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PILOT PROGRAM FOR IMPROVEMENT OF AIR QUALITY IN BITOLA

ABSTRACT

The present document is developed in order to provide a strategy for the air quality improvement in the municipality of Bitola, the second largest urban settlement of the Country. The air quality assessment was carried out for all the pollutants regulated by the national legislation that was recently revised according to the European Directives. The emission study carried out to define the main emitting sources in the area shows a prevalent role of the stationary sources (domestic and commercial heating, industrial sector) respect to the mobile ones (traffic) in contributing to the total emission of NO_x, SO₂, PM. A dedicated study was deserved to the emission assessment of REK Bitola power plant, the most important energy producing installation of the whole Country (designed capacity of 675MW). The plant, fuelled by coal is not located in Bitola Municipality and is about 18 km far from the centre of the city. Anyway due to the magnitude of the plant and the relative emissions, a dispersion modelling was used to estimate the possible influence of REK Bitola to the air pollution in Bitola. The result of the study shows a minor influence of the plant in the air pollution of Bitola due mainly to the meteorological situation of the zone. The prevailing wind (N-S) contribute to diffuse the plant emission far away from the city.

The air quality assessment was carried out with the air quality information collected by the two air quality stations in the Bitola area. The study shows that the most critical pollutant in Bitola region is the particulate matter: PM₁₀ concentrations exceed both the daily and annual limit value in both measurement stations. Moreover the ozone long term objective is exceeded in both station and the possibility of an exceedence of the target value should be taken into account especially for Bitola 2 measurement station. No exceedence of critical levels (limit values) are recorded for nitrogen dioxide, sulphur dioxide and carbon monoxide during the previous five years. So these pollutants are not classified critical in Bitola.

Concerning PM₁₀, it is very obvious that secondary PM₁₀ has great significance in total PM₁₀. For this reason the measures must include actions to reduce emission of the precursors of secondary PM₁₀, i.e. NO_x, SO₂, VOC and NH₃ emissions. Moreover there is no data available concerning the PM_{2.5} concentrations. Nevertheless due to the likely significant contribution of the PM_{2.5} fraction to the total PM₁₀, an integrated policy is needed in order to reduce both the PM₁₀ and PM_{2.5} emissions. Finally it can be observed that there is no data available about lead, benzene and PAH levels in Bitola region. The lack of data also concerns micropollutants arsenic, nickel and cadmium regulated by the Directive 2004/107/EC. For this reason a conservative approach is adopted, considering these pollutants as potentially critical.

According to the result of the emission and the air quality study assessments, a strategy for the air quality improvement is proposed. A set of possible measures were defined in order to reduce the emissions. These measures are classified in short terms measures and long terms measures. The short terms measures should be adopted as soon as possible in order to decrease the concentration of the most critical pollutants. The long terms measures needs more time to be implemented because of the funding and the planning. The plan must be review each five years.

1. INTRODUCTION

The pilot programme for air improvement of air quality in Bitola was developed as a part of the activities of Twinning project 'Strengthening the central and local level capacities for environmental management in the area of air quality' funded by the European Union. The pilot programme aims at reduction of pollution and improving the air quality in Bitola. This programme is prepared in accordance to articles 23 and 26 of the Law on Ambient Air Quality where the requirements from the European Union air quality related legislation have been transposed. Air quality improvement programmes should be developed for those zones and agglomerations where the levels of pollutants in ambient air exceed limit values or target values set for pollutant concentrations. In regards to this, air quality assessment has been prepared with an analysis of the basic pollutants NO₂, SO₂, CO, O₃ and PM₁₀ for the western and eastern zones and the Skopje agglomeration, which is the geographical division of the Republic of Macedonia in relation to air quality assessment.

It was established that as part of the western zone programme a separate pilot programme for air quality improvement for the city of Bitola is needed. In this programme an assessment of NO₂, SO₂, CO, O₃, and PM₁₀ concentrations based on the measurement data of years 2007-2011 from two measurement stations in Bitola was carried out using the indicators defined in the legislation. The data was analysed in relation to the limit/target values stated in the Decree for limit values of the levels and types of pollutants in the ambient air and alert thresholds, the terms of achievement of the limit values, the margins of tolerance, target values and long term objectives (Official Gazette of RM No. 50/05). Based on this assessment the most critical pollutant in Bitola is the particulate matter: PM₁₀ concentrations exceed both the daily and annual limit value in both measurement stations. Due to the origin and the characteristics of this pollutant a medium or long term strategy with structural measures is required in order to reduce its concentration in the ambient air. In addition to particulate matter PM₁₀ reduction of ozone concentrations is included in the programme as long term objective for this pollutant is exceeded in Bitola. For formation of both of these pollutants other pollutants have a significant role and therefore the measures must include actions to reduce emission for example NO_x, SO₂, VOC and NH₃ emissions. The short-term measures in the programme are prepared mainly for years 2013-2018 and the medium or long term measures mainly for years 2013-2023.

The measures to improve local air quality in Bitola that are presented here are based on the emission quantities in the inventories and air quality data assessment. These measures should be adopted progressively in the next 5 years. Currently it is not possible to assess the effects of the different emission sectors on local air quality, and therefore the measures cover all the major emission sectors. The measures are divided into three categories, short-term, long-term and common measures. The short-term measures are the ones that can be put into force quite quickly and without significant additional resources and funding. The impact of these measures is not expected to be very significant but nevertheless they are important so that some progress in air quality improvement will be taken and seen at the local level in a short time.

The implementation of most of the measures to significantly decrease the emissions and the concentration of the critical pollutants take a longer time and need further planning and guaranteed funding. Implementation of these measures is expected to take several years and require political commitment in the local level. The measures developed in the local level will also have to be supported by the measures designed in the national level. The implementation of the measures will be followed and developed at local level with the coordination of the Ministry of Environment and Physical Planning. The programme and its measures should be reviewed in a 2-5 years period.

2. GENERAL INFORMATION

2.1. Characterization of the city of Bitola and its population

Bitola is the biggest city in the valley of Pelagonia and the second largest city in the country. City of Bitola is the centre of Municipality of Bitola and also main regional centre of the south-western region of the country. According to the National Statistic and the census held in 2002 Bitola is a city with 95 385 inhabitants.

The city of Bitola is divided to 5 settlements (Figure 1): Central Region has area of 710 ha covering 32 % of the total area in Bitola, area of Western Region is 430 ha (19 % of total area), North Region has area of 182 ha (8 % of total area), South Region has 173 ha (8 % of total area) and East Region has 750 ha (33 % of total area). In the Central city area 261 ha is classified as residential zone.

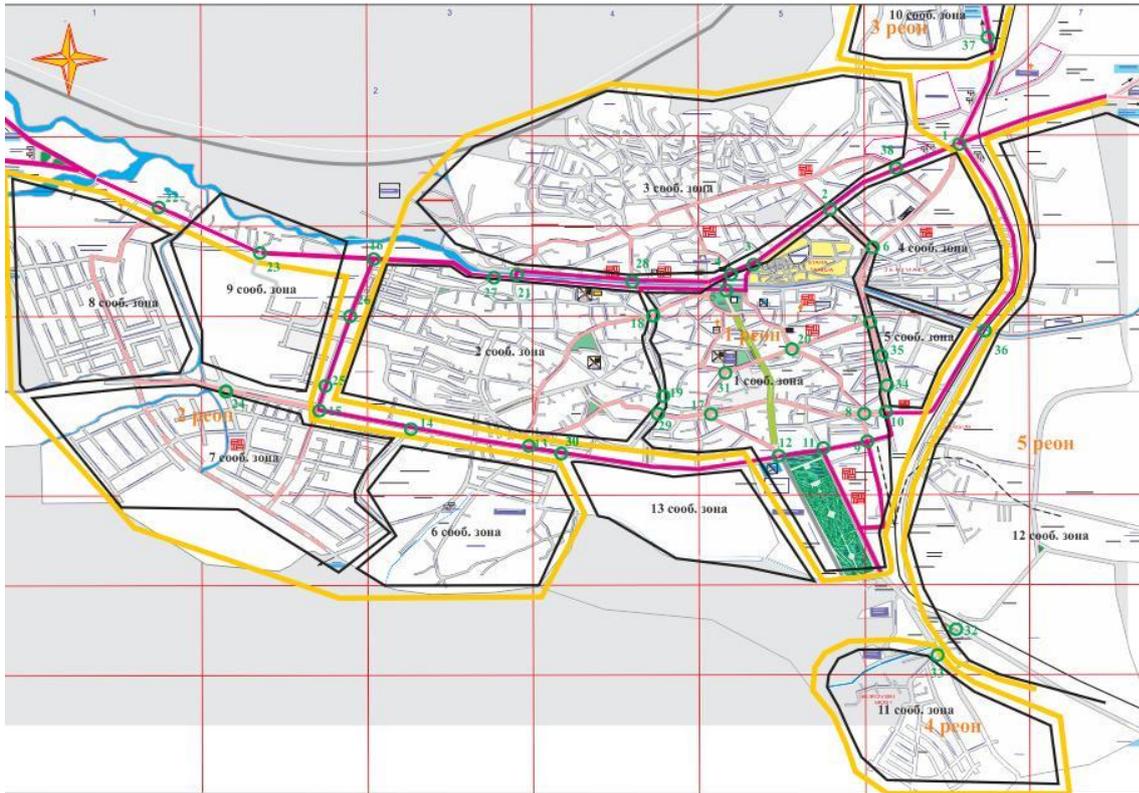


Figure 1. Settlements of Bitola

2.2. Climate and topography

The City of Bitola is located in the south-western part of the country, at the base of Baba Mountain with its highest peak Pelister (2 601 m), 13 km from the border with Greece. Four connected hills, called Bair, are located north of Bitola at an elevation of 640 to 890 m. South of the city is the hill Tumbe Kafe, 744 meters high, a branch of Neolica broader part of the Baba Mountain. To the east, Bitola is wide open towards the Pelagonia valley, to the west are the glacial bank of the river Dragor, the Gjavato valley and the peak Pelister. Bitola's elevation varies from 715 to 585 meters (west to east), making the average elevation of the city about 650 meters. This difference in the elevation has a significant effect on the layout of the city and the urban landscape. On one side the city is situated in the lowland area and on the other side in the hillside and mountainous area.

According to the meteorological observations the most frequent wind directions are north and south in Bitola and wind blows seldom from southwest and east. The proportion of light winds (speed category under 2 m/s) is 55–90 % depending on the direction sector. The proportion of fresher winds (wind speed over 6 m/s) is greatest in the south and west sector. The wind speed and direction are represented as wind rose in Figure 2.

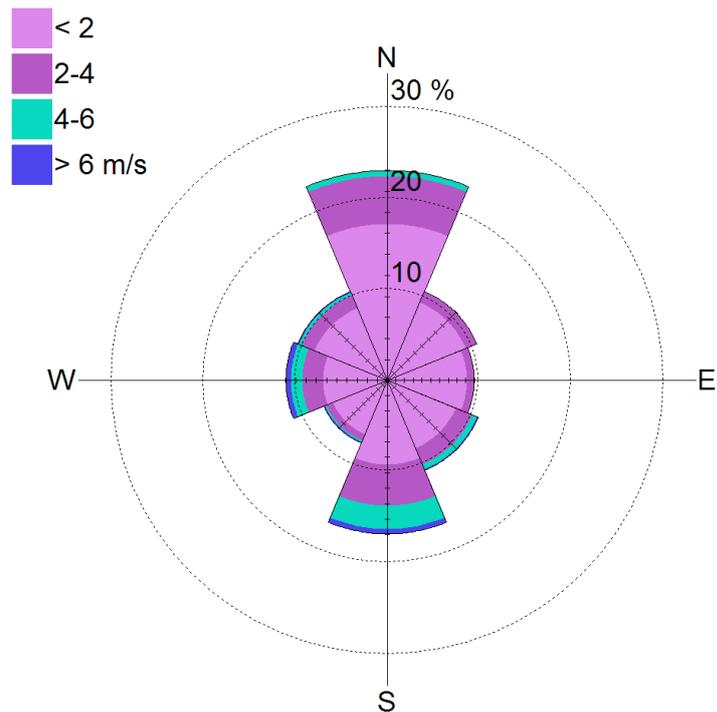


Figure 2. Wind rose representing the average wind speed and direction in Bitola during 2008–2010. The data is based on the synoptic meteorological observations in HMA weather station in Bitola. Wind rose represents as percentages (%) the average wind sectors (from where the wind is blowing) and the average wind speed (m/s) as percentages (%) of each sector.

