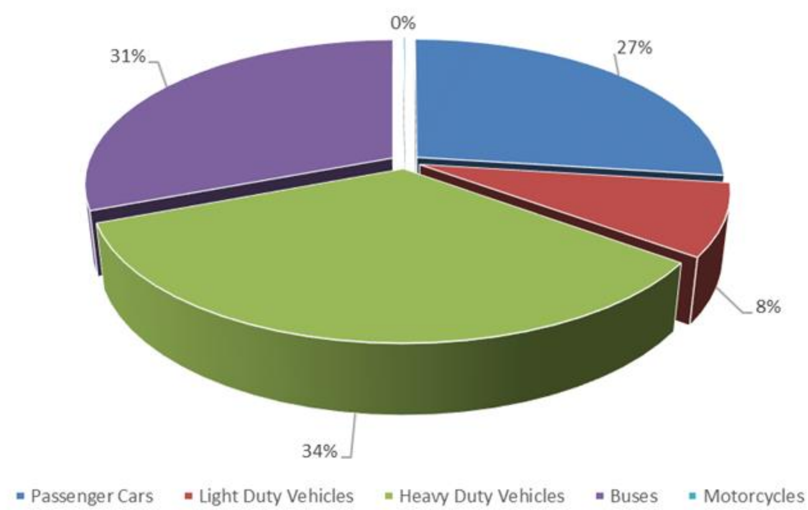


Figure 47. Distribution of NOx traffic emission in all vehicle categories

In total emissions of NOx, heavy duty vehicles contribute with 34%, buses with 31% and passenger cars with 27%.

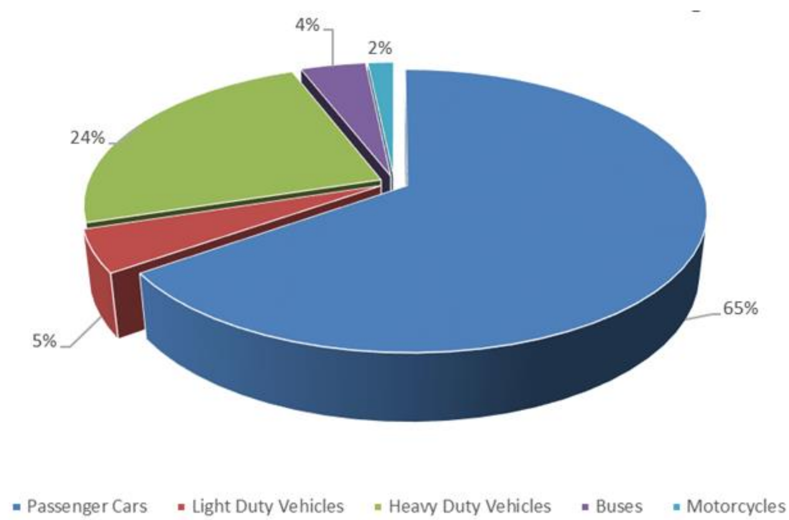


Figure 48. Distribution of CO traffic emission in all vehicle categories

The biggest contributors to emissions of CO from traffic sector are passenger cars with 65% and heavy-duty vehicles with 24%. The incomplete combustion of gasoline in vehicle engine cylinders is the main source of CO from traffic. Emissions of CO by diesel vehicles are much lower than gasoline vehicles, mainly due to excess air used in the diesel combustion which increases conversion of CO to CO_2 in the combustion process. So, the fact that large scale of emissions of CO from sector traffic are coming from passengers' vehicles is very much expected having into consideration that most of passenger cars registered in Bitola Region are using gasoline as fuel.

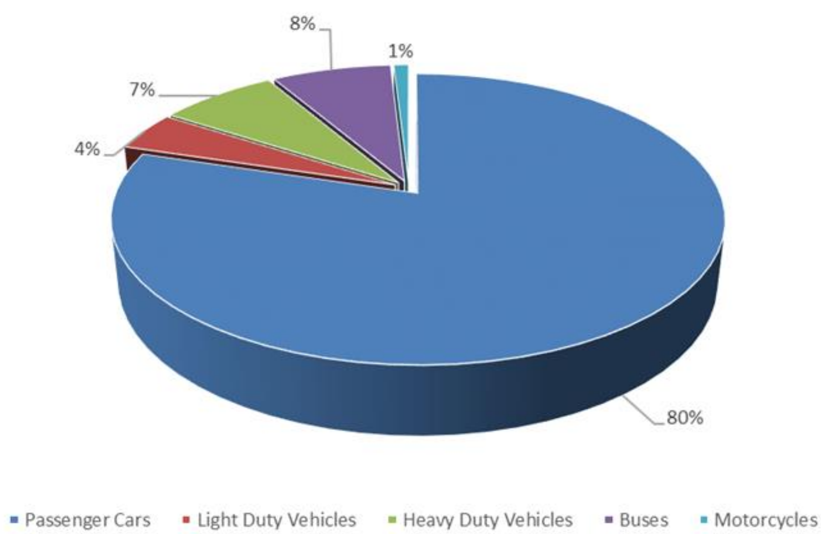


Figure 49. Distribution of SO_x traffic emission in all vehicle categories

Biggest share of 80% in emissions of SO_x from traffic sector have passenger cars which is very much expected because of high-sulfur fuels used in this category of vehicles.

Concerning the calculation of total emissions from traffic sector, the estimation of the mileage covered per year in urban area may entail some degree of uncertainty, since no referenced data are officially available at local level. Nevertheless, the magnitude of the mileage amount estimated for each category of vehicles in Bitola, Novaci and Mogila is comparable with the information retrieved in other areas of North Macedonia.

6.1.4. Manufacturing industries

Activities in this sector essentially cover combustion activities in industry belonging to the category 1.A.2. The GB 2019 provides guidance on estimating emissions where the combustion process is an integral part of the manufacturing process, example where fuels are process by-products or where combustion products and the process materials directly mix) and, where combustion products may be modified by the interaction with the production activity. As specified in the GB 2019, in many instances release of pollutants can occur due to both the process and combustion activities. It is generally not possible to allocate an emission between the process and combustion processes, so including mechanism which could allocate the emission between the process and combustion activity adds complexity to the inventory.

Industrial activities considered as industrial air pollution sources generally are stationary emission sources from following industries: metallurgy, food industry (meat products, bread and pastries products, food and beverages); processing of wood, paper and graphic activity; construction materials production and other. Those industrial activities are identified as major air pollution sources so their operability is regulated with environmental bylaws. According to existing legal environmental framework, operation of those facilities is controlled by issuing ecological permits (A or B) or approval of Elaborates for environmental protection.

Reviewing the entities where used technologies include industrial combustion, activity data for emission calculation was obtained by available data from major production facilities in the region of Bitola, Novaci and Mogila: Makedonija Pat – asphalt base Bitola, Granit – asphalt base Bitola, Poultry farm Beli Most Lisolaj, Fustelarko Bitola, Kiro Dandaro Bitola, BIMILK Bitola, Yeast and alcohol factory Bitola, Company Radevski, Company Velkovski, Concreate Solutions Bitola, Stenton Gradba and Marbi Vlatko Novaci.

Annual emissions of pollutants from manufacturing industries are presented in Table 23 and Table 23.

Table 23 Annual emissions of main pollutants from manufacturing industries

	pollutant						
	NOx	**CO**	**NMVOC**	**SOx**	**TSP**	**PM_{10}**	**$PM_{2.5}$**
	Unit Mg(t)						
Manufacturing industries	**41,69**	**15,54**	**211,77**	**12,79**	**13,40**	**7,94**	**3,00**

Table 24 Total emissions of heavy metals, PAHs, HCB and PCBs emitted from manufacturing industries

	pollutant											
	Pb	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**	**PAHs**	**HCB**	**PCBs**
	Unit Mg(t)										Unit kg	
Manufacturing industries	0,001	0,00003	0,00001	0,0001	0,001	0,0004	0,02	0,00001	0,003	0,00002	0,00003	0,00000005

6.1.5. Small combustion

This sector includes installations which are considered to have a thermal capacity ≤50MW which are used for providing commercial and institutional heating. Installations and equipment for small combustion in this sector are usually outdated and inefficient. These emissions are included in the category 1.A.4.

In small combustion installations a wide variety of fuels are used and several combustion technologies are applied. Air pollutant emitted strongly depends on the fuel type, combustion technologies as well as on operational practices and regular maintenance.

In the region of Bitola, Novaci and Mogila administrative capacities and educational institutions in municipalities of Bitola, Mogila and Novaci are identified as emission sources for this sector.

For calculation of emissions from small combustion tier 1 was used.

Activity data for calculation of emissions was obtained by fuel consumption from administrative and educational capacities in Bitola, Novaci and Mogila provided by each municipality.

Emissions from small combustion are given in Table 25 and 26.

Table 25 Emissions of main pollutants from small combustion

	pollutant							
	NOx	**CO**	**NMVOC**	**SOx**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
	Unit Mg(t)							
Small combustion	**7,39**	**4,40**	**1,65**	**2,20**	**1,16**	**1,13**	**1,05**	**0,15**

Table 26 Total emissions of heavy metals, PAHs, HCB and PCBs emitted from small combustion

	pollutant											
	Pb	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**	**PAHs**	**HCB**	**PCBs**
	Unit Mg(t)										Unit kg	
Small combustion	0,0003	0,0001	0,000005	0,000005	0,0003	0,0001	0,003	0,000004	0,002	0,00014	0,00002	0,0000002

6.1.6. Residential stationary combustion

This sector includes activity of small combustion unites used for residential heating. These emissions are included in the category 1.A.4.

Small combustion processes from households are considered significant due to their numbers, different type of combustion techniques and range of combustion efficiencies and emissions. Many of small combustion installations have no efficiency measures especially in economies undergoing transition. Installations used for residential heating are very diverse and used fuel generally depends on local, country or regional fuel supply and on the country economic development. Smaller combustion appliances used for residential heating, especially older single household installations are of very simple design with very pour combustion efficiency.

For calculation of air pollutants emitted from domestic heating as emission source, tier 1 default emission factors are used. Activity data is obtained from issued official statistic in MAKSTAT.

For calculation of air pollutants emitted from domestic heating as emission source, tier 1 default emission factors are used. Activity data is obtained from issued official statistic in MAKSTAT using proportion for estimating fuel consumption by type for households in Bitola, Mogila and Novaci

Emissions of air pollutants from residential stationary combustion are presented in Table 27 and Table 28.

Table 27 Emissions of main pollutants from residential stationary combustion

residential stationary combustion	pollutant							
	NOx	**CO**	**NMVOC**	**SOx**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
	Unit Mg(t)							
Bitola	17,30	1.302,67	195,16	4,75	260,04	247,03	240,53	22,72
Mogila	1,14	85,55	12,82	0,31	17,08	16,22	15,80	1,49
Novaci	0,57	43,12	6,46	0,16	8,61	8,18	7,96	0,75
TOTAL	**19,01**	**1.431,34**	**214,44**	**5,22**	**285,73**	**271,43**	**264,29**	**24,96**

Table 28 Total emissions of heavy metals, PAHs, HCB and PCBs emitted from residential stationary combustion

residential stationary combustion	pollutant											
	Pb	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**	**PAHs**	**HCB**	**PCBs**
	Unit Mg(t)										Unit kg	

Bitola	0,01	0,004	0,0002	0,0001	0,01	0,002	0,001	0,0003	0,17	0,11	0,002	0,0002
Mogila	0,001	0,0003	0,00001	0,000004	0,0005	0,0001	0,00004	0,00002	0,01	0,007	0,0001	0,00001
Novaci	0,0003	0,0001	0,00001	0,000002	0,0002	0,0001	0,00002	0,00001	0,01	0,004	0,0001	0,00001
TOTAL	**0,01**	**0,005**	**0,0002**	**0,0001**	**0,01**	**0,002**	**0,001**	**0,0003**	**0,18**	**0,121**	**0,002**	**0,0002**

6.2. Industrial processes and product use

Construction and demolition

This activity mainly results in emissions of particulates, but other pollutants may also be emitted, depending on the materials used in the work. At construction sites, construction materials are used to construct items including buildings and infrastructure. At demolition sites, a building, infrastructure, or other constructions are torn down, resulting in a lot of rubbish.

Tier 1 method has been applied for estimation of emissions coming from this source category where the activity data refer to floor area in m2 of the building constructed or demolished. The emissions from construction sites were estimated according to the basic approach included in the EEA Guidebook 2019.

Activity data on constructed dwellings are taken from MAKSTAT database. There is only data for area of constructed dwellings for municipality of Bitola, Novaci and Mogila. There is no precise data concerning the other classes of constructions (commercial buildings etc.), but for first approximation, the information of dwelling construction sites is useful to represent the magnitude of the construction related particulate emissions.

Calculations of $PM_{2.5}$, PM_{10} and TSP emissions factors are performed using GB 2019.

In Table 29 estimated emissions of $PM_{2.5}$, PM_{10} and TSP from construction and demolition activities are presented.

Table 29 Emissions of $PM_{2.5}$, PM_{10} and TSP from construction and demolition activities

activity	pollutant		
	TSP	**PM_{10}**	**$PM_{2.5}$**
	Unit (t/year)		
Construction and demolition	5,87	1,74	0,17

Solvent and product use

This category includes emissions from domestic solvent use including fungicides, degreasing and dry cleaning.

The most significant pollutant from this category is non-methane volatile organic compounds (NMVOC).

The calculation in this category is based on tier 1 where population data is multiply with the EF. Due to the lack of data, the activity data considered in this source category is population. Population data for the municipalities are taken from the publication assessment of the population in 2019 by gender and age, by municipalities and statistical regions published by SSO.

Calculated emissions for this category are presented in Table 30.

Table 30 Emissions from solvent and product use

activity	**NMVOC** (t/year)
domestic solvent use including fungicides	119,85
degreasing	84,89
dry cleaning	29,96
TOTAL for solvent and product use	**234,4**

6.3. Waste

Emissions related to the waste management activities refer mainly to waste disposal and small scale waste burning. There are no incineration or cremation activities, nor composting or domestic waste water treatment plants on the territory of these municipalities. The emissions from both categories were estimated using the basic approach included in the EEA Guidebook 2019 for the solid waste disposal activities and the small scale burning.

Tier 1 method has been applied for estimation of emissions coming from Biological treatment of waste - Solid waste disposal on land category where the activity data refer to municipal waste disposal.

According to MOEPP (Yearly report on processed environmental data) 42.114,52 tons of municipal solid waste is disposed in landfill for all three municipalities on yearly base. Data for Bitola and Novaci, refer to 2018 and Mogila for 2019. It is assumed that the amount of municipal waste is similar each year.

The average amount of waste burned for arable farmland (Open burning of waste GB 2013) was estimated to be 25 kg/hectare. Activity data on arable land are taken from the MAKSTAT database. This approach has been used for estimation of activity data. The activity data were calculated when the agriculture area expressed in hectares was multiplied with the factor 25 and divided by 1000 which equals to the waste burned in kg.

Emissions from sector waste are given in tables below.

Table 31 Emission of NOx, CO, NMVOC, SOx, TSP, PM_{10} and $PM_{2,5}$ from sector waste

activity	pollutant						
	NOx	CO	NMVOC	SOx	TSP	PM_{10}	$PM_{2.5}$
	t/year						
Biological treatment of waste - Solid waste disposal on land	0	0	65,70	0	0,02	0,01	0,001
Open burning of waste	4,53	79,55	1,75	0,16	6,61	6,43	5,97
TOTAL for sector waste	4,53	79,55	67,45	0,16	6,63	6,44	5,97

Table 32 Emission of Pb, Cd, As, Cr, Cu, Se, Zn, dioxins and furans from sector waste

activity	pollutant							
	Pb	Cd	As	Cr	Cu	Se	Zn	Dioxins and furans
	t/year							
Open burning of waste	0,001	0,0001	0,001	0,00001	0,0003	0,0001	0,02	0,0136

6.4. Agriculture

Within sector Agriculture emissions from agriculture practices, especially concerning the manure management, including animal husbandry and emissions following application of manure to land, and use of artificial fertilizers are estimated.

Manure management

Separate default Tier 1 EFs are provided for slurry and litter-based manure management systems to be multiplied with the animal numbers of the appropriate livestock categories.

The input data in this sub-sector is calculated by proportion from the number of registered heads of each domestic animal species for Pelagonia region derived from MAKSTAT.

Emission factors have been obtained from following guidebooks: GB 2016 - Default Tier 1 EF (EF NH_3) for calculation of NH_3 emissions from manure management; GB 2013 updated July 2015 -

Default Tier 1 EF for NO; GB 2016- Default Tier 1 EF for NMVOC, GB 2013 updated July 2015 - Default Tier 1 estimates of EF for particle emissions from animal husbandry (housing).

Use of fertilizers

For this category only number of fertilizers on national level is available. Therefore, the amount of kg kg-1 fertilizer-N applied was calculated scaled from National statics. The NH_3 emissions calculated on national level by use of Tier 2 methodology by using the N contents for different types of fertilizers. The NH_3 emissions on the territory of Bitola, Novaci and Mogila were calculated by use of arable land proportion.

According to the MAKSTAT database, in Municipality of Bitola, Mogila and Novaci there are 113504 ha of agriculture area, compared to 1263155ha on national level. The amount of a kg kg-1 fertilizer-N applied has been estimated (scaled from national statistics 17516558 kg kg-1 fertilizer-N applied) of about 1573995 kg kg-1 fertilizer-N applied in the Municipality of Bitola, Mogila and Novaci.

Only EF for NOx has been used for this category. NH_3 emissions were calculated using fertilize use of proportion on national and municipal level.

Total emission related to agricultural activities is listed in Table 33.

Table 33 Emissions from agriculture activities

activity		pollutant					
		NOx	NMVOC	TSP	PM_{10}	$PM_{2,5}$	NH_3
		[t/year]					
Breeding	Dairy cattle	1,867	157,474	16,73	7,636	4,97	204,842
	Non-dairy cattle	0,899	59,801	5,64	2,583	1,72	59,304
	Sheep	0,159	5,388	4,43	1,772	0,53	12,752
	Swine fattening pigs + Swine sows	0,010	5,125	6,16	2,790	0,49	33,730
	Goats	0,009	1,000	0,26	0,103	0,03	0,738
	Horses	0,037	2,191	0,14	0,062	0,04	1,971
	Laying hens	0,450	24,729	17,83	17,835	3,45	47,959
	Broilers	0,044	4,698	3,00	3,002	0,39	6,525
	Turkeys	0,003	0,314	0,33	0,334	0,04	0,359
	Other poultry (ducks) + gees	0,011	1,372	0,42	0,416	0,06	1,228
Use of Fertilizers		40,924	/	/	/	/	87,466
TOTAL		**44,412**	**262,091**	**54,94**	**36,532**	**11,73**	**456,874**

6.5. Summary data for air pollutant emission by sectors

Table 34 Summary data for air pollutant emission by sectors

sector	pollutant																				
	NOx	CO	NMVOC	SOx	TSP	PM_{10}	$PM_{2.5}$	NH_3	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PAHs	Dioxins and furans	HCB	PCBs
	t/year																			kg/year	
Energy production	5.280,45	1.664,82	51,03	105.431,34	3.596,24	2.428,23	983,59	/	0,55	0,07	0,11	0,52	0,33	0,04	0,48	1,64	0,36	0,003		0,0002	0,0001
Fugitive emissions	/	/	1.112,00	/	455,92	216,84	33,36	/													
Transport	363,11	572,76	216,18	38,58	22,19	18,36	15,42	6,13	0,004									0,001			0,00002
Manufacturing industries	41,69	15,54	211,77	12,79	13,40	7,94	3,00	/	0,001	0,00003	0,00001	0,0001	0,001	0,0004	0,02	0,00001	0,003	0,00002		0,00003	0,00000005
Small combustion	7,39	4,40	1,65	2,20	1,16	1,13	1,05	0,15	0,0003	0,0001	0,000005	0,000005	0,0003	0,0001	0,003	0,000004	0,002	0,00014		0,00002	0,0000002
Residential stationary combustion	19,01	1.431,34	214,44	5,22	285,73	271,43	264,29	24,96	0,01	0,005	0,0002	0,0001	0,01	0,002	0,001	0,0003	0,18	0,121		0,002	0,0002
Industrial processes and product use	/	/	234,40	/	5,87	1,74	0,17	/													
Waste	4,53	79,55	67,45	0,16	6,63	6,44	5,97	/	0,001	0,0001		0,001	0,00001	0,0003		0,0001	0,02		0,0136		
Agriculture	44,41		262,09	/	54,94	36,53	11,73	456,88													
TOTAL	**5.760,59**	**3.768,41**	**2.371,01**	**105.490,29**	**4.442,08**	**2.988,64**	**1.318,58**	**488,11**	**0,57**	**0,08**	**0,11**	**0,52**	**0,34**	**0,04**	**0,50**	**1,64**	**0,57**	**0,13**	**0,01**	**0,002**	**0,0003**

The share of each sector in emission of air pollutants is presented on charts below.

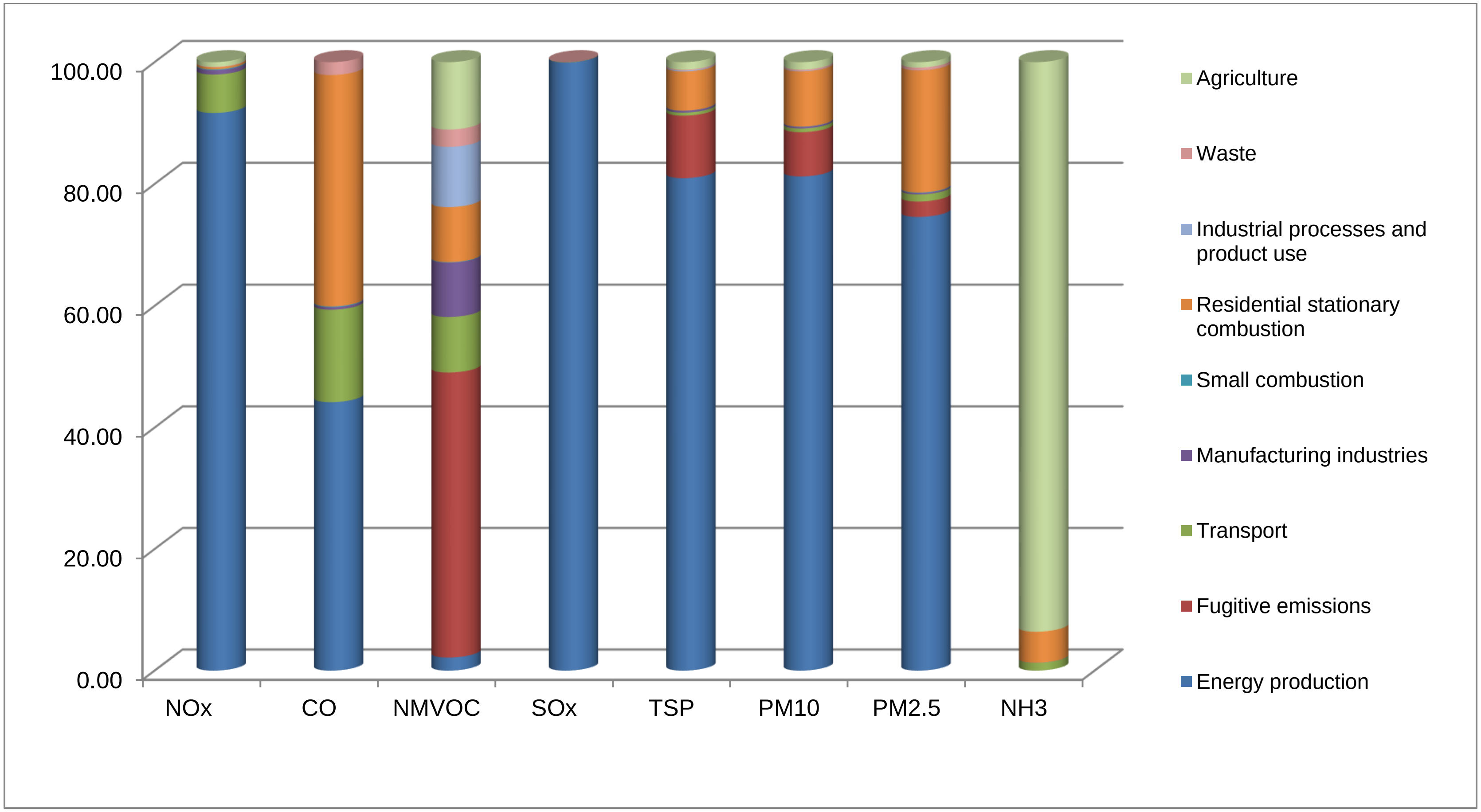
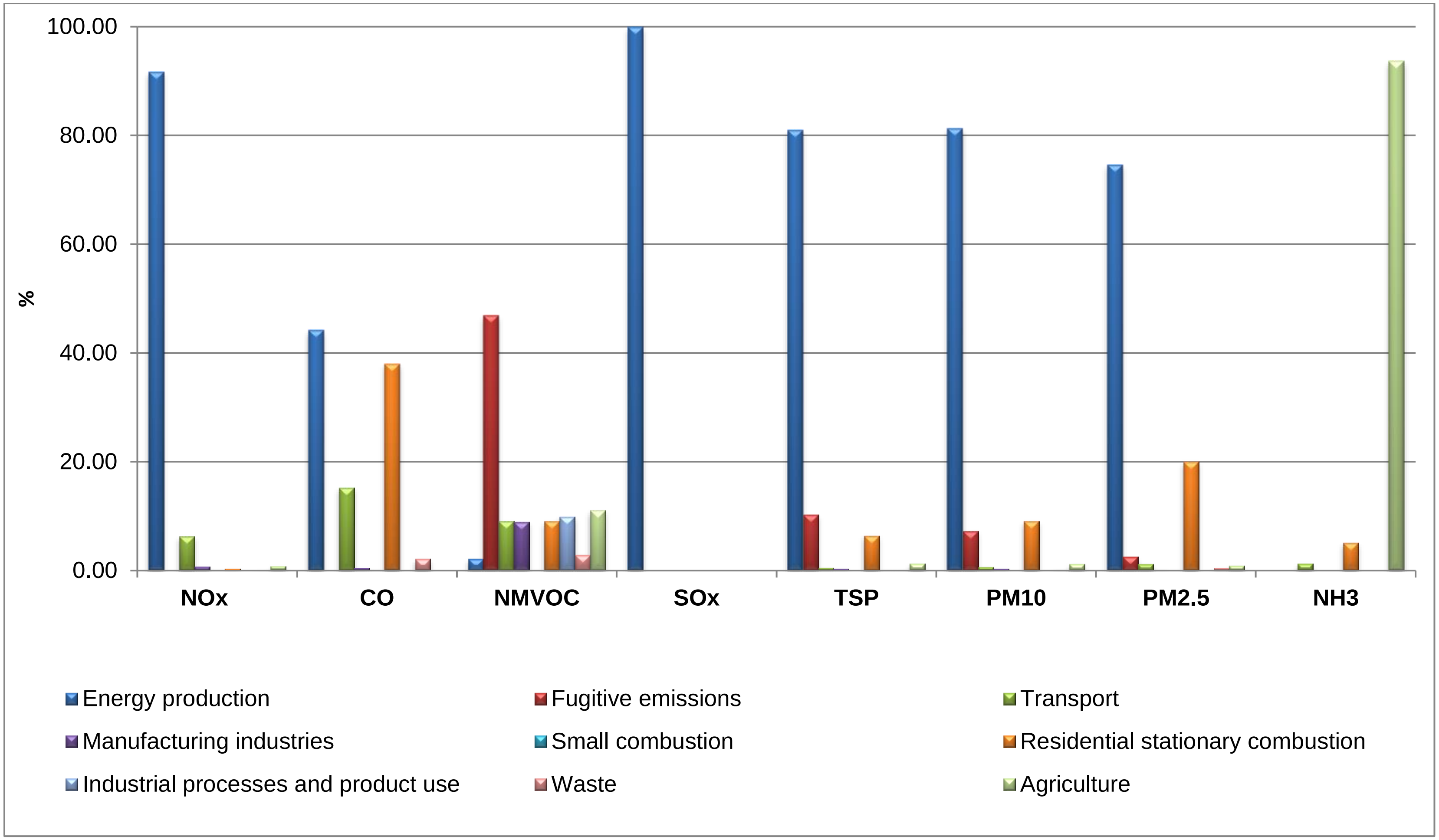


Figure 50 Emission of air pollutants by emission sectors


100.00
80.00
60.00
40.00
20.00
0.00
%
NOx
CO
NMVOC
SOx
TSP
PM10
PM2.5
NH3
Energy production
Fugitive emissions
Transport
Manufacturing industries
Small combustion
Residential stationary combustion
Industrial processes and product use
Waste
Agriculture

Emissions of each air pollutant by sectors are presented in following charts.