Monthly averaged temperatures are shown in Figure 3. The hottest month is August with average temperature around 23 degrees of Celsius. The coldest months are January and February when averaged temperature is only few degrees above zero. Monthly precipitation sum in years 2008, 2009 and 2010 are shown in Figure 4. Driest months are August and July. Averaged yearly precipitation is 583 mm (in the three year period).

Characteristic of Bitola climate is dry and very warm summer, and winters and springs with abundant rainfall.

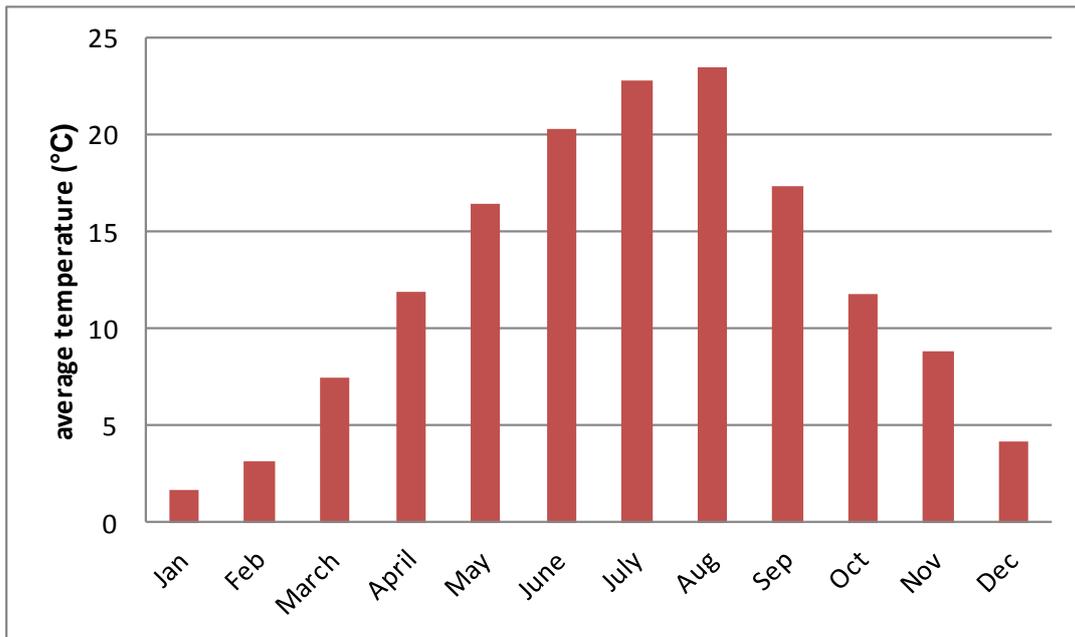


Figure 3. Monthly averaged temperature at Bitola.

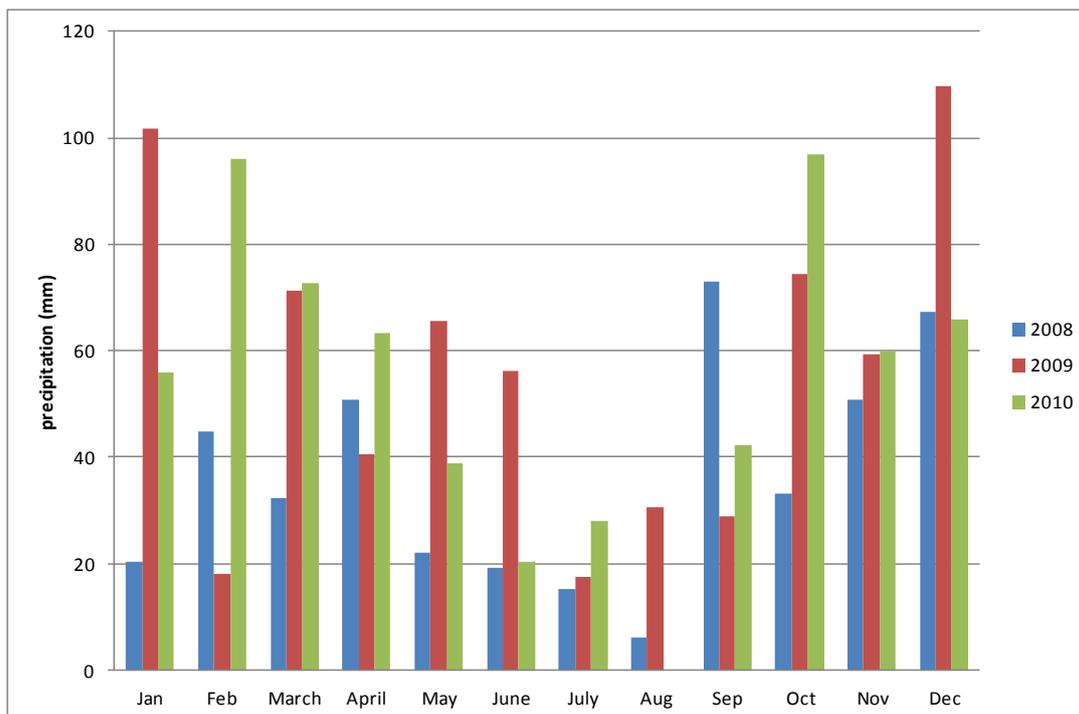


Figure 4. Monthly precipitation (mm) in Bitola in years 2008, 2009 and 2010.

3. LEGISLATIVE FRAMEWORK

3.1. EU Legislation transposed in the national legislation

3.1.1. Overview of the EU Air quality directives

European Community legislation in relation to ambient air quality is constituted mainly by the 2008/50/EC and 2004/107/EC Directives. The Ambient Air Quality and Cleaner Air for Europe (CAFE) Directive (2008/50/EC) was published in May 2008. It replaced the Framework Directive and the first, second and third Daughter Directives¹. The fourth Daughter Directive (2004/107/EC) will be included in CAFE at a later stage.

Directive 2008/50/EC has merged most of the previous legislation into a single Directive, providing new air quality objectives for PM_{2.5} (fine particles), with no changes to existing air quality indicators. This Directive represents the main reference in order to assess the ambient air quality in Member States on the basis of common methods and criteria. Moreover different protection targets are defined by legislation (human health, ecosystems, vegetation). According to the general objectives of this document more detailed information concerning the human health protection standards is given.

In compliance with the 2008/50/EC Directive Member States shall establish zones and agglomerations throughout their territory. Air quality assessment and air quality management shall be carried out in all zones and agglomerations. The air quality in each zone is assessed and classified with respect to upper and lower assessment thresholds, defined for each pollutant. In all zones and agglomerations, where the level of pollutants exceeds the lower assessment threshold established for those pollutants, at least fixed measurements shall be used to assess the ambient air quality.

Air quality limit values are established for sulphur dioxide, nitrogen dioxide, lead, PM₁₀, carbon monoxide and benzene in order to protect the human health.

3.1.2. National ambient air legislation

The Ministry of Environment and Physical Planning (MEPP) prepared the framework Law on Ambient Air Quality (Official Gazette 67/04, 92/07, 35/10, 47/11 and 59/12) in accordance with the old framework directive 96/62/EC for ambient air quality assessment and management, and adopted several amendments to the Law, in accordance with the Directive 2008/50/EC for Ambient Air Quality and Cleaner Air in Europe (the so called CAFÉ Directive). So far, 15 bylaws have been prepared and adopted in accordance to the EU regulations, and this process is still ongoing.

The Decree for limit values of the levels and types of pollutants in the ambient air and alert thresholds, the terms of achievement of the limit values, the margins of tolerance, target values and long term objectives was prepared in accordance with the old framework directive and the first three daughter directives. The sulphur dioxide, PM₁₀, lead, carbon monoxide, nitrogen dioxide and benzene limit values have been transposed in the existing Decree. Amendments to the Decree

¹ Framework Directive 96/62/EC, 1-3 daughter Directives 1999/30/EC, 2000/69/EC, 2002/3/EC

have been made with the limit values for PM_{2.5} specified in the Directive 2008/50/EC and the limit values for heavy metals specified in the Heavy Metals Directive 2004/107/EC.

Table 1 displays limit values for sulphur dioxide, PM₁₀, lead, carbon monoxide, nitrogen dioxide and benzene and Table 2 the limit values for the protection of human health concerning PM_{2.5}.

Concerning the ozone, target values and long-terms objectives are defined respectively for the protection of human health and the vegetation. Table 3 shows the ozone air quality standards for the protection of human health.

Table 1: Air quality limit values for the protection of human health (Proposal for changes to the Decree)

Averaging period	Limit Value	Margin of tolerance	Date by which limit value is to be met
Sulphur dioxide			
One hour	350 µg/m ³ , not to be exceeded more than 24 times a calendar year	150 µg/m ³ (43 %)	-(¹)
One day	125 µg/m ³ , not to be exceeded more than 3 times a calendar year	None	-(¹)
Nitrogen oxide			
One hour	200 µg/m ³ not to be exceeded more than 18 times a calendar year	50% on 19 July 1999, decreasing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2010	1 January 2010
Calendar year	40 µg/m ³	50% on 19 July 1999, decreasing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2010	1 January 2010
Benzene			
Calendar year	5 µg/m ³	5 µg/m ³ (100 %) on 13 December 2000, decreasing on 1 January 2006 and every 12 months thereafter 1 µg/m ³ to reach 0% by 1 January 2010	1 January 2010
Carbon monoxide			
maximum daily eight hour mean (²)	10 µg/m ³	60%	-(¹)
Averaging period	Limit Value	Margin of tolerance	Date by which limit value is to be met
Lead			
Calendar year	0.5 µg/m ³ (³)	100%	-(¹)
PM₁₀			
One day	50 µg/m ³ , not to be exceeded more than 35 times a calendar year	50%	-(¹)
Calendar year	40 µg/m ³	20%	-(¹)
<p>(¹) Already in force since 1 January 2005</p> <p>(²) The maximum daily eight hour mean concentration will be selected by examining eight hour running averages, calculated from hourly data and uploaded each hour. Each eight hour average so calculated will be assigned to the day on which it ends i.e. the first calculation period for any one day will be the period from 17:00 on the previous day to 01:00 on that day; the last calculation period for any one day will be the period from 16:00 to 24:00 on that day.</p> <p>(³) Already in force since 1 January 2005. Limit value to be met only by 1 January 2010 in the immediate vicinity of the specific industrial sources situated on sites contaminated by decades of industrial activities. In such cases, the limit value until 1 January 2010 will be 1.0 µg/m³. The area in which higher limit values apply must not extend further than 1000m from each specific sources.</p>			

Table 2: PM_{2.5} - Air quality standards for the protection of human health (Proposal for changes to the Decree Annex 1)

Averaging period	Target value	Date by which target value should be met
Calendar year	25 µg/m ³	1 January 2010

Averaging period	Limit Value	Margin of tolerance	Date by which limit value is to be met
STAGE 1			
Calendar year	25 µg/m ³	20% on 11 June 2008, decreasing on the next 1 January and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2015	1 January 2015
STAGE 2 ⁽¹⁾			
Calendar year	20 µg/m ³		1 January 2020
⁽¹⁾ Stage 2- indicative limit value to be reviewed by the Commission in 2013 in the light of further information on health environmental effects, technical feasibility and experience of the target value in Member States.			

Table 3: Ozone - Air quality standards (target values and long-term objectives) for the protection of human health(Proposal for changes to the Decree Annex 1)

Objective	Averaging period	Target value	Date by which target value should be met ⁽¹⁾
Protection of human health	Maximum daily eight-hour mean ⁽²⁾	120 µg/m ³ not to be exceeded on more than 25 days per calendar year averaged over three years ⁽³⁾	1.1.2010

Objective	Averaging period	Long-term objective	Date by which long-term objective should be met
Protection of human health	Maximum daily eight-hour mean within a calendar year	120 µg/m ³	Not defined

⁽¹⁾ Compliance with target values will be assessed as of this date. That is, 2010 will be the first year the data for which is used in calculating compliance over the following three or five years, as appropriate.

⁽²⁾ The maximum daily eight-hour mean concentration shall be selected by examining eight-hour running averages, calculated from hourly data and updated each hour. Each eight-hour average so calculated shall be assigned to the day on which it ends i.e. the first calculation period for any one day will be the period from 17:00 on the previous day to 01:00 on that day; the last calculation period for any one day will be the period from 16:00 to 24:00 on the day.

⁽³⁾ If the three or five year averages cannot be determined on the basis of a full and consecutive set of annual data, the maximum annual data required for checking compliance with the target values will be as follows:

- for the target value for the protection of human health: valid data for one year,
- for the target value for the protection of vegetation: valid data for three years.

Alert thresholds are defined for sulphur dioxide, nitrogen dioxide and ozone (Table 4). The alert threshold is a concentration level beyond which there is a risk to human health from brief exposure for the population as a whole and at which immediate steps are to be taken by the Member States.

Table 4: Alert thresholds established by Annex 1 of the Decree)

A. Alert thresholds for pollutants other than ozone

To be measured over three consecutive hours at locations representative of air quality over at least 100 km² or an entire zone or agglomeration, whichever is the smaller.

Pollutant	Alert threshold
Sulphur Dioxide	500 µg/m ³
Nitrogen dioxide	400 µg/m ³

B. Information and alert thresholds for ozone

Purpose	Averaging period	Threshold
Information	1 hour	180 µg/m ³
Alert	1 hour ⁽¹⁾	240 µg/m ³

⁽¹⁾ For the implementation of Article 24, the exceedance of the threshold is to be measured or predicted for three consecutive hours.

The fourth Daughter Directive (2004/107/EC) concerns arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air. For these pollutants (except for mercury) a target value is established as the concentration in the ambient air fixed with the aim of avoiding, preventing or reducing harmful effects on human health and the environment as a whole, to be attained where possible over a given period. For each pollutant the concentration is determined in the PM₁₀ fraction. The target values for pollutants regulated by 2004/107/EC are shown in Table 5.

Table 5. Target values for arsenic, cadmium, nickel and benzo(a)pyrene (Annex 1 of the proposal for changes to the Decree)

Pollutant	Target value ⁽¹⁾
Arsenic	6 ng/m ³
Cadmium	5 ng/m ³
Nickel	20 ng/m ³
Benzo(a)pyrene	1 ng/m ³

⁽¹⁾ For the total content in the PM₁₀ fraction averaged over a calendar year

3.1.3. Air quality plans and programs

Air quality plans and programs should be developed to ensure that concentrations of air pollutants will not exceed the air quality standards (limit values, target values, alarm thresholds) when they have to be met. In accordance with the Law on Ambient Air Quality, (including the last amendments, Official Gazette 59 from 11.05.2012) the following documents shall be prepared for the planning of air quality protection :

- National plan for ambient air protection;
- Plan for improvement of the ambient air quality (Plan for ambient air quality);
- Short-term action plan for ambient air protection (short-term action plan);
- National programme for gradual reduction of the emission quantities from certain types of pollutants

The local air quality plans shall incorporate at least the following information

- 1) localization of the excessive pollution
- 2) general information;
- 3) responsible authorities;
- 4) nature and assessment of pollution;
- 5) origin of the pollution;
- 6) analysis of the situation;
- 7) details of measures and project for ambient air quality improvement that existed before the day of entry of this law into force;

- 8) details of the adopted measures and projects from the aspect of pollution reduction, listing and description of all measures specified in the project and
- 9) details of the planned measures or projects

The action plans should be drawn up indicating the measures to be taken in the short term where there is a risk of an exceedance of one or more alert thresholds in order to reduce that risk and to limit its duration. Where, in a given zone or agglomeration, there is a risk that the levels of pollutants will exceed one or more of the alert thresholds specified in The Decree for limit values of the levels and types of pollutants in the ambient air and alert thresholds, the terms of achievement of the limit values, the margins of tolerance, target values and long term objectives (Official Gazette of RM 50/2005), According to article 27-a of the Ambient Air Quality Law, action plans indicating the measures to be taken in the short term in order to reduce the risk or duration of such an exceedance shall be drawn up

All the short term measures established in order to reduce acute pollution episodes may be included also in the air quality plans. Moreover, where the information threshold or any of the alert thresholds is exceeded, necessary steps to inform the public shall be undertaken.

3.1.4. National Plan for the ambient air quality protection

The National Plan for the ambient air quality protection should be prepared for the whole country. It identifies and prescribes the measures for emission reduction and improvement of ambient air quality. For each measure the responsible institution and the deadline for its implementation should be defined. The National Plan for the ambient air quality protection is prepared in the frame of the project "Ratification and implementation of the last three protocols under LRTAP convention", financed by the Netherlands government. The National Plan is adopted by the Government upon proposal of the Ministry of Environment and with the consent of the Ministry of Health and the Ministry of Economy, and is referring to the period 2012-2017. The National plan was sent to all relevant institutions for commenting and is expected to be adopted in November 2012 .

3.1.5. Plan for ambient air quality improvement

According to the air quality assessment, in the zones or agglomerations, where the levels of pollutants in ambient air exceed any limit value or target value, plus any relevant margin of tolerance in each case, air quality plans should be prepared for those zones and agglomerations in order to achieve the related limit value or target value. In Skopje agglomeration the Air quality plans should be prepared by the mayor the City of Skopje and other municipalities in Skopje region (all together 10) with the cooperation of the Ministry of Environment and Physical Planning for the period of five years.

In Eastern and Western zone which cover several municipalities, the Minister of Environment and Physical Planning based on the assessment from notion (1) from this article, regulated with a settlement, will choose the municipality which will be in charge of preparing the air quality plan in cooperation with the mayors from the remaining municipalities whose territories are covered under the zone or agglomeration. Exactly this Programme for the municipality of Bitola will be the basis for preparing the Plan for improvement of the ambient air quality in the western zone of which this municipality is a part of. The Mayors of the remaining municipalities that belong to that zone or

agglomeration are obligated to submit all available necessary data and also to ensure means for preparation of the air quality plan (art. 26 of LAAQ).

3.1.6. Short- term action plan for ambient air protection

In the zones or agglomerations, where there is a risk that the levels of pollutants in ambient air will exceed one or more of the alert thresholds, short term action plan should be prepared indicating the measures to be taken in the short term in order to reduce the risk or duration of such an exceedance. The short-term action quality plans in Skopje agglomeration and both zones shall be prepared in the same manner as the Plan for ambient air quality improvement according art. 26 of LAAQ.

3.1.7. *National program for gradual reduction of the emission quantities of certain pollutants*

The National emission reduction program shall be prepared in order to progressively reduce the national annual emissions of certain pollutants in the ambient air for a specified period. It specifies the measures for reducing pollutants in relation to the upper limits – ceilings of emission and the projections for reducing the quantities of pollutant emissions on annual level until 2020.

The terms for preparing the programme for gradual reduction of the emission quantities of sulphur dioxide (SO₂), nitrogen oxides (NO_x), ammonia (NH₃) and volatile organic compounds(VOC) are specified in article 23 of the amendments to the Law on Ambient Air Quality adopted in 2010. This article proscribes the development of the programme at national level for 2010-2020.

The National emission reduction program should be adopted by the Government on the proposal of the Ministry of Environment and Physical Planning. The National emission reduction program is in process of preparation in the frame of the project “Ratification and implementation of the last three protocols under LRTAP convention”, financed by the Netherlands government. The National emission reduction program for the period 2012-2020, upon proposal of MEPP, was adopted by the Government of the Republic of Macedonia in July 2012.

3.1.8. Transposition and implementation of the emission directives

The Rulebook on limit values for the permissible levels of emissions and types of pollutants in the exhaust gases and vapours emitted in the air from stationary sources was published in October 2010 (Official Gazette of RM 141/2010). In this Rulebook, in spite of the existing legislation, parts of the VOC Directive 1999/13/EC, LCP Directive 2001/80/EC were transposed using the available guidelines for the limit values as part of the documentation of the Best Available Techniques (BAT). This Rulebook entered into force in January 2011.

Integrated pollution prevention and control Directive 2008/1/EC

The requirements of the Integrated Pollution Prevention and Control (IPPC) Directive 2008/1/EC are transposed in the national legislation and the system for integrated control and pollution prevention was established. Installation inventory that is covered by IPPC was created. All installations should receive A or B integrated permits in accordance to the operation plan or the IPPC permits (this is a transitional phase that should be completed until 2014). A type integrated permits, in accordance to the operational plan, are under jurisdiction of MEPP and till the end of 2007, all 127 installations submitted their applications. B type integrated permits are under jurisdiction of LSG. These processes for IPPC permit issuing are still in progress. In MEPP, out of all 127 installations, 28 IPPC and permits in accordance to the operational plan, have been issued.

Limitation of emissions of certain pollutants into the air from large combustion plants Directive 2001/80/EC (LCP Directive)

The Directive 2001/80/EC or the Directive of large combustion plants with from and above 50 MW, regardless of the type of fuel, solid, liquid or gas, that it's being used, is approved with the purpose of the annual emission reduction of certain pollutants like sulphur dioxide, nitrogen oxides and dust from the combustion plants, and establishing emission limit values (ELV) for the current and new installations.

The installations in the Directive are defined as old or new and taking into account the time period that the installation started working and also the time period when the integrated environmental permit (IPPC permit) was issued.

The Directive gives ELV for the current and the new installations, which are transposed in the Rulebook for permissible levels of emissions and types of pollutants into exhaust gases and vapours emitted into the air from stationary sources.

The manner of measurement and emission calculation prescribed in the Directive as ISO and CEN standards are mentioned in the Rulebook on the methodology, manners, procedures, methods and means for stationary sources emission measurement (Official Gazette num 11/12). ISO and CEN emission measurement standards which are covered in the annex of this Rulebook are taken along with the endorsement method as Macedonian-MK standards by the Technical committee 17 for air quality.

Emission reduction of sulphur dioxide, nitrogen oxides and total particulate matter from the large combustion plants (LCP) and the gas turbines is being specified as a legal requirement in article 47 from the Law of ambient air quality. According to this article, a Decree for identification of the combustion capacities which should undertake measures for ambient air quality protection was approved, with which part of the Directive 2001/80/EC is being transposed. According to the decree, these installations (installations with capacity more than 50 MW) are obliged to prepare a Plan for taking measures for air protection with prescribed emission reduction actions and time frame for fulfilling the appropriate installation. It should be pointed out that out of the identified 13 LCPs,

7units prepared their own reduction plan. . From the installations which are large combustion plants near Bitola, REK Bitola has prepared a plan for emission reduction. This plan must be taken into account when implementing this Bitola air quality programme.