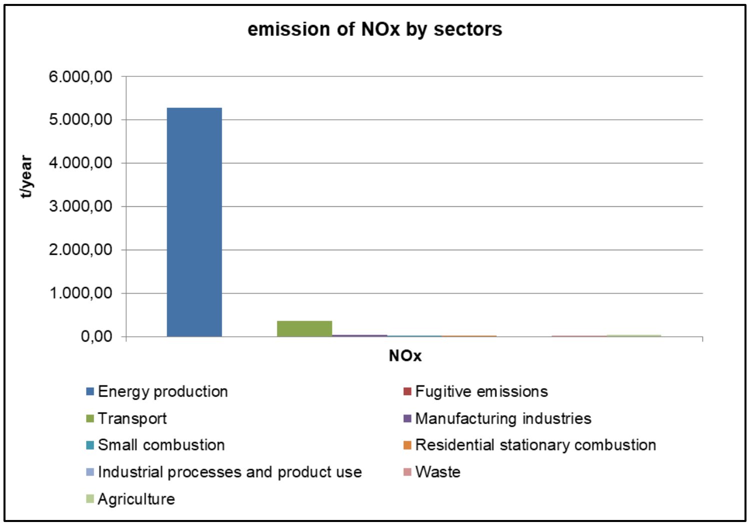


Figure 51 Emission of NOx by sectors

Energy production sector has biggest share in emission of NOx (91,67%) due to energy production technology and production capacity of power plant Bitola. In the region of Bitola, Mogila and Novaci due to high emissions from REK Bitola other sectors have significantly lower contribution to total emissions of NOx, meaning sector transport contributes with 6,30% in total emission of NOx and sector agriculture with 0,77%.

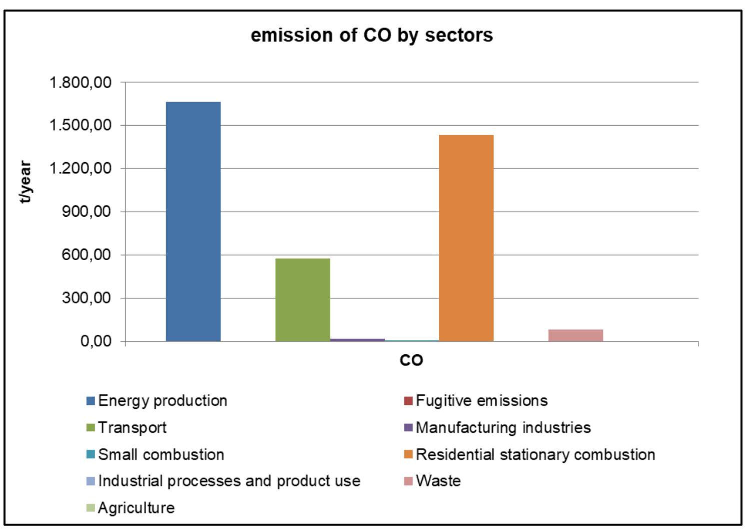


Figure 52 Emission of CO by sectors

In emission of CO energy production sector contributes with 44,18%, residential stationary combustion with 37,98% and transport with 15,20%.

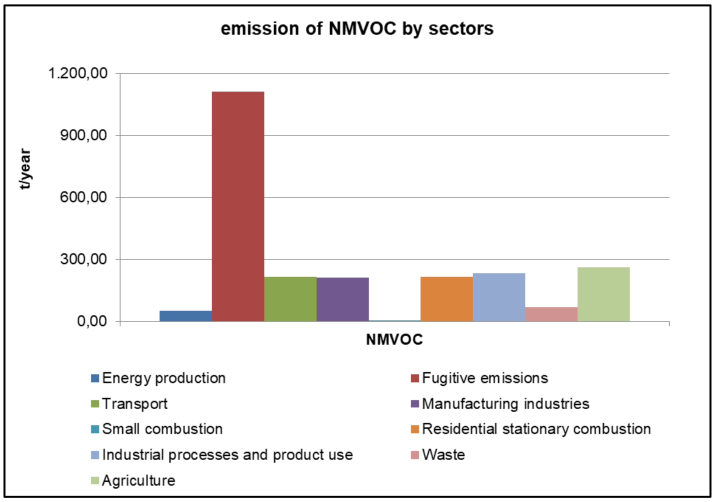


Figure 53 Emission of NMVOC by sectors

Biggest share in emission of NMVOC (46,90%) have fugitive emissions from open coal mining at coal mines Suvodol and Brod-Gneotino where lignite for thermal power plant Bitola is excavated. Sector agriculture contributes with 11,05%, sector transport with 9,12%, sector residential stationart combustion with 9,04%, and manufacturing industries with 8,93% in total emission of NMVOC.

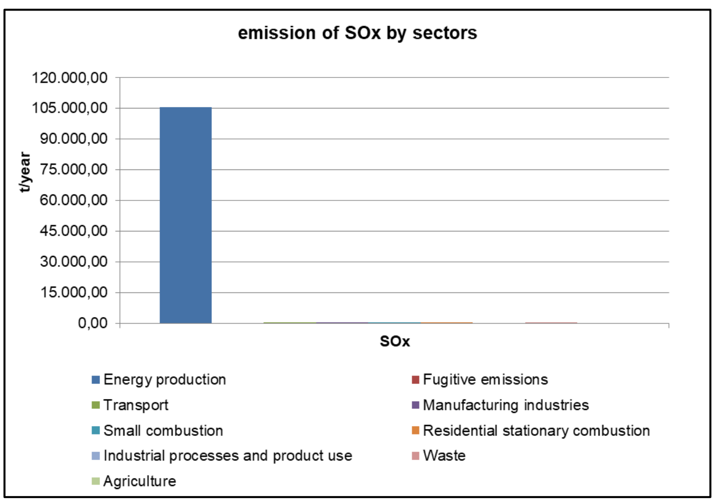


Figure 54 Emission of SOx by sectors

Reasonably, having in consideration the operational processes and lignite composition used for energy production in power plant Bitola, it is expected that near all the emission of SOx (99,94%) comes from energy production sector.

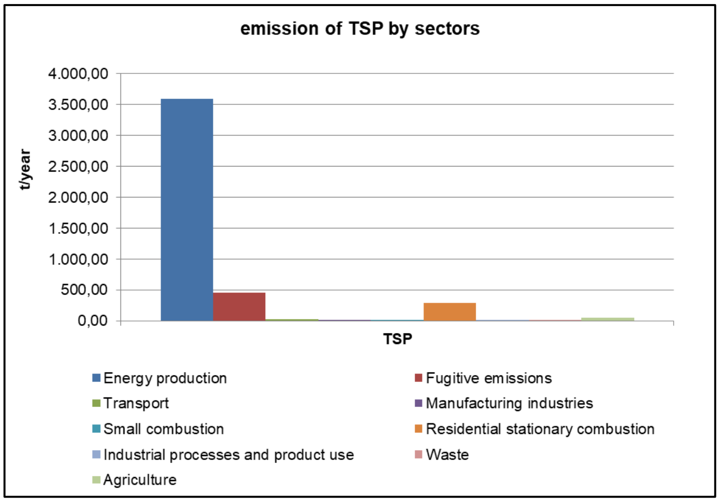


Figure 55 Emission of TSP by sectors

80,96% of emission of TSP originates from energy production sector, 10.26% originates from fugitive emissions and 6,43% from residential stationary combustion.

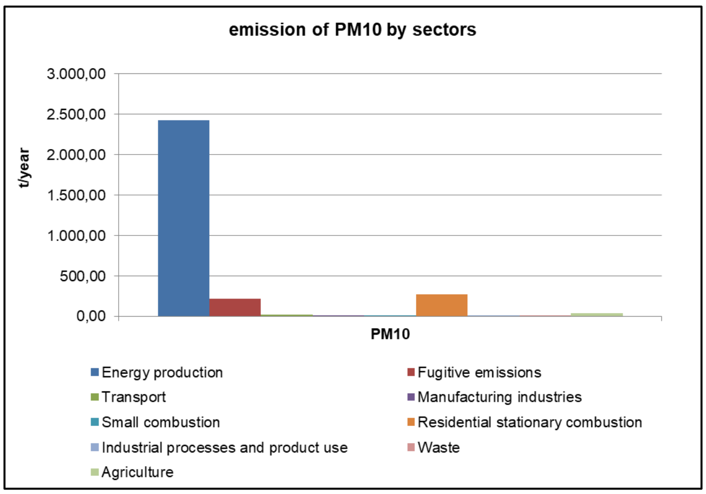


Figure 56 Emission of PM10 by sectors

Energy production sector contributes with 81,25% in emission of PM_{10}, residential stationary combustion with 9,08% and fugitive emissions with 7,26%.

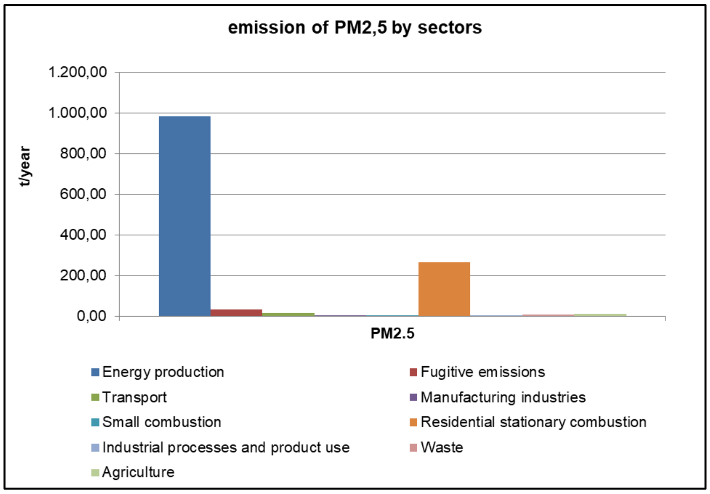


Figure 57 Emission of PM2,5 by sectors

Biggest share in emissions of $PM_{2,5}$ has energy production sector (74,59%). Residential stationary combustion contributes in emissions of PM2,5 with 20,04%.

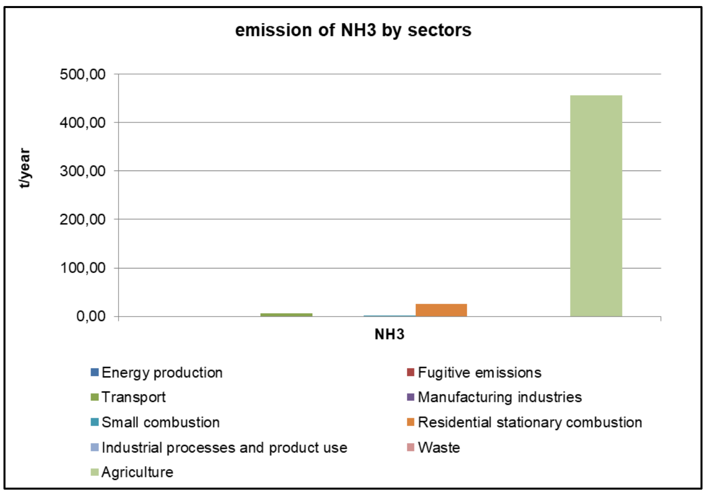


Figure 58 Emission of NH_3 by sectors

93,60% of emission of NH_3 originates from sector agriculture. Sector residential heating contributes with 5,11% and other sectors have insignificant share in emission of NH_3.

7. ANALYSIS OF THE CURRENT SITUATION REGARDING HEALTH ASPECTS

Research studies on health aspects of exposure to low air quality are increasing the awareness for prioritization of the activities aimed to improving air quality. These studies are pointing that exposure to even relatively low concentrations of air pollutants may lead to health issues especially among vulnerable categories. According to the studies, adverse effects of air pollutants to human health are presented in the following table.

Table 35 Adverse effects on human health by air pollutants

Pollutant	Possible health effect
Particulate matter (PM)	Deterioration of cardiovascular and lung diseases, heart attack and arrhythmia. Can cause cancer. Can lead to arteriosclerosis, infant and newborn respiratory diseases. The outcome can be premature death.
Ozon (O_3)	Can cause reduction of lung function, deterioration of asthma and lung disease. Can lead to premature death.
Nitrogen dioxide (NO_2)	Increased mortality caused by cardiovascular, lung and respiratory diseases.
Sulfur dioxide (SO_2)	Deterioration of asthma, reducing lung function and inflammation of respiratory system. Can cause headache, discomfort and anxiety.
Polycyclic aromatic hydrocarbon, especially Benzo[a]pyrene	carcinogen
Carbon monoxide (CO)	Can cause heart diseases and damage to nervous system. Can cause headache and fatigue.
Arsenic (As)	Carcinogen. Can cause lung cancer.
Cadmium (Cd)	carcinogen
Lead (Pb)	It can affect almost any organ and system, especially the nervous and cardiovascular systems. It can have negative cognitive effects in children and can lead to high blood pressure in adults.

Mercury (Hg)	It can affect the liver, kidneys, digestive system and respiratory system. It can also affect the central nervous system.
Nickel (Ni)	carcinogen
Benzene (C_6H_6)	carcinogen

Source: air.moepp.gov.mk

Air quality improvement is one of the mechanisms for health prevention, indicating that many of the human health issues are related to poor air quality. Ambient air pollution is major environmental problem. Adverse effects of air pollution are documented in every part of Europe as well as the rest of the world. These effects include diseases and reduction of life years for a year or more for citizens of big cities. (*Source: WHO*) According to the findings of WHO, providing accurate information for the air pollution health effects is basis for further defining scientific, effective and correctly targeted strategies for reducing the health effects, at minimum cost.

Due to the increased cost of implementing health polices considering the air pollution, it often is used as an indicator of the economic sustainable development.

Scientific researches show that exposures on particulate air pollution leads to further deterioration of population health status. This further means higher economic losses due to increased need of health care services, increased medication use, absenteeism from work and school, restricted activity and losses due to premature deaths and active years of life.

In 2019 as part of the project “TRAP- Transboundary Air Pollution Health Index Development and Implementation” a Health risk assessment for municipality of Bitola was prepared. This document presents various data related to health aspects when analyzing the health effects from air pollution.

Common indicator for analyzing the health impact from the air pollution is mortality. Table 36 presents data for age-specific mortality excluding external causes of death in the period 2015-2017 for age 30 and over.

Table 36: Age-specific natural mortality in Bitola

year	age - 30 and over					
	Municipality of Bitola			Republic of North Macedonia		
	male	female	total	male	female	total
2015	596	592	1188	9990	9609	19599
2016	545	564	1109	10137	9359	19496
2017	604	570	1174	10053	9495	19548

average	582	575	1157	10060	9488	19548

Source: State Statistical Office (SSO). 2019

Table 37 shows the natural mortality rate per 10000 population in Bitola.

Table 37: Natural mortality rate per 10000 population in Bitola in period 2015-2017

year	all age groups					
	Municipality of Bitola			Republic of North Macedonia		
	male	female	total	male	female	total
2015	199,8	183,5	191,3	154,8	144,3	149,4
2016	182,7	174,8	178,6	157,0	140,5	148,7
2017	202,5	176,6	189,0	142,6	155,7	149,0
average	195,0	178,3	186,3	155,8	142,5	149,0

Source: State Statistical Office (SSO). 2019

The average all-cause natural mortality rate in Bitola is higher than the national average all-cause mortality rate.

As major health risk, air pollution can lead to various health issues such as respiratory and cardiovascular diseases. Cardiovascular mortality generally comes from death cases caused by myocardial infarction, arterial hypertension, stroke, and heart failure. Many latest studies suggest that exposure to polluted air is much higher health risk than it was previously considered.

Table 38 shows age-specific and cause-specific mortality rate from circulatory diseases.

Table 38 Age-specific mortality rate from circulatory diseases per 10,000 population in Bitola and RN Macedonia, for 2015-2017

Mortality rate from circullatory diseases	age - 30 and over					
	Municipality of Bitola			Republic of North Macedonia		
	male	female	total	male	female	total
2015	87,8	91,4	89,7	87,9	93,2	90,6
2016	69,7	74,7	72,3	82,8	83,1	82,9
2017	80,8	85,2	83,1	82,6	86,9	84,8
average	79,4	83,8	81,5	84,4	87,7	86,1

Source: State Statistical Office (SSO). 2019

Data for age specific mortality rate from respiratory diseases are presented in Table 39.

Table 39 Age-specific mortality rate from respiratory diseases per 10,000 populations in Bitola and RN Macedonia, for 2015-2017

Mortality rate from respiratory diseases	age - 30 and over	
	Municipality of Bitola	Republic of North Macedonia

	male	female	total	male	female	total
2015	3,0	1,9	2,4	6,7	4,6	5,7
2016	3,4	1,5	2,4	7,9	4,8	6,3
2017	4,7	2,2	3,4	8,1	4,7	6,4
average	3,7	1,9	2,7	7,6	4,7	6,1

Source: State Statistical Office (SSO). 2019

From the presented data it is obvious that in male population the ratio is 3 to 4 times higher than in the female population both in Bitola and in the total national population.

Lung cancer is the most common lung disease that causes death cases. In table 40 data for mortality rate from lung cancer are presented.

Table 40 Age-specific mortality rate from lung cancer per 10,000 population in selected municipalities and RN Macedonia, for 2015-2017

Mortality rate from lung cancer	age - 30 and over					
	Municipality of Bitola			Republic of North Macedonia		
	male	female	total	male	female	total
2015	10,1	1,9	5,8	11,7	2,6	7,1
2016	13,1	2,5	7,6	12,1	3,2	7,6
2017	12,4	2,8	7,4	10,5	3,0	6,7
average	11,8	2,4	6,9	11,4	3,0	7,1

Source: State Statistical Office (SSO). 2019

The IARC (International Agency for Research on Cancer) statement from 2013 and many scientific evidence and literature are classifying air pollution as carcinogenic for human population. This scientific evidence is showing that long time exposure to air polluted with particulate matter is a contributing factor that increases the occurrence of lung cancer.

The impact of particulate air pollution on human health in Bitola municipality is analyzed by quantification of the burden of disease from particulate air pollution is based on commonly used methodologies that provides relation between exposures to current air quality and mortality of the population. Available scientific based evidence is pointing $PM_{2.5}$ as main pollutant which can potentially cause cardiovascular diseases and lung cancer. Also, in the recent years, trends of air pollution with $PM_{2,5}$ are increasing. $PM_{2,5}$ particulates because of their small size have the ability to easily enter human respiratory and circular systems causing body systems and organ disorders.

Air pollution caused death cases are presented by estimation taking into consideration other influencing factors such as population age distribution, presence of vulnerable population, relevant lifestyles and occupation and education level of the population.

Due to strong correlation between air pollution and meteorological parameters, in the TRAP document relevant correlation matrices are developed for presenting the relations between air pollution with $PM_{2,5}$ and PM_{10}, meteorological data and specific and all-cause natural mortality.

These correlation matrices are shown on figure 59 and figure 60.

		PM_{10}	$PM_{2.5}$	Temperature	Pressure	Global radiation	All-cause Mt	Mt I00-I99	Mt J00-J99	Mt Lung-cancer
PM_{10} (μg/m³)	Pearson Correlation	1								
(N=36)	Sig. (2-tailed)									
$PM_{2.5}$ (μg/m³)	Pearson Correlation	1.000**	1							
(N=36)	Sig. (2-tailed)	.000								
Temperature (⁰C)	Pearson Correlation	-.844**	-.844**	1						
(N=32)	Sig. (2-tailed)	.000	.000							
Pressure (hPa)	Pearson Correlation	.700**	.700**	-.447*	1					
(N=35)	Sig. (2-tailed)	.000	.000	.010						
Global radiation (W/m²)	Pearson Correlation	-.736**	-.736**	.913**	-.519**	1				
(N=35)	Sig. (2-tailed)	.000	.000	.000	.001					
All cause Mt,	Pearson Correlation	.554**	.554**	-.505**	.277	-.345*	1			
30 and over *(N=36)*	Sig. (2-tailed)	.000	.000	.003	.107	.042				
Mortality I00-I99,	Pearson Correlation	.532**	.532**	-.465**	.291	-.256	.795**	1		
30 and over *(N=36)*	Sig. (2-tailed)	.001	.001	.007	.090	.137	.000			
Mortality J00-J99,	Pearson Correlation	.245	.245	-.469**	-.169	-.304	.469**	.438**	1	
30 and over *(N=36)*	Sig. (2-tailed)	.150	.150	.007	.332	.076	.004	.007		
Mortality Lung cancer,	Pearson Correlation	.092	.092	.000	.098	.071	.252	-.073	.061	1
30 and over *(N=36)*	Sig. (2-tailed)	.592	.595	.999	.574	.685	.138	.672	.725	

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
Mt - Mortality

Source: "TRAP- Transboundary Air Pollution Health Index Development and Implementation- Health risk assesment",2019

Figure 59. Correlation matrix between stressors, meteorological parameters and mortality, Bitola for the period 2015-2017

		PM_{10}	$PM_{2.5}$	Temperature	Pressure	Global radiation	HA J00-J99, all ages	HA J00-J99, 0-5 yrs	HA I00-I99, 30 +
PM_{10} (μg/m³)	Pearson Correlation	1							
(N=36)	Sig. (2-tailed)								
$PM_{2.5}$ (μg/m³)	Pearson Correlation	1.000**	1						
(N=36)	Sig. (2-tailed)	.000							
Temperature (⁰C)	Pearson Correlation	-.844**	-.844**	1					
(N=32)	Sig. (2-tailed)	.000	.000						
Pressure (hPa)	Pearson Correlation	.700**	.700**	-.447*	1				
(N=35)	Sig. (2-tailed)	.000	.000	.010					
Global radiation	Pearson Correlation	-.736**	-.736**	.913**	-.519**	1			
(W/m²) *(N=35)*	Sig. (2-tailed)	.000	.000	.000	.001				
Hosp. admiss. J00-J99,	Pearson Correlation	.333*	.333*	-.435*	-.017	-.312	1		
all ages *(N=36)*	Sig. (2-tailed)	.047	.047	.013	.922	.068			
Hosp. admiss. J00-J99,	Pearson Correlation	.477**	.477**	-.534**	.082	-.482**	.560**	1	
0-5 yrs *(N=36)*	Sig. (2-tailed)	.003	.003	.002	.640	.003	.000		
Hosp. admiss I00-I99,	Pearson Correlation	-.138	-.138	-.100	-.164	-.155	.321	.377*	1
30 and over *(N=36)*	Sig. (2-tailed)	.423	.423	.586	.347	.375	.056	.023	

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
HA - hospital admissions

Source: "TRAP- Transboundary Air Pollution Health Index Development and Implementation- Health risk assesment",2019

Figure 60. Correlation matrix between stressors, meteorological parameters and hospital admissions, Bitola for the period 2015-2017

For assessing the health impact or particulate air pollution, the number of premature death cases due to long term exposure that could be avoided if the concentrations of $PM_{2,5}$ were within the limit values using relevant methodology is estimated for the population aged 30 and over. The estimated health impact of $PM_{2,5}$ pollution in Bitola is presented in Table 41.

Table 41 Estimated health impact of $PM_{2.5}$ polluted air in the municipality of Bitola, due to long-term exposure for the period 2015-2017

	PM2.5 (μg/m^3) 3-year average	Natural mortality /100,000	Natural mortality /100,000 30+	Attributable mortality (attributable deaths)							
				WHO limit value PM2.5 (10 μg/m^3)				EU limit value PM2.5 (25μg/m^3)			
				#	95% CI	AR(%)	/100,000	#	95% CI	AR(%)	/100,000
Bitola	35.9	1,282	1,863	**167**	112-216	14.4	**269.1**	**74**	49-97	6.4	**118.6**
RNM	39.9	960	1,490	**3,218**	2,163-4,147	16.5	**245.4**	**1,676**	1,110-2,190	8.6	**127.8**

**Note: PM2.5 values were converted from PM10 values with a coefficient of 0.65.*
Source: "TRAP- Transboundary Air Pollution Health Index Development and Implementation- Health risk assesment",2019

In the table (AR%) Attributable proportion/fraction/attributable risk percent is the fraction of the population at risk that will develop a particular disease or condition as a result of that exposure. AR is the number of cases that will be eliminated if exposure is also eliminated. *(Source:https://www.statisticshowto.datasciencecentral.com/attributable-risk/)*

The estimated excess number of cases at exposure to 0.0 μg/m^3 which is unrealistic (hypothetical) scenario in Bitola municipality is 225 premature death cases (excess number of cases at a certain category of exposure) (95% CI 152-288) and population excess incidence (estimated number of attributable cases per 100,000 populations at risk) of 362 per 100,000 population at risk (95% CI 244.9-464.1). That means that 225 death cases could be attributed to the exposure to PM2.5, that presents 19.4% (AR%) of total all cause natural mortality for the age group 30 and over (three-year average number of death cases 1157).

Compared to the national estimation, it is calculated that 4,171 excess deaths at exposure to 0.0 μg/m^3 that presents 21.3% of total all cause natural mortality (three-year average number of cases 19,548). Population excess incidents in RN Macedonia is 318 per 100,000 (95% CI 215.9-406.2).

Following table presents the estimated risk percent (AR (%)) for the three scenarios.

Table 42. Estimated Risk percent (AR (%)) for the three scenarios

	PM2.5 (μg/m^3)	**Natural mortality**	**"Zero" scenario PM2.5 (0.0 μg/m^3)**			**WHO limit value PM2.5 (10 μg/m^3)**			**EU limit value PM2.5 (25 μg/m^3)**		
	3-year average	**30+**									
		#	#	95% CI #	% of Total Mt	#	95% CI #	% of total Mt	#	95% CI #	% of total Mt
Bitola	35.9	1157	225	152-288	19.4	167	112-216	14.4	74	49-97	6.4
RNM	39.9	19548	4,171	2,832-5,327	21.3	3,218	2,163-4,147	16.5	1,676	1,110-2,190	8.6

**Note: PM2.5 values were converted from PM10 values with a coefficient of 0.65.*
Source: "TRAP- Transboundary Air Pollution Health Index Development and Implementation-Health risk assessment", 2019

According to the presented table 6.4% of total mortality in Bitola could be avoided if recommended EU Directive limit value for $PM_{2.5}$ is met. This percentage on a national level is 8.6%. If WHO AQG limit values for $PM_{2.5}$ are met 14.4% of total death cases in Bitola can be avoided and on national level 16.5% of death cases can be avoided. The proportion of all-causes (natural) mortality as percent of total mortality (AR%) due to particulate air pollution exposure, exposures exceeding WHO AQG and EU Directive limit values, for age group 30 and over in Figure 61.