4. CONNECTION TO OTHER PROGRAMS AND STRETEGIES

National Plan for the ambient air quality protection and the National program for gradual reduction of the emission quantities of certain pollutants.are the two strategic documents relevant for air protection are in relation with the following strategic documents which have been adopted nationally:

- Second National Communication on Climate Change adopted in 2009
- Strategy for Energy to year 2030
- Strategy to promote energy efficiency to 2020
- Basic study on renewable energy
- National Strategy and National Plan for Waste Management
- National Strategy for Transport

This program will be in-line with the all strategic documents of the country.

5. ANALYSIS OF THE ORIGINS OF EMISSIONS IN BITOLA

5.1. General

There are three existing emission inventories in the country: National Cadastre of polluters and pollutants, CORINAIR inventory and greenhouse gas (GHG) Inventory. The system of Pollutant Release and Transfer Register (PRTR), National emission ceilings (NEC) inventory and Inventory on the large combustion plants (LCP) have not been established yet. The development pathways of the three existing inventories are given below:

CADASTRE of polluters and pollutants

Data on companies identified as air polluters are entered into the national electronic Access database - the Cadastre of air pollutants and polluters. The first prepared Cadastre for air emissions included data from 2004/2005, and the second included data for period 2008-2009. This database contains data from around 1 600 entities, regarding the amount of pollution for the following five pollutants: CO, NO_x, SO₂, VOC and TSP, as well as additional data on entity location, description of the technological process, general data for the business subject, electricity consumption etc. These data are gathered by site distribution and collection of the questionnaires from the business subjects, emission measurements and estimations.

CORINAIR Inventory

Calculations of pollutants emission are carried out on the basis of multilateral agreements in the area of air, namely Convention on Long-Range Transboundary Air Pollution (CLRTAP) through the program for inventory of pollution CORINAIR (CoR Inventory for Air Emission). This program through the SNAP (Selected Nomenclature of Air Pollution) methodology is applied for air emission inventory of the main air pollutants: CO, NO_x, SO₂, VOC and TSP. The application of CORINAIR methodology received status of adopted national methodology in 2009 and it is also used for reporting towards the European Environmental Agency and CLRTAP. The inventories according to the CORINAIR methodology have been prepared since the year 2001.

GHGs Inventory

In addition to inventory by SNAP methodology under the CLRTAP, inventory of substances belonging to the group of greenhouse gases (GHGs) have been prepared for the first time in 2002 under UNDP project. The inventory was based on the methodology from the Intergovernmental Panel for Climate Change (IPCC). The three main GHGs (CO₂, N₂O, CH₄) were estimate and time series 1990-1998 were included. The inventory referred to the following key sectors: energy, industrial processes, agriculture, land-use change and forestry, and waste. In 2008 the Second National Communication on Climate Change was produced. This cycle included information on the other non-direct GHGs: HFCs, PFCs and SF₆ as well as CO, NO_x, SO_x and NMVOCs. Time series 1999-2002 were recalculated for the period 1990-1998. The preparation of the Third National Communication on Climate Change started at the end of 2012.

Other information and references about the emission sources

In addition to the cadastre and the inventories listed above, two further reference documents are used in the present plan, in order to gain some information concerning the traffic and the non-industrial sources in Bitola. The first is the master thesis document "Air pollution in Pelagonia region and emission reduction measurements" made by Maja D. Barabanovska for the University of St Clement of Ohridin 2004. The second document is the "Assessment study of traffic impact on the environment" made by University of St. Clement of Ohrid, in 2011.

5.2. Main Emission Sources

5.2.1. Industrial sources

The most important single emission source nearby Bitola is the energy plant of REK Bitola, providing about 70 % of the electricity for the whole country. According to the emission permit documentation, the power plant has three units (3 x 225 MW capacity) and it uses local lignite as a fuel. The annual emissions, according to the measurements carried out in 2007, are calculated in about 80'000 tons for SO₂, 11'000 tons for NO_x and 11'000 tons for particulate matter, at the maximum capacity of the plant. The power plant is located outside the Bitola in Novaci municipality, about 15 km eastwards from Bitola. The power plant emissions are channelled in two stacks which are both 250 meters high. The plant has large storage areas for fly ash next to the power plant. These storage areas dust sometimes during heavy winds. Due to the importance of the emission amounts related to this plant, a modelling study was performed (part 5.4.3 of this programme) in order to evaluate the influence of this plant, that is relatively far from Bitola settlement, to the air pollution of the city.

Emissions of the major pollutants from REK Bitola for the period 2006 to 2011 is presented in table 4.

Table4 Emission of pollutants from REK Bitola for the period 2006 - 2010

Year	Total flow (Nm ³ /y)	CO [t/y]	CO ₂ [t/y]	SO ₂ [t/y]	NO _x [t/y]	Dust emissions SPM [t/y]
Emission from stack 1 (Block 1 and Block 2)						
2006	13700,22	187,58	0,00	26044,64	5239,80	1800,27
2007	12752,93	255,93	2446490,88	25426,77	4693,50	5002,26
2008	25643,79	427,20	3901072,39	24743,97	8046,69	3678,89
2009	14634,53	618,97	5457870,96	46656,14	10711,24	5788,81
2010	12319,89	558,60	3949968,50	35738,68	10494,15	3892,32
Emission from stack 2 (Block 3)						
2006	9252,59	134,24	0	21164,2	4941,45	1634,85
2007	8163,08	107,98	1529240	14601,42	3059,39	2596,3
2008	7708,07	135,32	2656326	17910,78	5434,15	2273,6
2009	7105,87	242,02	2726414	23468,56	5025,42	2626,57
2010	7399,37	282,95	2465266	23633,91	5910,43	2399,53

The total quantity of allowed SO₂ emissions with emission limit value (ELV) is 7905,14 t/y. , and in 2010 the annual SO₂ emissions from Block 1 and 2 are 35738,68 t/y meaning that the installation emits 4,5 times the allowed SO₂ quantity.

The total allowed SO₂ quantity with ELV for Block 3 is 11096,12 t/y, and in 2010, the annual SO₂ emissions from Block 3 are 23633,91 t/y meaning that the installation emits 2 times the allowed SO₂ quantity.

The total quantity of allowed NO_x emissions with emission limit value (ELV) for Block 1 and 2 is 9486,16 t/y, and in 2010, the annual NO_x emissions are 10494,15 t/y meaning that the installation emits 10% higher NO_x quantity than the allowed. For Block 3 the quantity of allowed emission of NO_x with emission limit value (ELV) is 4755,48 t/y, and in 2010, the annual NO_x emissions are 5910,43 t/y, i.e. 20 % higher NO_x value than the allowed.

The total quantity of allowed emission of dust with emission limit value (ELV) for Block 1 and 2 is 1581,03 t/y, and in 2010, the annual dust emissions from Block 1 and 2 are 3892,32 t/y meaning that the installation emits 60% higher dust values than the allowed. For Block 3 the allowed quantity of dust emissions with ELV for Block 3 is 792,58 t/y, and in 2010 the annual dust emissions from Block 3 is 2399,53 t/y, meaning 3 times the allowed ELV.

When preparing the Emission reduction plans for large combustion plants(LCP), the total annual air emissions and the share of REK Bitola in the total annual emissions in 2010 by pollutant have been determined. The share of each pollutant from REK Bitola in the total annual emissions is shown on the next graphs.

The share of REK Bitola in the total annual SO₂ emissions for 2010 from large combustion plants in Macedonia is 44% Graph 8.

The share of REK Bitola in the total annual NO_x emissions for 2010 from large combustion plants in Macedonia is 45 % (Graph 9).

The share of REK Bitola in the total dust emission is 44% of the total dust emissions from all major combustion plants and is shown in Graph 10.

In addition to REK Bitola, according to the local documentation about the emission permits, the industrial settlements close to Bitola city are constituted by approximately twenty small-medium factories. The second most important company in sense of emissions to air is the sugar and yeast factory. This production structure is quite old (approximately fifty years) and has heavy oil fuelled heating plant dedicated mainly to the lime production process by carbonate rock. The lime is used for the sugar refining process. In the recent years this unit has not been working in full capacity because of the market conditions in the Republic of Macedonia.

In addition to those two companies there are two asphalt stations and a printing house in Bitola causing some emissions to air.

According to the master thesis concerning the assessment of the main sources for the air pollution in Bitola, the emissions originated by industrial sources (except for REK Bitola) were estimated for several pollutants, including SO_x, NO_x, and PM. The results of this calculation, are reported in the following table. According to EMEP/CORINAIR SNAP97 nomenclature, emissions are classified in sector 03 (emission from industrial combustion) and sector 04 (emission from industrial production).

Table 6. Estimation of industrial emissions in the city of Bitola

Sector	SO₂(t/year)	NO_x(t/year)	PM(t/year)
03	245	66	57
04	1233	456	4920
Total	1478	755	5531

It can be observed that the contribution of the industrial production processes to the total industrial emissions is significantly higher than the industrial combustion processes for all the pollutants considered.

5.2.2. Traffic sources

According to the document "Assessment study of traffic impact on the environment" in Bitola, the first information shown in order to estimate the emissions concerns the composition of the vehicle fleet registered in Bitola.

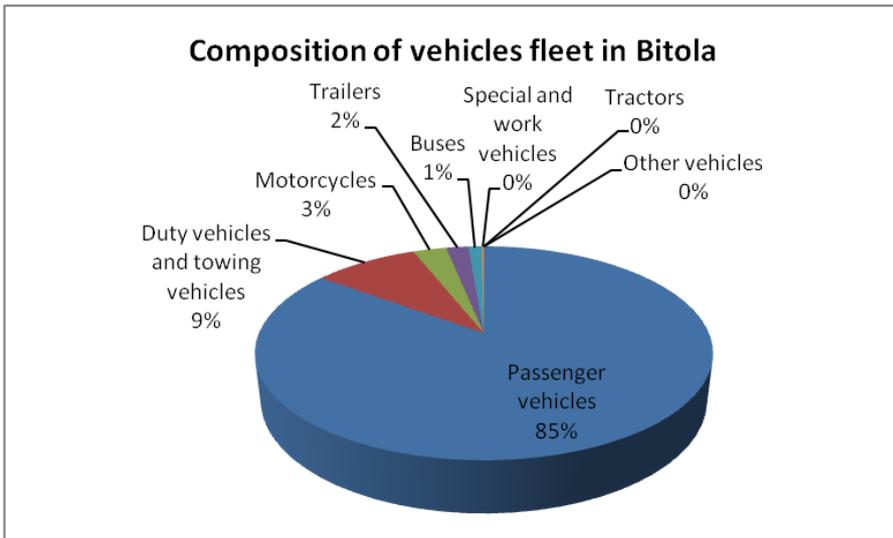


Figure 5. Composition of vehicle fleet in Bitola

The chart in Figure 6 shows the distribution of vehicles by type of fuel. Passenger vehicle is the only class distributed on three different kinds of fuels (gasoline, diesel and gas). About the total of duty vehicles, buses and work vehicles are fuelled by diesel. The great part of motorcycles is gasoline fuelled, but a little part is still fuelled by mixture.