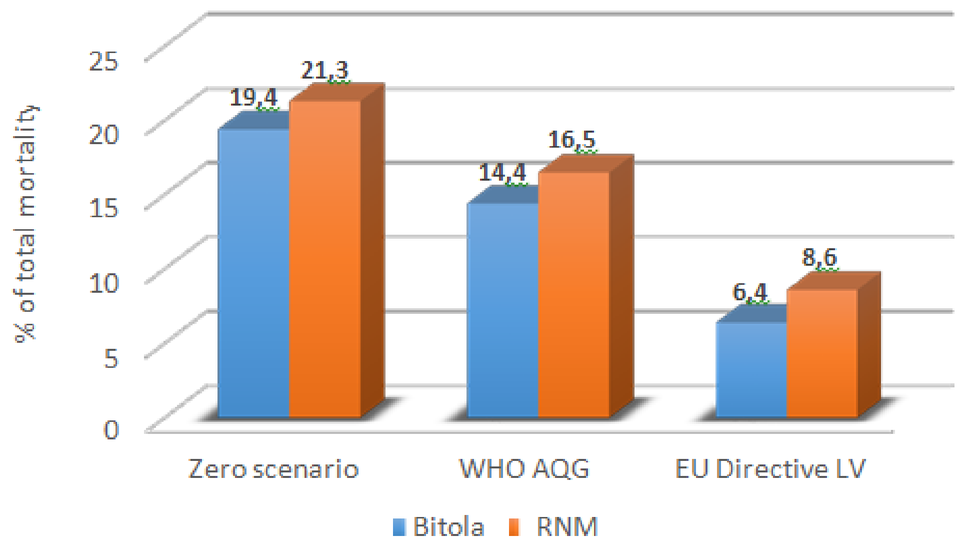


Figure 61. Proportion of all-causes (natural) mortality as percent of total mortality (AR%) due to particulate air pollution exposure, exposures exceeding WHO AQG and EU Directive limit values, for age group 30 and over

Figure 62 shows excess incidence per 100,000 population.

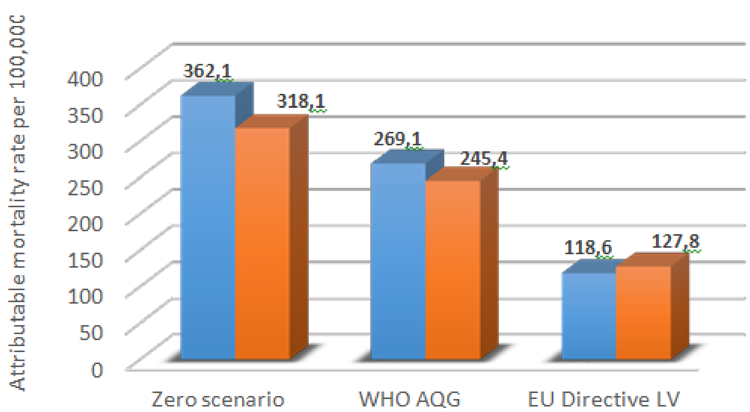


Figure 62. Excess incidence per 100,000 population due to particulate air pollution exposure exposures exceeding WHO AQG and EU Directive limit values, for age group 30 and over

For defining public health actions and policies, assessment of health benefits and estimating the disease health burden caused by exposure to PM2,5 air pollution, an indicating metric “Years of Life Lost (YLL)” is commonly used.

In 2016 the European Environmental Agency (EEA) has issues data for number of premature deaths attributed to $PM_{2.5}$. For the 28 countries in the European Union EU-28 the number of premature deaths related to long time $PM_{2,5}$ exposure is 4,466,000.

Using the YLL metric, the largest relative health impact from $PM_{2,5}$ is noticed in central and eastern European countries (Kosovo, Bulgaria, Serbia, the former Yugoslav Republic of Macedonia and Hungary) where the highest concentrations $PM_{2.5}$ are detected.

The latest EEA report presents estimated 30,400 YLL (1,469/100,000) at exposure to 28.7μg/m^3 in 2015 for the Republic of North Macedonia, an average taken from urban background station only.

Data for years of life lost due to premature mortality in terms of all-cause natural mortality for Bitola is presented in figure 63.

Health endpoint: All-cause mortality (excl. external causes of death), stressor $PM_{2.5}$

	Estimated YLL ('000) (WHO GBD 2016), >30 y.	3-years mean $PM_{2.5}$ (μg/m^3)	RR Macedonian exposures (10μg/m^3)	Population attributable fraction (PAF)	Estimated burden of diseases-YLL #	*LCL 95% CI*	*UCL 95% CI*	Years of life saved if annual mean of $PM_{2.5}$ is reduced to 10 μg/m^3 (WHO LV)	Standardized rate (YLL)/100,000 population
Bitola	380.7	35.9	**1.241**	**0.011**	**4,264.7**	2,686	5,839	**3,159**	**4,654**
Skopje	380.7	43.3	**1.298**	**0.069**	**26,455.5**	16,902	35,706	**20,622**	**4,804**
RNM	380.7	39.9	**1.271**	**0.213**	**81,235.0**	55,148	103,741	**59,010**	**3,914**

**WHO LV (WHO Limit value, Air Quality Guideline for particulate matter, ozone, nitrogen dioxide and sulfur dioxide. 2005)*

Source: "TRAP- Transboundary Air Pollution Health Index Development and Implementation- Health risk assesment",2019

Figure 63 Years of life lost due to premature mortality in terms of all-cause (natural) mortality

As presented in the figure, for Bitola the estimated number of saved years of healthy life if WHO AQG limit values are achieved, is 3,159 years (74% of the disease burden), while the national health gain will be 59,010 years of healthy life (73% of the disease burden).

Years of life lost due to premature mortality in terms of cardiopulmonary mortality and premature mortality in terms of lung cancer are presented in Figure 64 and Figure 65.

Health endpoint- cardiopulmonary mortality, stressor $PM_{2.5}$

	Estimated YLL ('000)	3-years	**Population attributable**	**Estimated burden of diseases-YLL**	Years of life saved if	**Standardized rate**

	(WHO GBD 2016), >30 y.	mean $PM_{2.5}$ (µg/m³)	RR Macedonian exposures (10 µg/m³)	fraction (PAF)	#	*LCL 95% CI*	*UCL 95% CI*	annual mean of $PM_{2.5}$ is reduced to 10 µg/m³ (WHO LV)	YLL/100,000 population
Bitola	231.8	35.9	**1.358**	**0.02**	**3,403**	807	6,370	**2,538**	**3,714**
Skopje	231,8	43.3	**1.394**	**0.09**	**20,858**	5,141	37,316	**16,310**	**3,788**
RNM	231.8	39.9	**1.317**	**0.26**	**61,115**	17,762	94,435	**43,999**	**2,945**

**WHO LV (WHO Limit value, Air Quality Guideline for particulate matter, ozone, nitrogen dioxide and sulfur dioxide. 2005)*

Source: "TRAP- Transboundary Air Pollution Health Index Development and Implementation- Health risk assesment",2019

Figure 64 Years of life lost due to premature mortality in terms of cardiopulmonary mortality

Health endpoint- Lung cancer mortality, stressor $PM_{2.5}$									
					Estimated burden of diseases- YLL				
	Estimated YLL ('000) (WHO GBD 2016), >30 y.	3-years mean $PM_{2.5}$ (µg/m ³)	**RR Macedonian exposures (10 µg /m ³)**	**Population attributable fraction (PAF)**	**#**	***LCL 95% CI***	***UCL 95% CI***	Years of life saved if annual mean of $PM_{2.5}$ is reduced to 10 µg/m³ (WHO LV)	**Standardized rate YLL/100,000 population**
				0.03	**593**	174	1,123	**450**	**647**
Bitola	24.1	35.9	**1.535**	**0.15**	**3,492**	1,088	6,117	**2,751**	**634**
Skopje	24.1	43.3	**1.676**	**0.38**	**9,127**	3,549	13,164	**6,417**	**439**

**WHO LV (WHO Limit value, Air Quality Guideline for particulate matter, ozone, nitrogen dioxide and sulfur dioxide. 2005)*

Source: "TRAP- Transboundary Air Pollution Health Index Development and Implementation- Health risk assesment",2019

Figure 65. Years of life lost due to premature mortality in terms of lung cancer

Estimations made in TRAP-Transboundary Air Pollution Health Index Development and Implementation- Health risk assesment",2019 for number of YLL for Bitola compared with the estimations for Skopje as largest city in RNM and the estimations on national level are presented in figure 66 and figure 67.

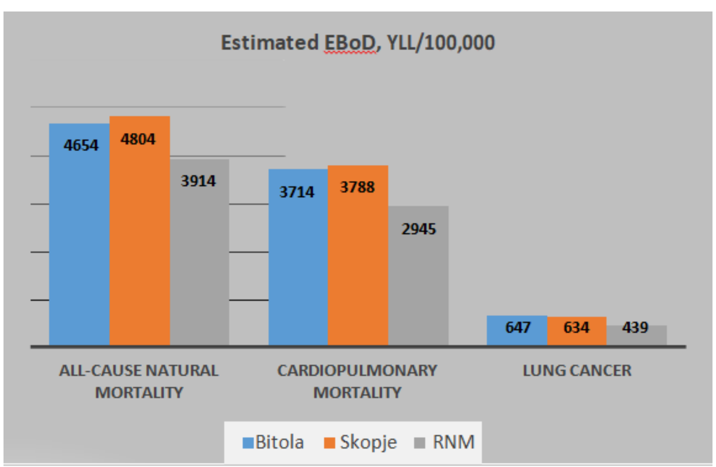


Figure 66 Estimated burden of disease expressed as YLLs per 100,000 population

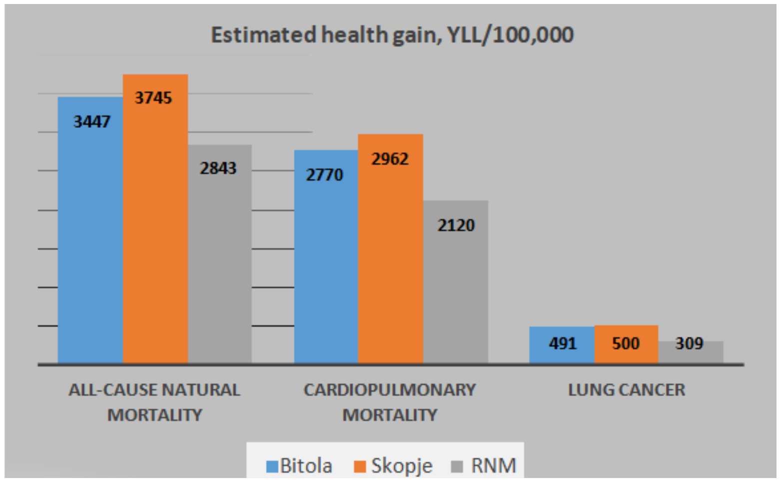
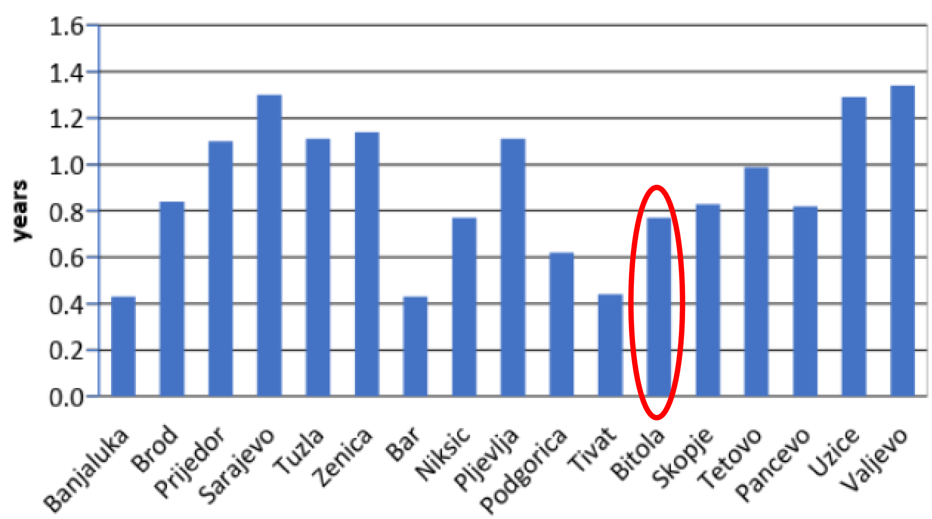


Figure 67 Estimated health gain, YLLs per 100,000 population

Presented data lead to conclusion that disease burden in the Bitola municipality is higher than the national ones, but also that health gain for Bitola will be greater if WHO limit values are achieved for all three selected health outcomes.

Results from the UNEP Western Balkan study "Air pollution and human health: The case of Western Balkans" are showing declination of 0.8 years in life expectancy attributed to $PM_{2.5}$ exposure in the municipality of Bitola.

On figure 68 comparison with other Western Balkan cities covered with the study is presented.



Source: Air Pollution and Human Health: The Case of Western Balkans, UNEP 2019

Figure 68. Loss of life expectancy at age of 30 years due to $PM_{2,5}$ exposure exceeding the WHO's AQG level of 10μg/m^3

8. DEFINITION OF MEASURES AND ACTIVITIES FOR PROTECTION AND IMPROVEMENT OF AMBIENT AIR QUALITY

Measures and activities for environmental protection and improvement are of public interest according to the Law on environment. Air quality improvement measures are of high priority due to evident challenge for obtaining optimal air quality in present condition of documented concentrations of air pollutants above relevant limit values especially concentrations of PM_{10} in urban areas during winter period.

Existing legal framework provides competencies for environmental protection including air quality improvement based on several key principles:

- High protection level (environmental protection and health protection should be on highest level)
- Integration (environmental protection fundaments and goals should be fully integrated with strategic development plans and programs adopted by national and local authorities)
- Sustainable development (each activity should rationally and sustainably use national resources, considering environmental, social and economic issues)
- User / contaminator pays (each entity that is causing environmental impact should compensate with money for the made impact)
- Subsidiarity (local authorities have the right and obligation for undertaking measures and activities for environmental protection)
- Proportionality (adoption and implementation of legal acts should ensure proportionality between environmental demands and development needs)
- Precaution (if any activity is reasonably suspicious precaution measures should be implemented)
- Prevention (environmental measures and protection measures should be implemented prior to any harmful consequences)
- Cleaner production (comprehensive strategy is essential for health and environmental risks reduction and economic and ecologic efficiency regarding raw materials, production processes, products and services)
- International cooperation (bilateral, regional and international cooperation is crucial for environmental protection)
- Public awareness (public institutions and NGOs are promoting and raising public awareness for environmental protection)
- Public involvement and access to information (public involvement is insured during decision making) and

- Protective clause (relevant authorities have the right to temporary or permanently terminate any activity which is causing environmental damage).

General goals for air quality protection and improvement are:

- Consistent implementation of legal acts and regulations for reduction of air emission and air quality improvement,
- Achieving objectives for air quality improvement stated in national strategic plan documents,
- Improving air quality, minimizing health risks emerged from air pollution and biodiversity preservation,
- Reducing air pollutant emissions according national regulations and adopted international conventions,
- Promotion of energy efficiency and use of clean fuels in industry, domestic households, public institutions and transport,
- Increasing the share of renewable energy sources in energy production,
- Regular monitoring of air quality, data collecting, data validation and analysis, reporting, alarming and undertaking preventive measures for air quality protection.

According to the National Plan for ambient air protection (2013 – 2018) following goals should be reached to ensure air quality improvement:

- Reduction of air emissions,
- Maintaining the air quality in zones where limit values are not exceeded,
- Air quality improvement in zones where limit values are exceeded,
- Reduction of air emission from stationary sources,
- Minimizing and eliminating any negative impact to air quality.

Objectives for air quality protection and improvement are categorized as:

- Priority objectives
  - Implementing air quality protection and improvement objectives during decision making process on local, regional and national level,
  - Strengthening capacities for implementing legal framework and regulations aimed to ensuring air quality,
  - Minimizing air pollutant emissions from waste management and treatment,
  - Reducing air emissions from waste generated by agricultural activities,
  - Collecting and analyzing data from monitoring stations on time.

- Medium-terms objectives
  - Reducing emissions of air pollutants from industrial activities to the limit values set in valid relevant regulations,
  - Reducing emission of VOC from fuel storage and manipulation activities,
  - Reducing air pollutant emissions from transport to the limit values for human health and preservation of eco systems.
  - Increasing the share of RES in energy production and increasing the energy efficiency.

- Reducing air pollutant emissions from households,
- Increased use of eco fuels for residential and commercial heating,
- Encouraging the agricultural sector for production improvement and exploitation of waste as energy source,
- Air quality improvement by promotion of sustainable solutions in sectors which have air quality impact.

- Long-term objectives
  - Replacing fossil fuels with low air pollutant emission fuels,
  - Continuous monitoring of health risks related to air pollution,
  - Expansion of green areas in urban communities.

Proposed measures for improvement of air quality are specifically designed for each air emission source:

- ➢ Stationary sources (introducing measures for reducing emission from stationary sources, especially sources from energy production facilities, implementing best available technics and practices for new facilities, cleaner production, ...)

- ➢ Transport (reduction of air emissions from transport sector by using fuels with high quality, renewal of existing transport fleet, promotion of alternative transport vehicles-electric cars, bicycles, optimization of cargo distribution transport)

- ➢ Energy saving, energy efficiency and renewable energy sources (replacement of fossil fuels as energy source, reducing energy consumption by energy saving and energy efficiency, raising public awareness for air pollution)

- ➢ Agriculture (raising public awareness for agriculture waste management and using this type of waste as energy source)

- ➢ Waste (consistent implementation of legal framework for waste management for reducing air emission from this sector)

Air quality protection and improvement measures are divided in seven structural categories:

1. Measures for reduction of air emissions from stationary sources
2. Measures for reducing air emission from transport
3. Measures for promotion of energy saving, energy efficiency and renewable energy sources
4. Measures for reduction of air emission from waste
5. Measures for reduction of air emission from agriculture
6. Measures for supervision, organization and administration,
7. Measures for informing and alarming in case of exceeding the ambient air pollution threshold

Proposed air quality proposed measures are prioritized with high, medium and low priority.

Measures for reduction of air emissions from stationary sources:

M1 Regular and increased controls of installations with A and B ecological permits and Elaborates for environmental protection

M2 Improvement, modernization and implementation of Best Available Techniques for energy production processes in REK Bitola

M3 Regular measurement of air emission from industry combustion

M4 Gasification of Bitola

M5 Replacement of fossil fuels as energy source in administrative capacities.

M6 Replacement of inefficient domestic heating systems operating on fossil fuels with high efficient pellet stoves or inverters

M7 Preparation of Cadaster of pollutants for Municipality of Bitola

Measures for reducing air emission from transport

M8 Raising public awareness for using low or zero emission vehicles (hybrid or electrical cars, bicycles …)

M9 Providing benefits for procurement and usage of electric vehicles

M10 Optimization of traffic flow in the central part of city of Bitola

M11 Environmental friendly traffic mobility

M12 Introducing days without cars

Measures for promotion of energy saving, energy efficiency and renewable energy sources

M13 Preparation of Program for energy efficiency

M14 Recommendation for using renewable energy sources for domestic heating

M14 Reconstruction of existing residential, commercial and local administration objects for ensuring energy saving and energy efficiency

M15 Implementation of project for introducing central heating system

M16 Implementation of project for introducing central heating system

Measures for reduction of air emission from waste

M17 Improving regional waste management systems

M18 Raising public awareness for sustainable waste management

M19 Installation of waste recycling machines

M20 Monitoring and re-cultivation of illegal waste dumps

Measures for reduction of air emission from agriculture

M21 Improved control for preventing uncontrolled open fires of agricultural waste

Measures for supervision, organization and administration

M22 Regular maintenance of the installed ambient air monitoring stations

M23 Frequent inspection controls of the recognized emission sources

M24 Organizing educational campaigns for air quality

M25 Improvement of street lightning in municipality of Bitola

M26 Preparation of green cadaster

Measures for informing and alarming in case of exceeding the ambient air pollution threshold

M27 Preparation of Action plan for short time measures in case of increased air pollution

M28 Raising public awareness for not using energy sources with undefined quality or origin for domestic heating

Projection of measures must be done in a manner to assure maximum results in targeted sectors. The effectiveness of the projected measures should be controlled by responsible authorities during the whole implementation period, providing the possibility for improvement during realization. Essential issue in measures budgeting is assuring reliable funding sources so any interruption of the implementation is omitted.

In each category of measures, highest priority will be assigned to measures for reducing emission of pollutants which measured concentration in ambient air exceed the allowed limit values.

Second in priority list will be measures for reducing to optimal acceptable value emission of those pollutants which measured concentration in ambient air does not exceed the allowed limit values. Generally, measures are assigned with high, medium or low priority in order to optimally schedule the realization of the proposed measures according to demanded budgeting.

According to the projected period for realization measures are categorized as:

- Short term measures (planned to be realized within a period of 1-2 years)
- Medium term measures (planned for realization in next 3 to 5 year) and
- Long term measure (planned for realization in a period of 5 or more years).

The projected period for realization of each measure is assigned according to available capacities and funding sources.

Authorities responsible for realization of the air quality protection and improvement measures are defined by the Law for ambient air quality.

Pursuant to the amendments to the Law on Ambient Air Quality, the competence for preparation and adoption of ambient air quality plans at the local level is clearly defined based on two cumulative criteria - exceeding the limit values (or target values) and population. All local government units where the pollutants have exceeded any limit or target values or have more than 35,000 inhabitants will be required to prepare ambient air quality plans. During the preparation of the Air Quality Plan, the municipalities can invite the neighboring municipalities in order to be involved in the preparation of the plans by defining and implementing measures for improving the ambient air quality in their municipality.

Activities for implementing Air Quality Plan are funded by state budget, budgets of the municipalities and other funding sources according to the adopted working programs.

Legal entities and individuals responsible for operating of installations which are recognized as air pollution sources are obligated to implement and finance measures for reduction of air emissions as defined in the planning document.

Following tables are showing measures with scheduled period for realization and responsible institutions.

Measure No.	M1
Title	Regular and increased controls of installations with A and B ecological permits and Elaborates for environmental protection
Description	In order to ensure fulfillment of obligations stated in issued A and B ecological permits and elaborates for environmental protection, regular and increased inspection controls of installations are needed

Targeted sector	industry
Measure target	decreasing emission of pollutants from industry sources according to relevant legal framework for regulation of operational activities of installations with A and B ecological permits and elaborates for environmental protection
Targeted pollutants	PM10, CO, NOx, SO2, NMVOC
Beneftis for air quality	Reduction of air emission from industry sector will result with improved air quality on local, regional and national level
Other impacts	implementation of the measure will provide data for emitted pollutants from industrial stationary sources
Implementation	continuously
Responsible institution	MOEPP, State environmental inspectorate, municipality of Bitola, Novaci and Mogila
Implementation period	continuously
Costs	indirect costs will arise for installation operators for implementing systems for ensuring the obligations stated in A and B ecological permits and Elaborates for environmental protection.
Other requirements	increasing institutional capacities for inspection and control on local and national level
Indicator for implementation of the measure	number of inspections and controls

Measure No.	M2
Title	Improvement, modernization and implementation of Best Available Techniques for energy production processes in REK Bitola.
Description	REK Bitola is a major source of air pollutants in the region so actions for reducing emissions from REK Bitola are more than essential
Targeted sector	Energy industry
Measure target	reducing air emission from REK Bitola
Targeted pollutants	PM10, CO, NOx, SO2, NMVOC, HM

Beneftis for air quality	Reduction of air emissions from REK Bitola will improve air quality on local, regional and national level
Other impacts	Introducing green technology and BAT in energy production is a global challenge demanding planning and investments which must be integrated in national strategies and policies
Implementation	
Responsible institution	State government, REK Bitola
Implementation period	5 years
Costs	
Other requirements	Strategic goals from the National Strategy for Energy development should be considered, NERP for Large combustion plans
Indicator for implementation of the measure	monthly measurement of air emission from REK Bitola calculation of yearly emissions of pollutants

Measure No.	M3
Title	Regular measurement of air emission from industry combustion.
Description	regular measurements of emissions of pollutants from industry is a mechanism for controlling the air emissions from industry facilities
Targeted sector	Industry
Measure target	reducing air emission from industry facilities
Targeted pollutants	PM10, CO, NOx, SO2, NMVOC
Benefits for air quality	by reducing air emissions from industry improvement of air quality is expected
Other impacts	this measure will encourage operators of industry facilities to use fuels with low emission or implementing green production technologies
Implementation	continuously
Responsible institution	Municipalities, State inspectorate and MOEPP
Implementation period	3-5 years
Costs	costs for regular measurement of air emission are irrelevant compared with the expected benefits

Other requirements	increased capacities of inspection authorities on local and national level
Indicator for implementation of the measure	number of performed measurements in industrial capacities

Measure No.	M4
Title	Gasification of Bitola
Description	Project for gasification of Bitola and providing accessibility of natural gas for industry capacities and domestic and commercial objects is a precognition for replacement of fossil fuels as energy source
Targeted sector	Industry, domestic heating, commercial and administrative objects
Measure target	reducing air emissions by replacing fossil fuels with natural gas
Targeted pollutants	PM10, CO, NOx, SO2, NMVOC
Benefits for air quality	by reducing air emissions from industry improvement of air quality is expected
Other impacts	modernization of technological processes, reduction of generated industrial waste, reduction of expenses for heating
Implementation	continuously
Responsible institution	municipalities, state authorities
Implementation period	continuously
Costs	in the municipality budget total finances of 129.863.200 MKD denars are planned
Other requirements	expanding the natural gas pipeline
Indicator for implementation of the measure	number of objects connected to gas pipeline

Measure No.	M5

Title	Replacement of fossil fuels as energy source in administrative capacities.
Description	According to active program for environmental protection, replacing fossil fuels as energy source in administrative capacities is of high priority.
Targeted sector	
Measure target	reducing air emission from administrative capacities
Targeted pollutants	PM10, CO, NOx, SO2, NMVOC
Benefits for air quality	Implementation of this proposed measure will implicate long-term improvement of air quality
Other impacts	decreasing expenses for heating of administrative objects, final energy consumption, energy efficiency
Implementation	continuously
Responsible institution	municipalities
Implementation period	1-2 years
Costs	finances for implementing of this measure are available within the Annual programs for reducing of air pollution adopted by the state government
Other requirements	integration of the measure with the local and regional programs for reducing air pollution
Indicator for implementation of the measure	monitoring of air quality in each municipality

Measure No.	M6
Title	Replacement of inefficient domestic heating systems operating on fossil fuels with highly efficient pellet stoves or inverters
Description	This measure includes providing funds for subsidies of households for purchasing efficient pellet stoves or inverters
Targeted sector	domestic heating
Measure target	reducing air pollution from households

Targeted pollutants	PM10, PM2,5, CO
Benefits for air quality	using high efficient pellet stoves or inverters for domestic heating instead of conventional fossil fuel stoves can reduce emission of PM and PM2,5 up to 40%
Other impacts	significant improvement of air quality
Implementation	continuously
Responsible institution	municipalities
Implementation period	5 years
Costs	finances can be provided by municipality budget or state financial programs
Other requirements	Intensive campaign for encouraging households for replacement of conventional heating stoves with pellet stoves or inverters. Additionally, subsides programs for protection of vulnerable categories (single parents, social assistance beneficiaries, disabled persons,) are needed
Indicator for implementation of the measure	monitoring of air quality in each municipality

Measure No.	M7
Title	Preparation of Cadaster of pollutants for Municipality of Bitola
Description	Cadaster of pollutants is essential for documentation of active industrial capacities and quantification of air emission from stationary sources as basis for further monitoring of air pollution.
Targeted sector	all
Measure target	updated data for air emission sources and pollutants is essential for assessment of air quality
Targeted pollutants	PM10, CO, NOx, SO2, NMVOC
Benefits for air quality	Relevant data for air emission sources is basis for targeting measures for reduction of air pollution and long-term improvement of air quality
Other impacts	regular update of cadaster of emission sources and pollutants provides continual data

Implementation	continuously
Responsible institution	municipalities, MOEPP
Implementation period	1-2 years
Costs	250.000 MKD denars from municipality budget
Other requirements	increasing capacities of municipalities
Indicator for implementation of the measure	Prepared cadaster of pollutants