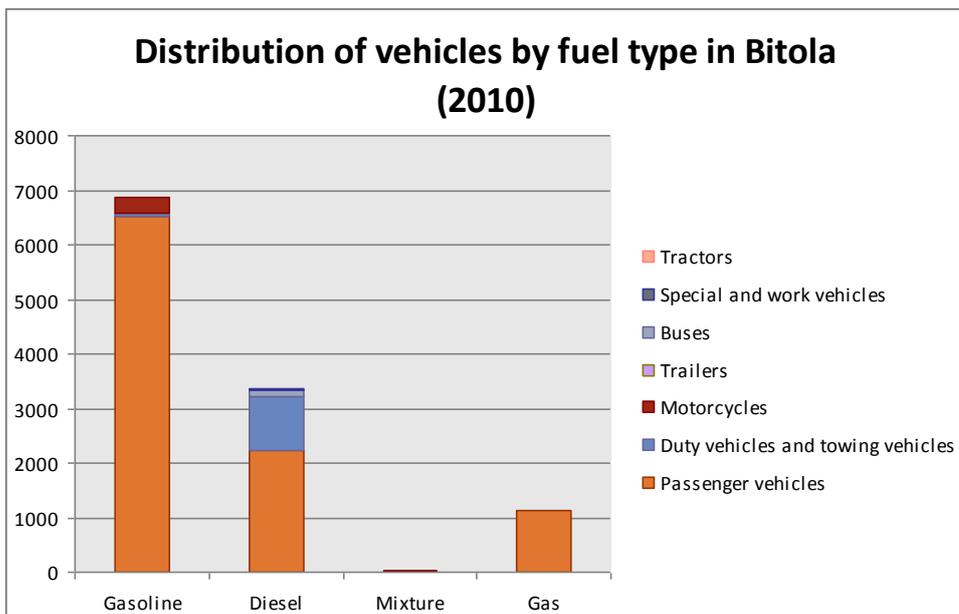


Figure 6. Distribution of vehicles by fuel type in Bitola

Basic information in order to assess traffic emissions in Bitola concerns the classification of motor vehicles into age groups according to the year of introduction of each of the Euro standards.

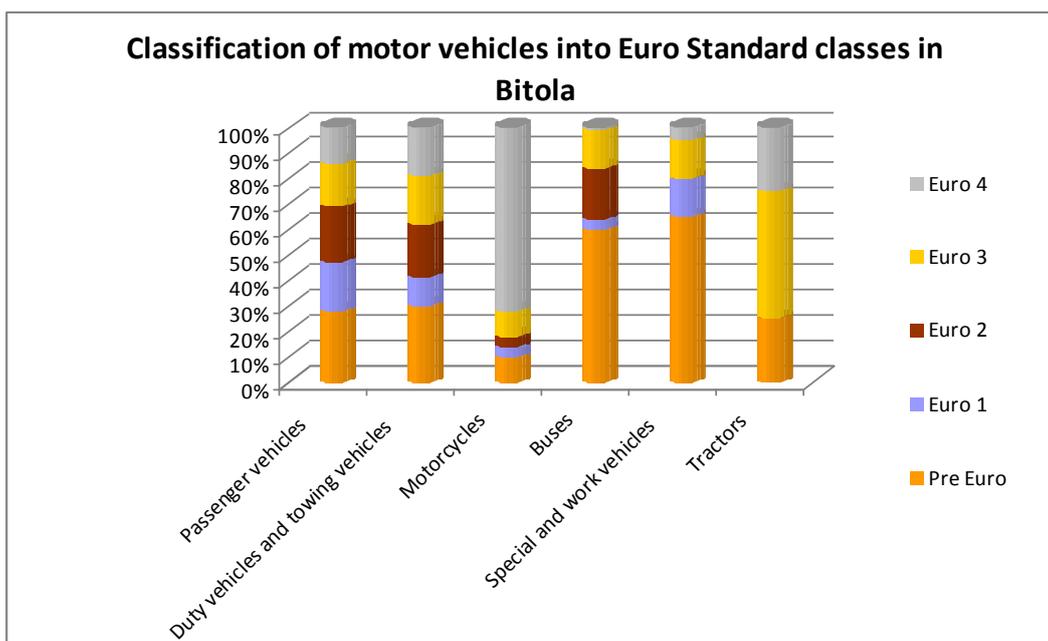


Figure 7. Classification of motor vehicles in Euro classes in Bitola

Figure 7 shows that in Bitola with the exception of the motorcycles and the tractors at least 55 % of the motor vehicles are classified Euro 0 (Pre-Euro), Euro 1 and Euro 2. This means that in general the most part of fleet is composed of vehicles with more of 10 years of activity. For the bus sector the statistic shows that more than half of vehicles are classified Pre-Euro (more than 18 years of activity).

Referring to the method included in “EMEP/EEA air pollutant emission inventory guidebook - Road transport GB2009 (June 2010 release)”², a traffic emission estimation is reported for NO_x, PM₁₀ and SO_x in order to assess the contribution of the urban traffic in Bitola to the total emission load. Due to the availability of information about the vehicle fleet in Bitola the emission estimation is carried out for public transport (buses), passenger vehicles, motorcycles and duty vehicles that constitute altogether about 98 % of total fleet. Details of the calculation are available as a part of the documentation of the Twinning project ‘Strengthening the central and local level capacities for environmental management in the area of air quality’.

Table 7. Emission estimation from traffic sources in Bitola

	NO_x (t/year)	PM₁₀ (t/year)	SO_x (t/year)
Public	33	1.5	0.1
Passengers vehicles	125	3.1	0.7
Motorcycles	1	0.2	0.01
Duty vehicles	50	3.8	0.3
TOTAL	208	8.7	1.1

Also the master thesis document mentioned in the previous paragraph includes an estimation of traffic emission based on the distribution of different classes of vehicles observed and counted

during a single day in the main streets of Bitola. The emissions were calculated according to the emission factors of 2004. A difference between the current and the master thesis estimations is recognized. In particular the master thesis document shows higher emissions related to traffic especially for PM_{10} (estimated in about 67 t/year) and SO_x (27 t/year), whereas the NO_x result (268 t/year) are comparable.

5.2.3. Non industrial sources

According to the case study made in 2005 by the Energy Regulatory Commission with a partnership program with Vermont Public Service Board about 26 000 households are present in Bitola. The strategy used for the domestic heating is shown in the following chart. It can be observed that the most part of the households are stove heated (85 %) and a minority is served by a central heating system (more than a building served by the same plant) or by an individual central heating plant (referred to a single building). No data are available for the type of fuel used in central heating systems. Differently some statistics are available for the individual central heating systems and for the stoves. The individual central heating plants in Bitola are estimated in 1 746 units, fuelled as shown in the following chart. Liquid fuels (oil, diesel oil etc.) are the most used for these kinds of plants with 41 % of the total, followed by wood (28 %), electricity (19%) and coal (12 %).

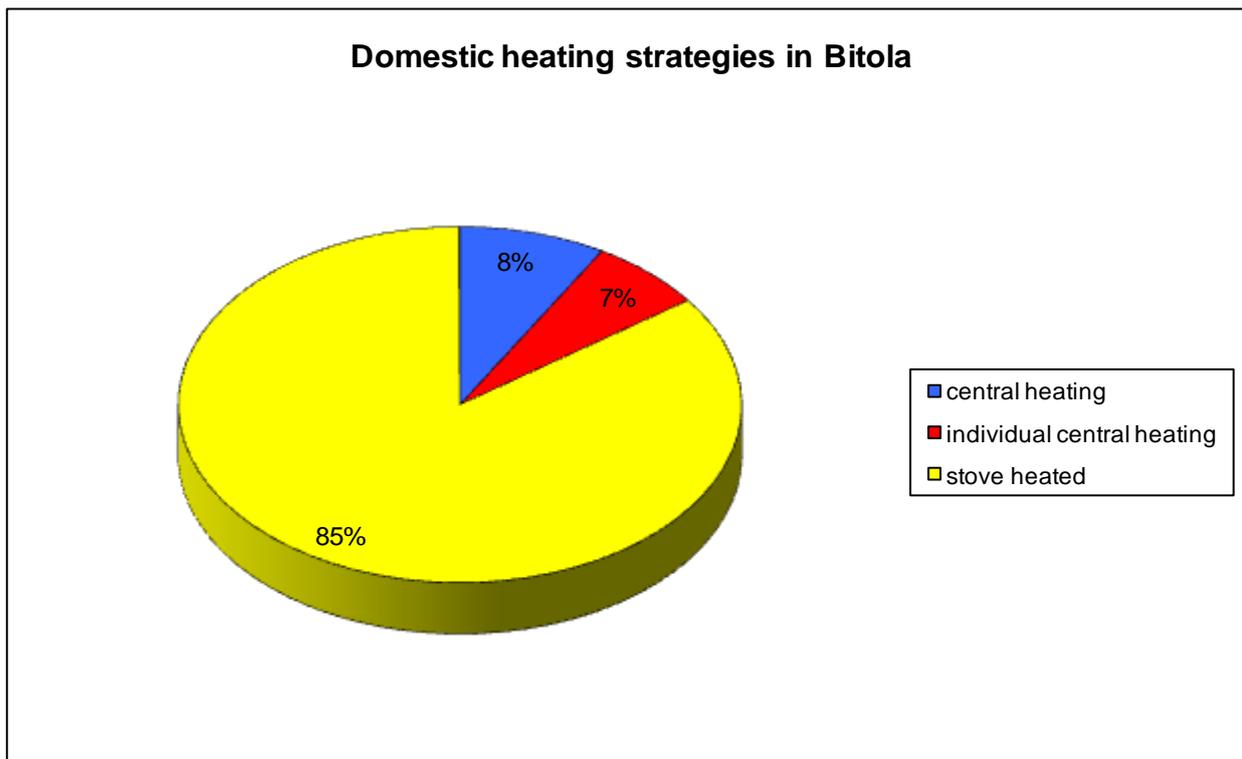


Figure 8. Domestic heating strategies in Bitola

Another basic information concerns the type of fuel used for the stoves, the most common type domestic heating plant in Bitola. It can be observed that more than half of these plants (64 %) are fuelled by wood, and another 35 % is constituted by electric stoves.

According to these data the use of wood in Bitola seems to be very common and this could be probably related to a significant contribution to the air pollution, especially for PM_{10} .

Individual central heating fuel distribution

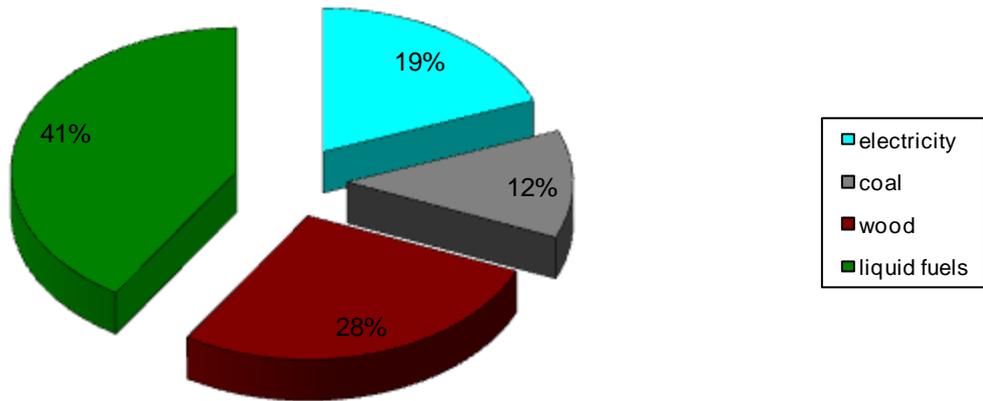


Figure 9. Individual central heating plants distribution by fuel

Stove heated households fuel distribution

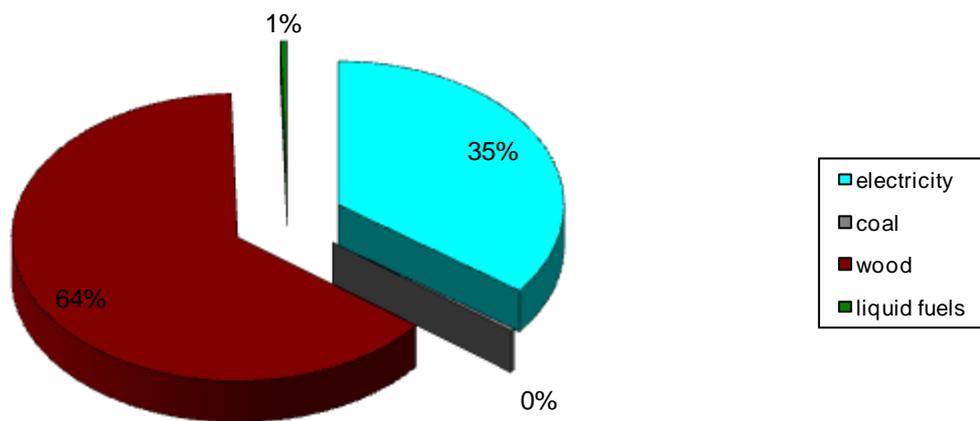


Figure 10. Stove heated household distribution by fuel

Moreover the air quality data series collected in Bitola allows defining the PM₁₀ as the most critical atmospheric pollutant in Bitola. For this reason an estimation concerning the emissions related to the domestic wood combustion in Bitola is needed.