Measure No.	M8
Title	Raising public awareness for using low or zero emission vehicles (hybrid or electrical cars, bicycles, …)
Description	Public campaigns for the benefits of using hybrid or electric vehicles and bicycles
Targeted sector	traffic
Measure target	Target of this measure is to raise the awareness of using hybrid or electrical vehicles for personal and commercial transport of people and goods
Targeted pollutants	CO, NOx, NMVOC
Benefits for air quality	long-term improvement of air quality
Other impacts	companies and local administration should be encouraged to purchase hybrid or electrical vehicles
Implementation	continuously
Responsible institution	municipalities
Implementation period	5 years
Costs	costs for public campaigns are insignificant
Other requirements	

Indicator for implementation of the measure	number of realized campaigns

Measure No.	M9
Title	Providing benefits for procurement and usage of electric vehicles
Description	Local administration should promote usage of low or zero emission vehicles by providing benefits for users like free parking lots or hours for free charging of electric vehicles
Targeted sector	traffic
Measure target	reducing emission from traffic
Targeted pollutants	CO, NOx, NMVOC
Benefits for air quality	Long-term improvement of air quality
Other impacts	achieving goal for increased usage of hybrid or electrical vehicles
Implementation	continuously
Responsible institution	municipalities
Implementation period	5 years
Costs	investments should be made in infrastructure for charging electric vehicles
Other requirements	construction of charging stations for electric vehicles

Indicator for implementation of the measure	annual number of registered hybrid and electric vehicle in each municipality

Measure No.	M10
Title	Optimization of traffic flow in the central part of city of Bitola
Description	Optimization of traffic flow in the central part of the City of Bitola should lower the traffic intensity by introducing special traffic mode for vehicles for distribution of goods and heavy vehicles and traffic synchronization for assuring traffic flow
Targeted sector	traffic
Measure target	reducing air emissions from traffic
Targeted pollutants	NOX, CO, NMVOC
Benefits for air quality	traffic is one of the key emission sources so reducing air emissions from traffic will directly improve the air quality
Other impacts	avoiding traffic jams and introducing alternative solutions for traffic regulation in the center of the City of Bitola
Implementation	short time
Responsible institution	municipality of Bitola
Implementation period	1-2 years
Costs	investments are minimal and are needed for finding optimal traffic solutions
Other requirements	Parked vehicles should not affect the traffic flow, so more parking sites are needed
Indicator for implementation of the measure	monitoring of air pollution in the central part of the City of Bitola

Measure No.	M11

Title	Environmentally friendly traffic mobility
Description	Improving traffic mobility through campaigns for using bikes and electric scooters, promotion of walking for short distances and introducing parking policies with higher prices for parking in the central part of the City of Bitola
Targeted sector	traffic
Measure target	reducing air emissions from traffic
Targeted pollutants	NOX, CO, NMVOC
Benefits for air quality	traffic is one of the key emission sources so reducing air emissions from traffic will directly improve the air quality locally
Other impacts	reducing expenses for fuel and maintenance of cars
Implementation	short time
Responsible institution	municipality of Bitola
Implementation period	1-2 years
Costs	Finances are needs for facilitation of procurements of bikes and electric scooters, in the municipality of Bitola budget 300.000 MKD denars are planned for procurement and installation of equipment for bicycle parking and servicing
Other requirements	additional finances should be secured for vulnerable categories
Indicator for implementation of the measure	monitoring of air pollution in the central part of the City of Bitola

Measure No.	M12
Title	Organizing days without cars
Description	Days without cars is effective campaign for raising public awareness and gaining habits for permanent environmental care, encouraging people to use bicycles, electric scooters and walking on small distances within urban cites
Targeted sector	traffic
Measure target	reducing air emission from traffic

Targeted pollutants	NOx, CO, NMVOC
Benefits for air quality	Impact on air quality can be insignificant at the moment, but on long terms this measure can produce important environmental and health habits
Other impacts	positive impact on public health due to improved physical activity and low exposition to polluted air
Implementation	continuously
Responsible institution	Municipality of Bitola
Implementation period	1-2 years
Costs	finances are needed for improving infrastructure of walking and bicycle tracks
Other requirements	interventions in infrastructure should be minimal without significant changes of the urban areas, construction of green areas by the walking zones
Indicator for implementation of the measure	area of marked walking zones

Measure No.	M13
Title	Preparation of Program for energy efficiency
Description	Program for energy efficiency with defined activities for assuring energy efficiency
Targeted sector	energy efficiency
Measure target	reducing energy consumption
Targeted pollutants	all
Benefits for air quality	Impact on air quality can be insignificant at the moment, but on long terms this measure can produce important benefits for air quality
Other impacts	
Implementation	short-term
Responsible institution	Municipality of Bitola
Implementation period	1-2 years

Costs	50.000 MKD denars are planned in the budget of municipality of Bitola
Other requirements	
Indicator for implementation of the measure	Prepared program for energy efficiency

Measure No.	M14
Title	Recommendation for using renewable energy sources for domestic heating
Description	This measure includes continuous campaign for the possibilities of using renewable energy sources like geothermal pumps and photovoltaic panels for providing domestic heating
Targeted sector	domestic heating
Measure target	reducing air emission from households
Targeted pollutants	PM10, PM2,5, CO
Benefits for air quality	significant improvement of air quality
Other impacts	energy saving for households and energy efficiency
Implementation	continuously
Responsible institution	municipalities
Implementation period	5 years
Costs	expenses for informative campaigns are insignificant regarding to benefits. For efficient implementation of this measure, finances procurement facilitation of equipment for RES should be obtained for households
Other requirements	solar systems and geothermal pumps must be available on the market
Indicator for implementation of the measure	continuous monitoring of air quality

Measure No.	M15

Title	Reconstruction of existing residential, commercial and local administration objects for ensuring energy saving and energy efficiency
Description	Reconstruction of residential, commercial and public objects for increasing energy efficiency by installation of external thermal isolation on residential objects, commercial objects, school objects, objects of local administration and other public objects
Targeted sector	residential heating, commercial sector and public administration
Measure target	reducing emissions from residential and commercial heating
Targeted pollutants	PM10, PM2,5, CO
Benefits for air quality	significant improvement of air quality due to decreased air emissions
Other impacts	energy saving for domestic heating, lower expenses for purchasing of fuels
Implementation	continuously
Responsible institution	municipalities
Implementation period	5 years
Costs	finances can be secured from State annual programs for reducing the pollution
Other requirements	Informative campaigns for benefits from energy efficiency are required
Indicator for implementation of the measure	Number of administrative object reconstructed for ensuring energy saving

Measure No.	M16
Title	Implementation of project for introducing central heating system
Description	Central heating system for municipalities Bitola, Mogila and Novaci is projected by ESM. This system is based on extracting water vapor from turbine 2 and 3 in REK Bitola and transporting it by pipeline to Bitola where it will be used for central heating of objects
Targeted sector	domestic and commercial heating

Measure target	reducing emissions from fuel combustion used for heating
Targeted pollutants	PM10, PM2,5, CO, NMVOC
Benefits for air quality	Replacing used heating systems with central heating systems will significant improve the air quality
Other impacts	reducing costs for heating
Implementation	the project is in implementation phase I
Responsible institution	ESM
Implementation period	
Costs	loan agreement with German Kfw bank is signed for 40 mil. EUR and 7 mil EUR are ESM investment
Other requirements	implementation of this project should be integrated and correlated with Program for implementation of National Strategy for energy development
Indicator for implementation of the measure	status of project implementation

Measure No.	M17
Title	Improving regional waste management systems
Description	Existing waste management system in municipalities Bitola, Mogila and Novaci does not meet international standards for waste management. Generated waste is collected and disposed on local land fields constructed without underground layer for soil and underground water protection or illegal dumps on the territory of those three municipalities. Therefore modern regional environmental friendly waste management system is more than necessary.
Targeted sector	waste
Measure target	reducing air emission from waste
Targeted pollutants	CO, PM10, PM2,5, NMVOC, NH_3
Benefits for air quality	long term improvement of air quality
Other impacts	developing possibilities for using waste as energy source
Implementation	continuously
Responsible institution	Municipality of Bitola, Mogila, Novaci, Center for development of Pelagonija Region
Implementation period	continuously
Costs	investments are needed for regular cleaning of illegal dumps, modernization of landfilled Meglenci, setting locations for disposal of different kind of waste (construction waste, bulky waste, broken vehicles, ….)
Other requirements	defining locations for disposal of different kind of waste
Indicator for implementation of the measure	annual quantity of disposed waste by type

The project is co-funded by the European Union and by National Funds of the participating Countries

Measure No.	M18
Title	Raising public awareness for sustainable waste management
Description	Public campaigns for the benefits of sustainable waste management
Targeted sector	waste
Measure target	Target of this measure is to raise the awareness for proper waste disposal, waste selection, waste recycling and waste treatment
Targeted pollutants	PM10, PM2,5, CO, NMVOC
Benefits for air quality	long-term improvement of air quality
Other impacts	sustainable waste management, raising project for reusing waste
Implementation	continuously
Responsible institution	municipalities
Implementation period	5 years
Costs	costs for public campaigns are insignificant
Other requirements	educational institutions should be included in the campaigns
Indicator for implementation of the measure	number of realized campaigns

Measure No.	M19
Title	Installation of waste recycling machines
Description	Installing recycling machines for disposing plastic bottles and cans
Targeted sector	waste
Measure target	Target of this measure is to encourage waste recycling of plastic and metal packages which are commonly used in everyday life, raising awareness for waste selection, waste recycling and waste treatment

Targeted pollutants	
Benefits for air quality	long-term improvement of air quality
Other impacts	reusing disposed waste
Implementation	short term
Responsible institution	municipalities
Implementation period	1-2 years
Costs	total finances of 2.000.000 MKD denars are planned in the budget of Municipality of Bitola
Other requirements	educational institutions should be included in the project
Indicator for implementation of the measure	number of installed waste recycling machines

Measure No.	M20
Title	Monitoring and re-cultivation of illegal waste dumps
Description	Illegal waste dumps are sources of pollution so they should be regularly monitored and projects for cleaning and re-cultivation of the land should be conducted
Targeted sector	waste
Measure target	reducing air emission from waste by eliminating illegal waste dumps and waste disposal on inappropriate areas
Targeted pollutants	PM10, PM2,5, CO, NMVOC
Benefits for air quality	long-term improvement of air quality
Other impacts	improvement of waste management system on local and regional level

Implementation	continuously
Responsible institution	municipalities
Implementation period	5 years
Costs	finances from the municipality's budgets are needed, there are possibilities for using funds according to program for developing of Pelagonia region
Other requirements	Studies for re-cultivation of affected areas should be conducted
Indicator for implementation of the measure	number of cleaned and re-cultivated illegal dumps

Measure No.	M21
Title	Improved control for preventing uncontrolled open fires of agricultural waste
Description	Regulations for preventing uncontrolled open fires are in force but there are still cases of open fires of agricultural waste, so intensive control is recommended
Targeted sector	waste
Measure target	reducing air emission from open fires
Targeted pollutants	Pm10, PM2,5, CO, NMVOC
Benefits for air quality	local improvement of air quality
Other impacts	preventing fires caused by uncontrolled open fires
Implementation	continuously
Responsible institution	municipalities
Implementation period	continuously

Costs	costs for modernization of inspection services
Other requirements	improved personal and technical capacities of inspection services with in the municipalities
Indicator for implementation of the measure	number of registered and prevented open fires of agricultural waste

Measure No.	M22
Title	Regular maintenance of the installed ambient air monitoring stations
Description	Two monitoring stations are installed on territory of Municipality of Bitola and they are providing data for air quality so they need to be maintained on regular basis
Targeted sector	
Measure target	monitoring and maintenance of the installed ambient air monitoring stations for obtaining regular operability for delivering air quality data
Targeted pollutants	
Benefits for air quality	air quality need to be regularly monitored in order to follow implementation of the measured and revise the measures if needs
Other impacts	data collected by monitoring stations are also used for following air quality trends and are very useful for defining effective air quality protection measures
Implementation	continuously
Responsible institution	MOEPP
Implementation period	continuously
Costs	this activity needs investment and should be planned within annual budgets

Other requirements	technical capacities for proper maintenance service of the ambient air monitoring stations are mandatory
Indicator for implementation of the measure	annual number of days when each station was out of work

Measure No.	M23
Title	Frequent inspection controls of the recognized emission sources
Description	Monitoring operations of recognized air emission sources are essential for assuring that operators are working in compliance with environmental law and bylaws
Targeted sector	industry
Measure target	assuring compliance with environmental law and bylaws and preventing any activities that can harm local air quality
Targeted pollutants	PM10, PM2,5, SO2, NOx, CO, HM, NMVOC
Benefits for air quality	controls and preventive measures are assuring good air quality on long terms
Other impacts	Frequent inspection controls of air emission sources minimizes any occurrence of harmful activity
Implementation	continuously
Responsible institution	Municipality inspectorate, MOEPP
Implementation period	continuously
Costs	costs for this activity are irrelevant
Other requirements	increased capacities of the inspectorate
Indicator for implementation of the measure	number of controls and irregularities found

Measure No.	M24
Title	Organizing educational campaigns for air quality
Description	Organizing educational campaigns for raising public awareness for the benefits of optimal air quality and health aspects of exposure to polluted air
Targeted sector	industry, traffic, domestic and commercial heating
Measure target	Raising public awareness for initiating actions for reduction of pollution and minimizing adverse health effects due to polluted air
Targeted pollutants	
Benefits for air quality	this measure will not have direct impact to air quality, but on long terms will assure high environmental awareness by changing people habits when it comes to environmental issues
Other impacts	educational campaigns for air quality can be a supplement to regular elementary and secondary education
Implementation	continuously
Responsible institution	municipalities, Center for public health Bitola, authorities from state government
Implementation period	continuously
Costs	municipality budget of 400.000 MKD denars is planned for campaigns for environmental protection
Other requirements	this measure must be integrated with the programs for air quality protection on local and regional level
Indicator for implementation of the measure	number of realized campaigns