According to the master thesis document, the annual wood consumption in Bitola is estimated in about 22 000 tons. The related emission is estimated in about 2 t/year of SO₂, 19 t/year of NO_x and 28 t/year of PM₁₀. A comparison of these data with the total emissions originated by the non industrial combustion plants (sector 2 in the following table) shows that the contribution of the wood combustion to the total emission seems to be marginal.

Table 8. Emission estimation from non industrial combustion sources in Bitola

Sector	SO ₂ (t/year)	NO _x (t/year)	PM(t/year)
02	677	238	554

Especially for PM₁₀, the development of the emission factors (EF) related to wood combustion must be taken into account. The table above was gained with the emission factors related to 2004: For PM₁₀ the average emission factor for wood stoves was about 85 g/Gj. The updated EMEP CORINAIR guidebook (reference year 2009) establishes the average PM₁₀ EF related to the residential wood fuelled stoves in 810 g/Gj, about ten times higher. According to this information the wood combustion becomes a significant source especially for PM₁₀ domestic emission in Bitola.

4.2.5 Summary of emission inventories

In this paragraph the emissions from different sources discussed in the previous parts (industrial combustion and production, non industrial combustions and traffic) are compared in order to define the main sectors responsible for the emission of each pollutant. The emission figures in table 9 are based on the latest and most accurate data that was available, when making the inventory. Table 9 does not include the emissions of REK Bitola, which is not located in the city of Bitola itself. The emissions of REK Bitola have been during the last years as follows: 80'000 tons for SO₂, 11'000 tons for NO_x and 11'000 tons for particulate matter.

Table 9. Total emissions in the city of Bitola

Sector	SO ₂ t/year	NO _x t/year	PM t/year
Non industrial combustion	680	240	550
Industrial combustion	250	70	60
Industrial production	1250	460	4900
Total (stationary sources)	2180	770	5510
Traffic (mobile sources)	30	270	70

Because of the uncertainties in the emission inventory some assumptions are pointed out:

- Concerning the industrial sources the current situation in Bitola has changed in the last years with a decrement of the active productive settlement. According to this data probably the emissions related to sectors 02 and 03 are overestimated. However according to the information gained in Bitola the sugar and yeast factory are still active and probably it may

contribute significantly to the total emissions from the sectors 03 and 04. This assumption is due to oldness of this plant that seems not be modified during the last decades.

- Concerning the non industrial combustion, the PM₁₀ new emission factors related to the stove wood combustion is significantly higher (about ten times) than the EF used for master thesis. According to the wide use of wood in Bitola as fuel for the domestic heating systems the PM₁₀ emission in the non industrial sector are probably underestimated: as a consequence of the reduction of industrial activity in Bitola probably the non industrial combustion sector should have a significant role in the PM₁₀ emissions.
- Concerning the mobile sources the 2004 data shows that for SO₂ and PM₁₀ the contribution of traffic is not significant to the total emission. Moreover the calculation carried out with the 2010 data confirms this data with extremely low load of PM₁₀ and SO₂ emission attributable to traffic. The NO_x emission from traffic is significant but probably not comparable to the emission from stationary sources.

These assumptions allow summarizing two important conclusions about the emission issue in Bitola:

1. The evolution of the emission situation in Bitola in the last few years should suggest an update of the emission inventory for this area as one of the basic activity for the future, in order to confirm the assumptions made in the present document. This is also supported by the fact that during the next years especially emission of SO₂ and NO_x from REK Bitola will decrease significantly because of the new emission limits.
2. The information gained suggests focusing the attention in planning the air pollution reduction measures toward the stationary sources sectors instead of the mobile ones. Particular attention should be deserved to the emission related to domestic heating.

The emission inventories made for this programme cover the area of the Bitola city and REK Bitola, which is situated outside the municipality of Bitola, but which may have an important influence on air quality in the region. Except emissions of REK Bitola other emission in the surrounding area of Bitola have not been inventoried, because based on the data available it was assumed that their impact on local air quality in Bitola is not significant.

6. AIR QUALITY ASSESSMENT IN BITOLA REGION

6.1. The process of establishing zones and agglomerations

Two zones and one agglomeration for the basic pollutants SO₂, CO, NO₂, NO_x, PM₁₀ and O₃ have been established on the territory of the country for the primary pollutants.

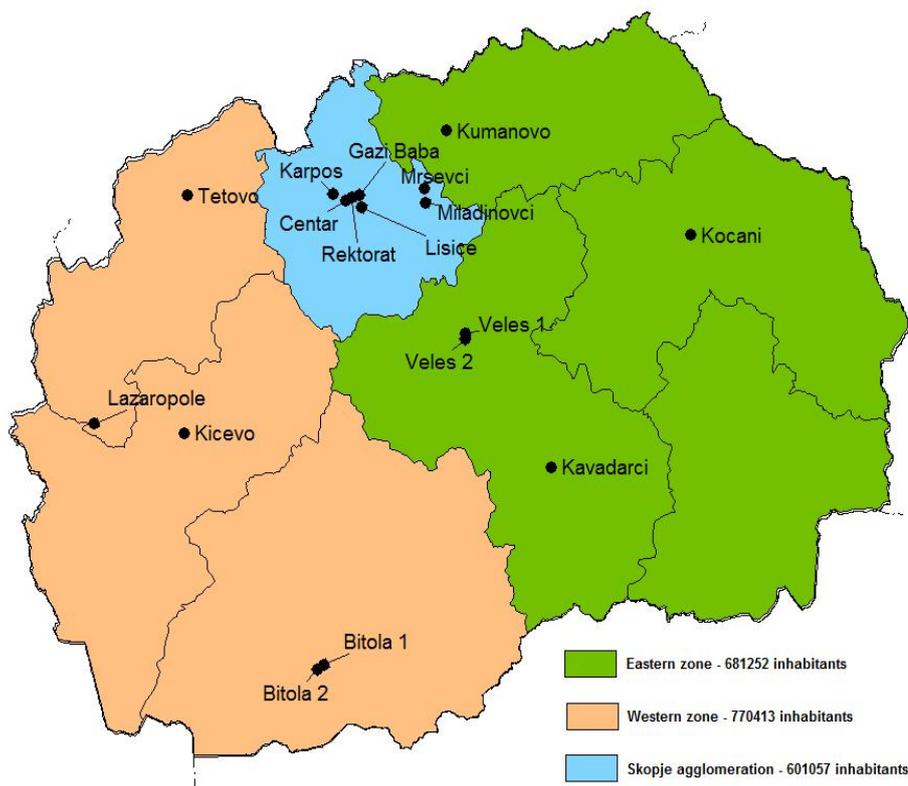


Figure 11. Classification of zones and agglomerations and situation of air quality measurement stations.

The zones are defined as: Western zone (South west, Polog and Pelagonija statistical region) and Eastern zone (North east, South east, Vardar and East statistical region) and one agglomeration Skopje (Skopje statistical region).

Table 10. Basic data per zone

Zones/agglomeration	Statistical regions	Number of population	Area / km ²	Population density
Eastern zone	Vardar	681 252	13 183	51.67
	East			
	North East			
	South East			
Western zone	Pelagonija	770 413	10 476	73.54
	Polog			
	South West			
Skopje agglomeration	Skopje	601 057	1 718	349.91

It can be seen from the table that the Eastern zone represents the largest area, with lowest population, the Western zone represent area with highest number of population, but Skopje agglomeration has a highest population density with a lot of urban areas in a relatively small surface area. City of Bitola is situated in Pelagonia region in Western zone of the country.

6.2. Air quality network at national and local level

According to the Law on ambient air quality for air quality monitoring on the territory of the country, the Government established national ambient air quality monitoring network. This network is managed by the Ministry of Environment and Psychical Planning. It consists of 17 air quality monitoring stations, connected with the air quality database located in the Macedonian Environmental Information Center with GPRS connection. In the frame of the network there is calibration laboratory, for regular calibration of the instruments. Five of these stations are located in Skopje (Karpos, Centar, Lisice, Rektorat and Gazi Baba), two in municipality of Ilinden (Miladinovci and Mresevci), two in Veles (Veles 1 and Veles 2), two in Bitola (Bitola 1 and Bitola 2), one in Kicevo, Kocani, Kumanovo, Tetovo, Lazaropole and Kavadarci.

The Bitola stations are operational since April 2004. For the purpose of measurement and monitoring of the ambient air quality in settlements and industrial areas, Municipalities and the City of Skopje, may establish local networks. For now the local authorities in Bitola has not established local monitoring network.

6.2.1. Bitola 1 monitoring station

Bitola 1 station is industrial station located 250 m from the nearest road (coordinates: 21°21'11,93 N 41°02'30,04 E) at 576 m above the sea level, in suburban area. It measures SO₂, NO_x, NO, NO₂, CO, O₃ and PM₁₀ concentrations and meteorological parameters (temperature, humidity, wind direction, wind speed, global radiation and pressure). The surrounding area is generally open and comprises agricultural areas and small industrial installations. The nearest industrial installation is factory for ice cream "CERMAT" 350 m away. Heat energy production units area located 2–4 km away between the wind sectors south-west and south-east from the station. The major air pollutant in Bitola is REK Bitola power plant which produces electricity. REK Bitola has extremely high SO₂ emissions and it is located 13 km eastwards from the Bitola 1 station. According to the prevailing wind directions (north and south) REK Bitola rarely affects monitored concentrations. Like suburban – industrial station, this station should monitor the combined effect of the numerous industry and energy production units.

In the surrounding of the Bitola 1 station there is new meteorological station, managed by HMA and operational since May 2011. Also, on the same location from 1974 till 2009, HMA performed measurement of the SO₂ and black smoke.

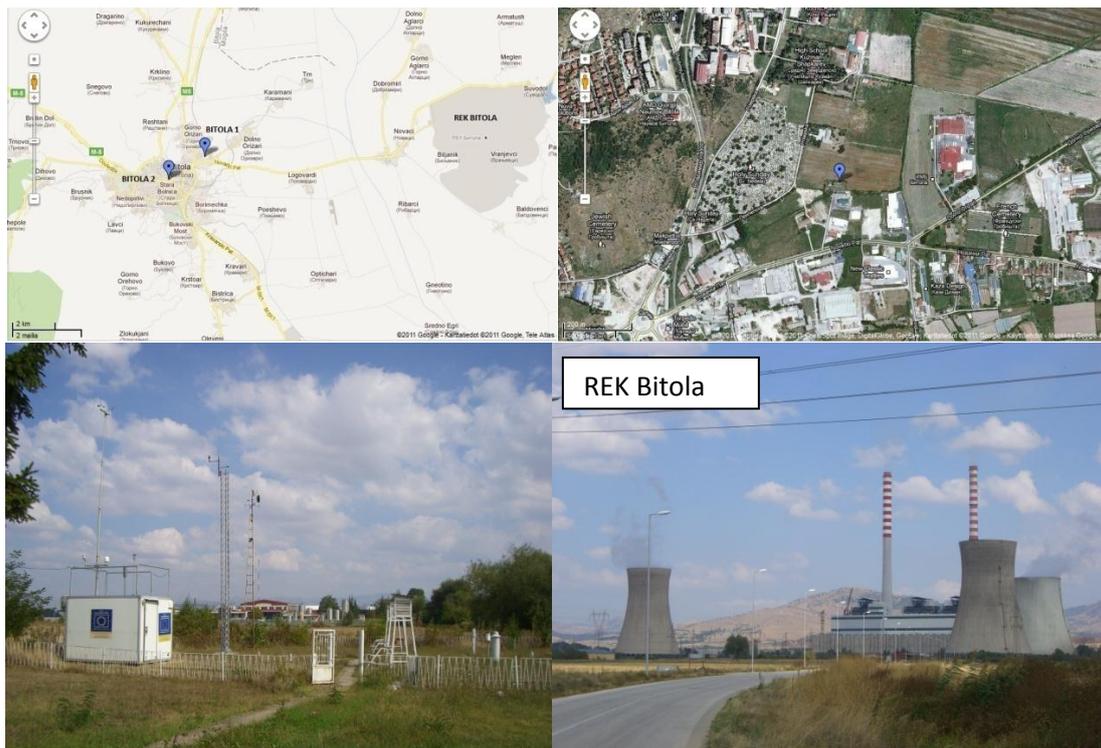


Figure 12. Location of Bitola 1 station.

6.2.2. Bitola 2 monitoring station

Bitola 2 is a traffic station located in the centre of Bitola, in the yard of administrative buildings. This station is classified as an urban – traffic station. The nearest crossroad is 40 m away from the station (coordinates 21°20'00,38 N 41°01'55,48 E) at 615 m above the sea level. Also, on a distance of 2-3m there are parking lots beside the station. It measures SO₂, CO, NO_x, NO, NO₂, O₃ and PM₁₀ concentrations and meteorological parameters (temperature, humidity, wind direction, wind speed, global radiation and pressure). The surrounding area comprises of medium and small dwellings and buildings. Main source of emission in this area is traffic, but and also commercial, institutional and residential combustion.



Figure 13. Bitola 2 monitoring station

6.3. Air quality data in Bitola

6.3.1. Sulphur Dioxide

According to the current legislation, sulphur dioxide concentrations (SO_2) is regulated by two limit values for protection of human health and critical level for the protection of vegetation. For the period 2007-2011, the measurements from the both Bitola stations show that there were no exceedances of either the hourly and daily limit value. The annual average values both from Bitola 1 and Bitola 2 stations for the period 2007-2011 are presented in Figure 14.

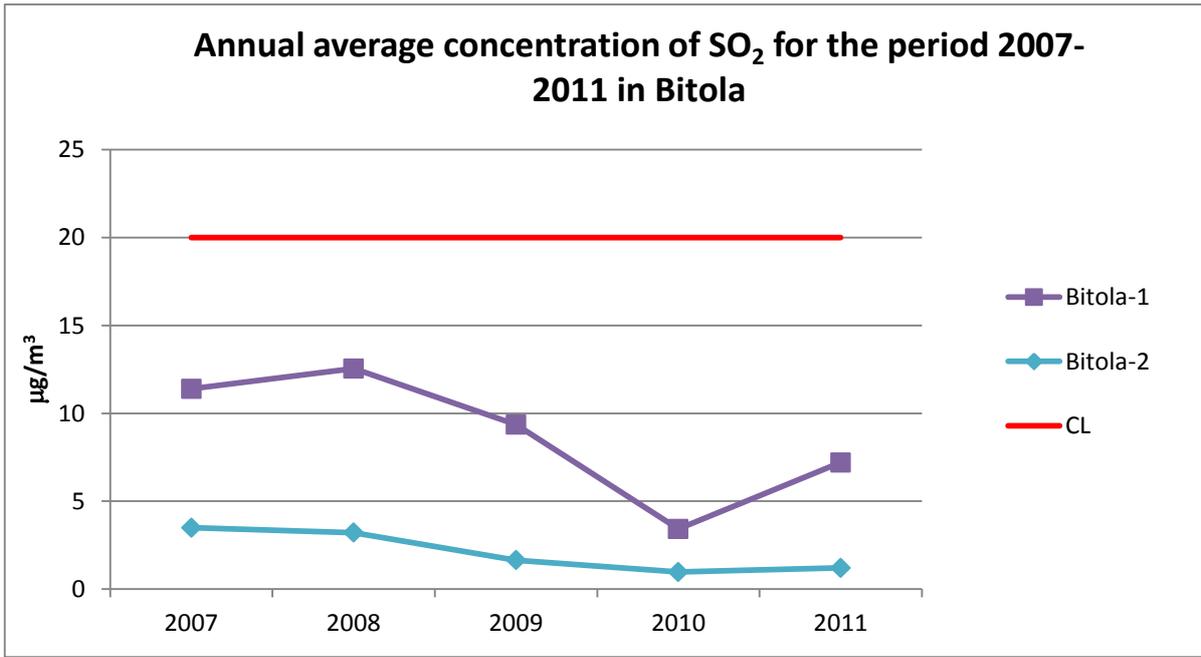


Figure 14: Annual average values of SO₂ at the Bitola measurement stations for the period 2007-2011

From the Figure 14 it can be seen that the concentrations of this pollutant are higher at Bitola 1 station comparable to Bitola 2 station, due to the emissions coming out from nearby thermoelectric power plant. For the protection of vegetation, the critical level is meant to be applied only for rural background areas. The both station in Bitola are not that type of stations. The hourly concentrations of SO₂ for Bitola measurement stations in 2011 are presented in the Figure 15.

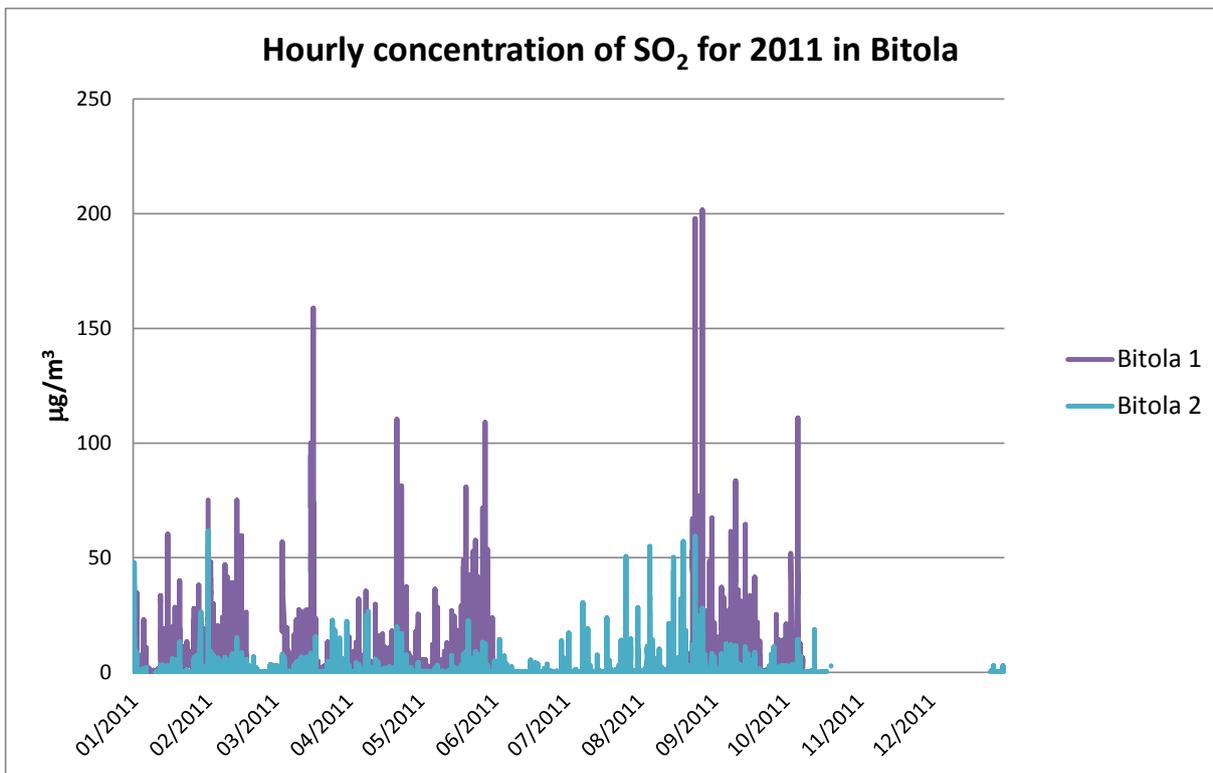


Figure 15: The hourly concentration of SO₂ in 2011 from both Bitola stations.

The daily average concentrations of SO₂ for Bitola measurement stations in 2011 are presented on the Figure 16.

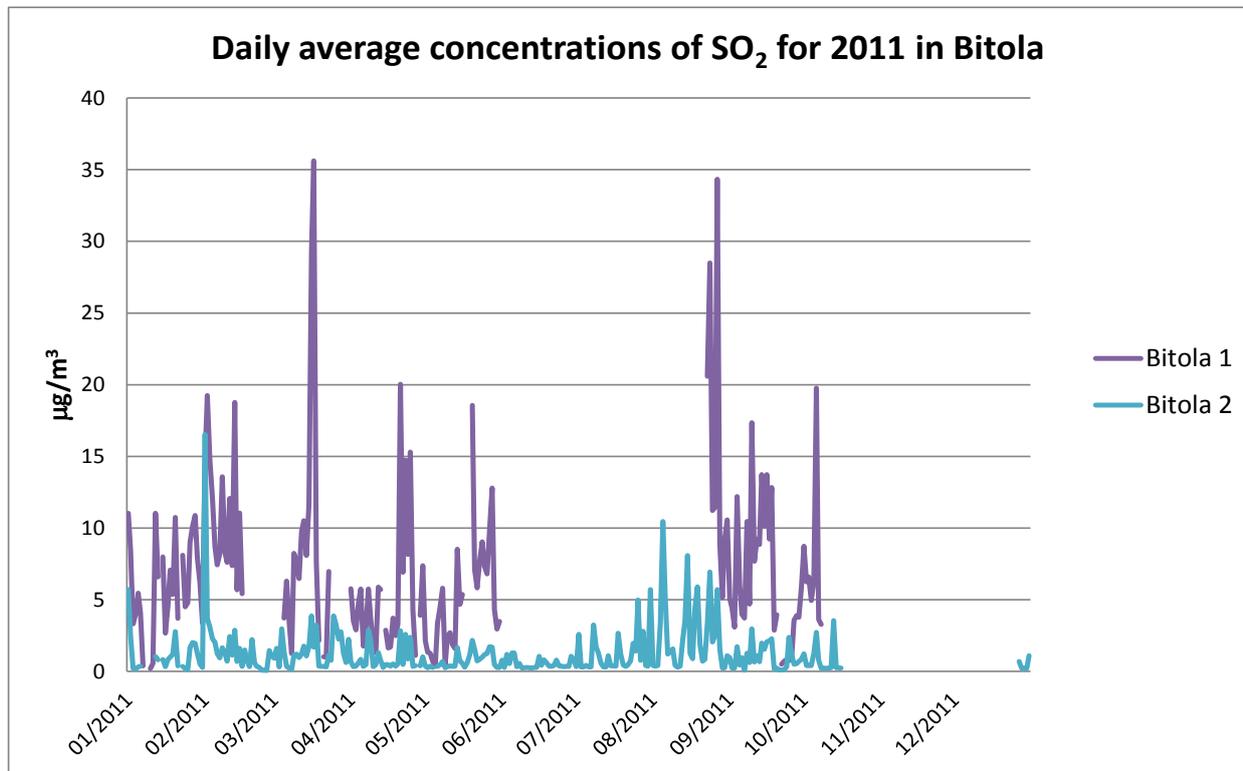


Figure 16: The daily average concentration of SO₂ in 2011 from both Bitola stations

Maximum daily average for Bitola 1 is 37 µg/m³ and maximum hourly value is 202 µg/m³. For Bitola 2 station maximum daily average is 16 µg/m³ and 62 µg/m³ is the maximum hourly value. Winter averages are 8 µg/m³ and 1 µg/m³ for Bitola 1 and Bitola 2 station, respectively.