Measure No.	M25

Title	Improvement of street lightning in municipality of Bitola
Description	Energy consumption by street lightning can be reduced by replacing conventional bulbs with energy saving light bulbs
Targeted sector	energy
Measure target	reducing energy consumption
Targeted pollutants	
Benefits for air quality	modernization of street lightning with energy saving light bulbs will reduce energy consumption which will improve air quality on regional and national level
Other impacts	reducing costs for energy consumption in municipality budget
Implementation	continuously
Responsible institution	municipality of Bitola
Implementation period	1-2 years
Costs	finances in municipality budget should be planned
Other requirements	public procurement for purchasing and montage of energy saving light bulbs is needed
Indicator for implementation of the measure	percentage of replaced conventional street bulbs with energy saving light bulbs

Measure No.	M26
Title	Preparation of green cadaster

Description	Preparation of green cadaster for Municipality of Bitola will provide data for urban green area in Bitola which will be used for revitalization of existing green areas and planning and construction of new urban green areas according to international standards for urban green area square meter per capita
Targeted sector	
Measure target	expanding the urban green areas in Bitola
Targeted pollutants	
Benefits for air quality	improvement of air quality is expected on long terms
Other impacts	improvement of zones for walking and biking in Bitola
Implementation	short-term
Responsible institution	Municipality of Bitola
Implementation period	1-2 years
Costs	300.000 MKD denars in the municipality budget are planned for this activity
Other requirements	conducting public procurement for purchasing of service
Indicator for implementation of the measure	prepared green cadaster

Measure No.	M27
Title	Preparation of Action plan for short time measures in case of increased air pollution
Description	Preparation of Action plan with defined measures in case of increased air pollution which will improve air quality on short terms
Targeted sector	all
Measure target	Action plan with measures in case of increased air pollution is an instrument of the municipality for immediate reaction when increased air pollution is detected. Realization of this action plan should provide undertaking measures in all air emission sectors for reduction of air pollution
Targeted pollutants	PM10, PM2,5, NOx, SO2, CO

Benefits for air quality	by decreasing emission of air pollutants from each sector improvement of air quality is expected
Other impacts	reducing time of people's exposure to increased air pollution
Implementation	whenever increased air pollution is detected
Responsible institution	Municipalities
Implementation period	
Costs	no finances for preparation of Action plan are needed
Other requirements	
Indicator for implementation of the measure	Prepared action plan for measures in case of increased air pollution

Measure No.	M28
Title	Raising public awareness for not using energy sources with undefined quality or origin for domestic heating
Description	Public awareness for not using fuels with undefined quality as energy source for domestic heating is very low especially in some categories of citizens so they need to be targeted with educational campaigns, campaigns for fuel and stove procurement facilitations and campaigns for health impacts from using energy sources with undefined origin
Targeted sector	domestic heating
Measure target	minimizing the use of energy sources with undefined quality or origin
Targeted pollutants	PM10, PM2,5, CO, NMVOC
Benefits for air quality	energy sources with undefined quality and origin have major impact to local air quality so by reducing usage of this king of energy sources improvement of air quality is expected
Other impacts	reducing exposure to harmful substances emitted in the households
Implementation	continuously

Responsible institution	municipalities, state government, ministry for social policy
Implementation period	5 years
Costs	For efficient realization of this measure and overcoming energy poverty additional program for financing procurement of acceptable energy sources for domestic heating is required, especially for categories like social assistance beneficiaries, single parents, and disabled people.
Other requirements	this measure should be integrated with other programs and policies
Indicator for implementation of the measure	monitoring of air quality

In the period of preparing of this document, an ongoing implementation measure for reducing air emission from the sector domestic heating is active in municipality Bitola and municipality Novaci. This measure is funded by the state budget and it refers to subsidizing the households for purchasing inverter climate systems for domestic heating.

Another ongoing project is Preparation of Cadaster of pollutants for Municipality of Bitola and it is fully funded by Municipality of Bitola.

Environmental protection investments including investments for air quality improvement depend on national and local sustainable economic growth which is in correlation with energy production and energy consumption. Optimization of those processes requires involvement, responsibility, awareness and commitment from every stakeholder, beginning with state and local authorities to each individual as clean air final beneficiary.

9. MONITORING OF THE PLAN IMPLEMENTATION

For the monitoring implementation of the Plan for Air Quality, the indicators defined in the previous chapter should be followed. Following the indicator will allow assessment of the degree of implementation of the relevant measure. In order to get the information on the status of implementation of the measures, the coordinator appointed by the LSGUs should submit a request to the competent institutions responsible for implementing the measures.

Based on the data received, the coordinator assigned by the LSGU, will prepare a report on the extent of implementation of the planned measures for improvement of the air quality in accordance with Amendments of the Law on ambient air quality (Official Gazette of the Republic of North Macedonia no 151/2021). This kind of report is prepared once per year. The first evaluation report on implementation of the plan is prepared after 2 years from adoption of the plan, and the following reports each year until 31 March for the previous two years. The LSGUs shall submit the evaluation reports, regarding implementation of the plan, to the MoEPP and publish them on the LSGU web site.

10. CONCLUSIONS

Air quality plan for Bitola is a part of the project "Transboundary Air Pollution Health Index Development and Implementation" implemented by the Ministry of environment and physical planning of the Republic of North Macedonia, Centre for climate change - Gevgelija, Environmental center of Western Macedonia in Florina, Greece, Municipality of Florina, Greece and European regional framework for cooperation Thessaloniki, Greece.

The Air Quality Plan for Bitola is prepared according to Rulebook on the detailed content and the manner of preparing the plan for improving the ambient air quality (Official Gazette of RM No.148/2014).

This document refers to air quality in municipality Bitola, Novaci and Mogila. Objectives presented in the Air Quality Plan for Bitola are based on the assessment of local air quality in Bitola, Novaci and Mogila.

Due to the fact that air quality is measured in the city of Bitola, results from the two air quality monitoring stations were used for the air quality assessment. Data from air quality measurements in Bitola showed that the most critical substance are particles. Thus, exceedances above the limit values of solid particles up to 10 micrometers are observed especially in the winter period when they are several times higher than the average daily limit value. In summer, however, there are exceedances of the target value for ozone as a result of higher solar radiation. No exceedances were observed for the other measured pollutants.

Identification of air emission sources is based on key emission sectors: energy and combustion facilities, industry, domestic heating, transport, waste and agriculture.

Input data are obtained by official issued document and databases such as: Statistical Yearbooks of Republic of North Macedonia, MAKSTAT DATABASE from SSO, publications published by SSO in different areas (Transport, Industry in the Republic of North Macedonia, Industry and Energy, Livestock, Agriculture and Forestry), Energy Balance of the Republic of North Macedonia by Ministry of economy, Measurements data from the industrial operators and waste incineration plant, International web page databases (FAO, Eurostat and etc. and other data from relevant national ministries and agencies (MOD, PEMF, MAFWS and others).

According to available data, emissions of air pollutants from the identified emission sectors are calculated for each identified emission sector except for the Energy industry sector where data from emission measurement are also used. Emission factors used for the calculation are according EMEP/EEA guidebook 2019, national emission inventory and Informative inventory reports prepared by MEPP. Selection of emission factors tier level is made according to the available activity data and prior expert knowledge of the technology used in facilities and plants relevant for each emission sector. Emission sectors covered with this report are: Energy sector (energy production fugitive emissions, transport, manufacturing industries, small combustion and residential stationary combustion); Industrial processes and product use (construction and demolition, solvent and product use); waste and agriculture.

Presented summary data shows that:

- Largest share in emission of NOx, SOx, TSP, PM_{10} and $PM_{2,5}$ has the Energy production sector which is highly expected because in this sector emissions from Power Plant REK Bitola are included, as the point source with the highest thermal capacity in the country.

- Residential heating is one of the key sources for emission of TSP, PM_{10} and $PM_{2,5}$ and CO contributing with 6,43% in TSP, 9,08% in PM10, 20,04% in PM2,5 and 37,98% in CO emissions….

- 46,90% of emission of NMVOC originates from fugitive emissions while other source contribute with…

- Sector agriculture is the key sector contributing with 93,60% in emissions of NH_3.

Main objective of the Air Quality plan for Bitola is proposing effective measures for air quality improvement and enable the proper prioritization of the measures in order to have major reduction of emissions and improvement of air quality in these municipalities.

Based on identified key air emission sources and critical pollutants, following prioritization of the measures is suggested:

Measures with high priority

M1 Regular and increased controls of installations with A and B ecological permits and Elaborates for environmental protection

M2 Improvement, modernization and implementation of Best Available Techniques for energy production processes in REK Bitola

M3 Regular measurement of air emission from industry combustion.

M4 Gasification of Bitola

M5 Replacement of fossil fuels as energy source in administrative capacities

M6 Replacement of inefficient domestic heating systems operating on fossil fuels with high efficient pellet stoves or inverters

M7 Preparation of Cadaster of pollutants for Municipality of Bitola

M10 Optimization of traffic flow in the central part of city of Bitola

M13 Preparation of Program for energy efficiency

M15 Reconstruction of existing residential, commercial and local administration objects for ensuring energy saving and energy efficiency

M23 Frequent inspection controls of the recognized emission sources

M27 Preparation of Action plan for short time measures in case of increased air pollution

Measures with medium priority

M8 Raising public awareness for using low or zero emission vehicles (hybrid or electrical cars, bicycles, …)

M11 Environmental friendly traffic mobility

M12 Organizing days without cars

M14 Recommendation for using renewable energy sources for domestic heating

M16 Implementation of project for introducing central heating system

M17 Improving regional waste management systems

M18 Raising public awareness for sustainable waste management

M20 Monitoring and re-cultivation of illegal waste dumps

M22 Regular maintenance of the installed ambient air monitoring stations

M25 Improvement of street lightning in municipality of Bitola

Measures with low priority

M9 Providing benefits for procurement and usage of electric vehicles

M19 Installation of waste recycling machines

M21 Improved control for preventing uncontrolled open fires of agricultural waste

M23 Frequent inspection controls of the recognized emission sources

M24 Organizing educational campaigns for air quality

M26 Preparation of green cadaster

M28 Raising public awareness for not using energy sources with undefined quality or origin for domestic heating

Proposed measures were based on best social and economic practices implemented in air quality protection policies.

Measures and activities for environmental protection and improvement are of public interest according to the Law on environment. Air quality improvement measures are of high priority due to evident challenge for obtaining optimal air quality in present condition of documented concentrations of air pollutants above relevant limit values especially concentrations of PM_{10} in urban areas during winter period.

Implementation of measures for improving air quality must be followed by introducing mechanisms for control of their efficiency which allows timely adjustments and modifications for increasing the effectiveness of the measures. Real implementation of air quality measures demands commitment and coordination on local, regional and national level and it must lead to maintaining optimal air quality.

11. REFERENCES

1. MOEPP, Republic of North Macedonia Informative Inventory report 1990-2019- https://air.moepp.gov.mk/?page_id=928;

2. EMEP/EEA air pollutant emission inventory guidebook 2019;

3. National plan for clean air and programs with defined measures for 2019 - 2021 (Official Gazette of RNM no. 18/2019, 277/2019, 36/2021);

4. Pilot Program for air quality improvement in Bitola, Twining project for strengthening capacities on local and central level for environmental management in the area of air quality, 2016

5. National Plan for protection of ambient air quality in the Republic of Macedonia for the period 2013 – 2018;

6. National Program for gradual reduction of the quantities of certain pollutants in Republic of Macedonia for the period 2012-2020;

7. National emission reduction plan (NERP) of Sulphur dioxide (SO_2), nitrogen oxides (NOx) and dust from existing large combustion plants of Republic of Macedonia;

8. Strategy for environment and climate change 2014 – 2020;

9. Third National Plan for Climate Change, 2013;

10. Strategy for Energy Development in Republic Of North Macedonia Until 2040;

11. Strategy for promotion of energy efficiency by 2020;

12. MOEPP, National Waste Management Plan (2009-2015) and Draft National waste management plan (2020 – 2026);

13. National Transport Strategy 2018-2030 ;

14. National Action Plan for ratification and implementation of Heavy Metal Protocol, Protocol for POPs and the Gothenburg Protocol to the Convention for long distance cross-border air pollution, 2010;

15. Program for Development of Pelagonija Planning region 2020-2024;

16. Action Plan for realization of the Program for Development of Pelagonija Planning region in 2021;

17. SSO, State Statistical Office, Census 2002;

18. Local Environmental Action Plan of Bitola, 2016;

19. http://airquality.moepp.gov.mk;

20. SSO, Statistical Yearbook of Republic of North Macedonia 2020;

21. SSO, Statistical Yearbook of Republic of North Macedonia 2019;

22. Ministry of economy, Energy Balance of the Republic of North Macedonia;

23. UN Environment. Air Pollution and Human Health: The case of Western Balkans. 2019;

24. TRAP- Transboundary Air Pollution Health Index Development and Implementation- Health risk assessment, 2019;

25. UNEP, Air Pollution and Human Health: The Case of Western Balkans, 2019;

26. WHO Air Quality Guidelines Global Update 2005. Particulate matter, ozone, nitrogen dioxide and sulfur dioxide;

27. GBD 2015 Mortality and Causes of Death Collaborators. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet. 2016; 388:1459–54;

28. https://doi.org/10.1016/S0140-6736(16)31012-1;

29. WHO (World Health Organization) Review of evidence on health aspects of air pollution—REVIHAAP project. Technical report, 2013;

30. European Commission. Air Quality Directive 2008/50/EC;

31. European Commission. Impact assessment— annex to the communication on the thematic strategy on air pollution and the directive on ambient air quality and cleaner air for Europe. European Union: Brussels, 2005. p 138;

32. http://ec.europa.eu/environment/archives/cafe/pdf/ia_report_en050921_final.pdf;

33. WHO, Health Risk Assessment of air pollution. 2016. Available on: http://www.euro.who.int/en/health-topics/environment-and-health/air- quality/publications/2016/health-risk-assessment-of-air-pollution-general-principles-2016;

34. European Environmental Agency. Air Quality in Europe - 2018 report. Available on: https://www.eea.europa.eu/publications/air-quality-in-europe-2018

35. https://www.unep.org/news-and-stories/press-release/air-pollution-responsible-one-five-premature-deaths-19-western

36. Municipality of Bitola, Annual Plan for public procurement in 2021