As the concentrations are clearly below the limit value, SO₂ is not considered as a critical pollutant.

6.3.2. Nitrogen Oxides

According to the current legislation, nitrogen dioxides concentrations (NO₂) is regulated by two limit values hourly limit value and an annual limit value as shown in Table 1. For the period 2007-2011, the measurements from the both Bitola stations show that there were no exceedances of either the hourly or daily limit value.

The annual average values both from Bitola 1 and Bitola 2 stations for the period 2007-2011 are presented in Figure 17.

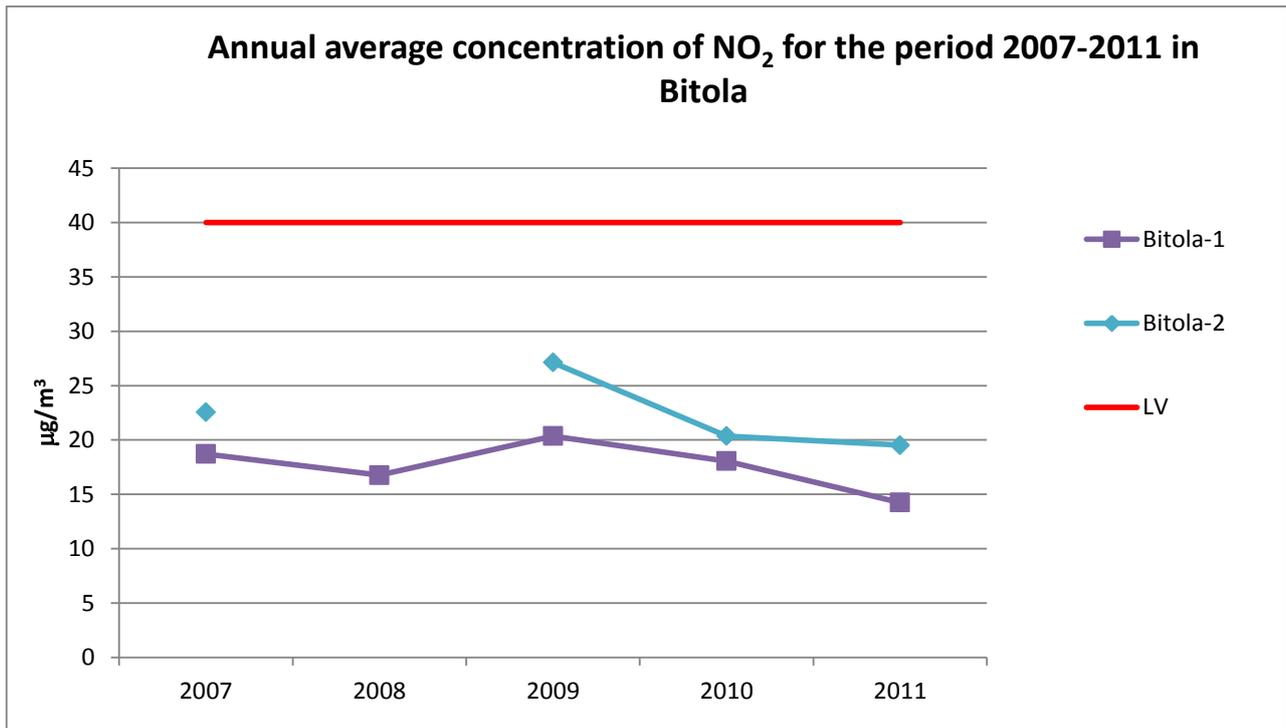


Figure 17. Annual average values of NO₂ at the Bitola measurement stations for the period 2007-2011

From the Figure 17 it can be seen that the concentrations of this pollutant are higher at Bitola 2 station comparable to Bitola 1 station, due to the emissions mainly coming out from the traffic. The hourly concentrations of NO₂ for Bitola measurement stations in 2011 are presented in the Figure 18.

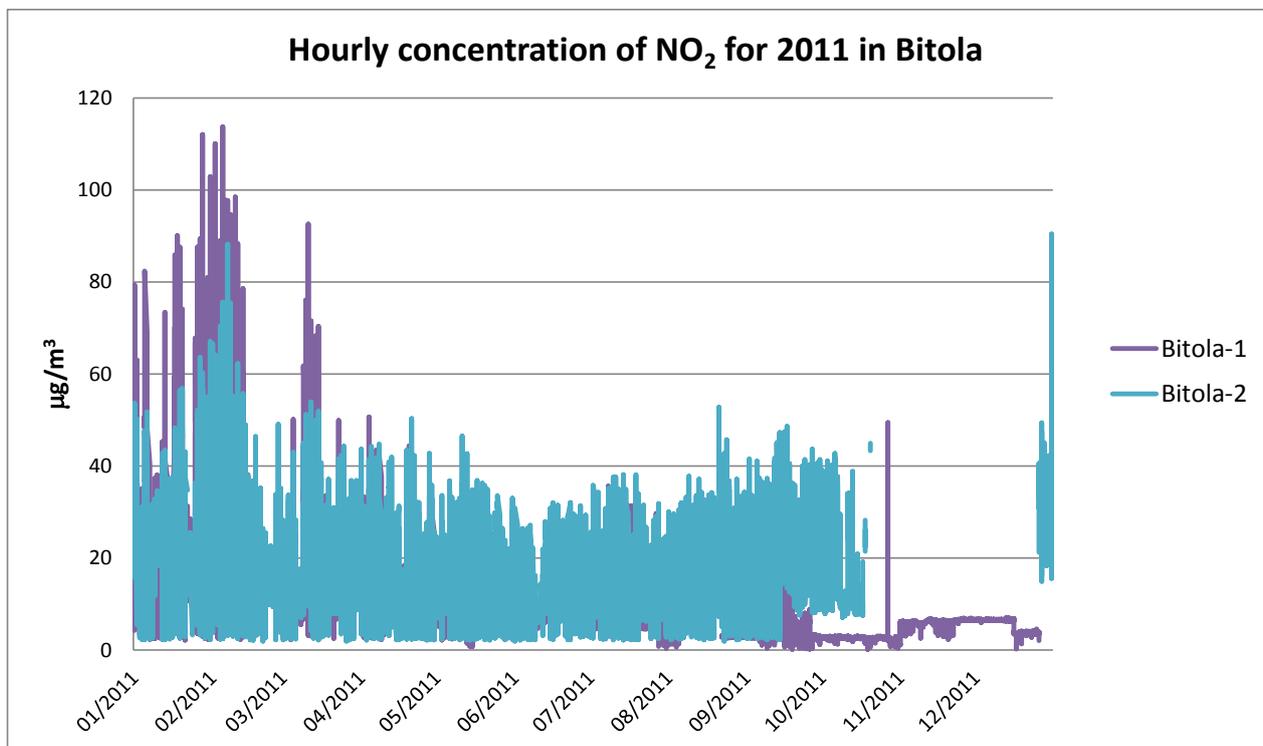


Figure 18. The hourly concentration of NO₂ in 2011 from both Bitola stations.

The annual average concentrations from Bitola 1 station is $14 \mu\text{g}/\text{m}^3$ and from Bitola 2 station is $20 \mu\text{g}/\text{m}^3$. There are no exceedances of annual and hourly limit values from these two stations. Maximum hourly value for Bitola 1 station is $170 \mu\text{g}/\text{m}^3$ and for Bitola 2 station is $90 \mu\text{g}/\text{m}^3$.

Error! Reference source not found. shows the average daily variation of NO_2 concentration in 2011 in Bitola air quality stations.

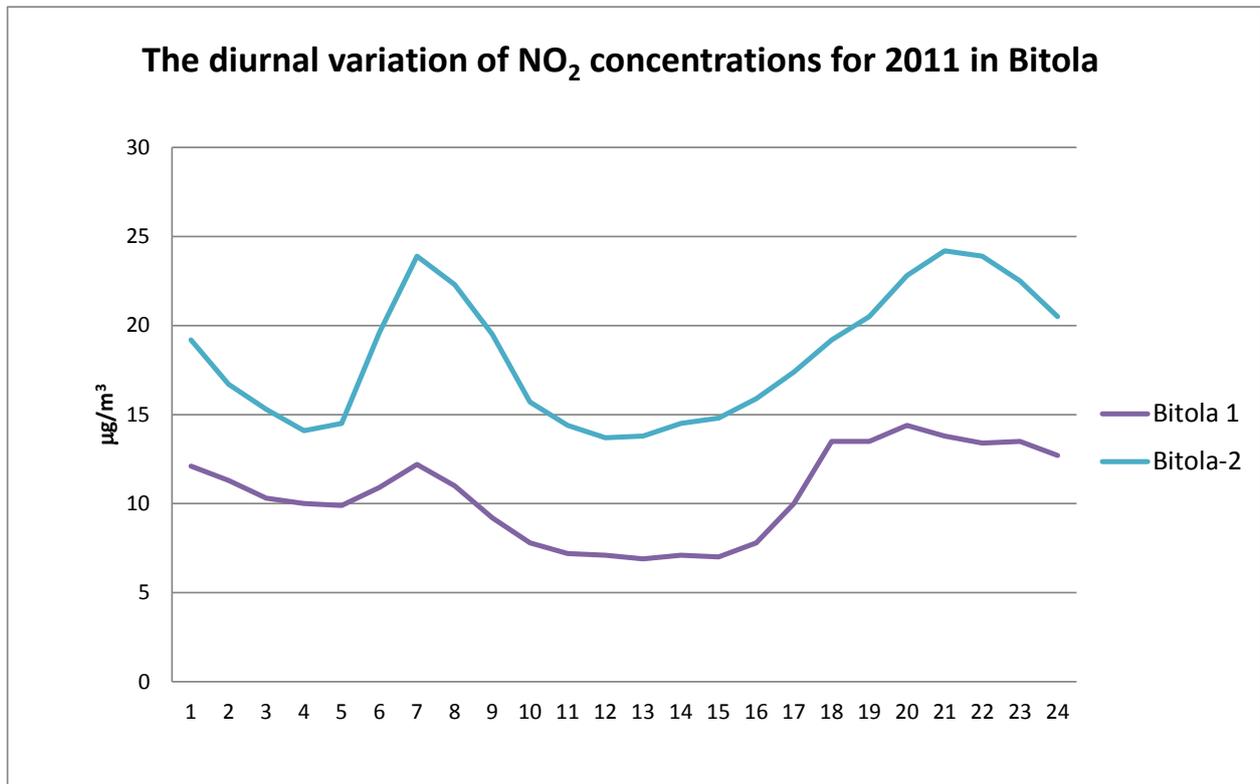


Figure 19. Diurnal variation of NO_2 concentrations at Bitola 1 and Bitola 2 measurement stations.

As we can see from the figure above from the daily variation the level of the traffic station is higher than the level of the background station. The highest concentrations in the day in Bitola stations are recorded in the morning around 7 to 9 am and 5-6 pm. This is due the rush hour in the traffic in Bitola stations which is the main source of emission of this pollutant.

6.3.1. Suspended particles with size up to 10 micrometers (PM_{10})

According to the current legislation, particulate matter with a diameter less than $10 \mu\text{m}$ (PM_{10}) is regulated by two limit values as shown in the Table 1. The exceedance of the daily limit values of PM_{10} for the Bitola measurement stations are shown in Table 11.

Table 11. Exceedance of the daily limit values of PM₁₀ for the Bitola measurement stations

Year	Bitola 1	Bitola 2	Allowed number of exceedance
2007	154	180	35
2008	160	148	35
2009	93	171	35
2010	102	140	35
2011	159	147	35

The daily limit value for the protection of human health (50 µg/m³) has been exceeded very clearly both in Bitola 1 and in Bitola 2 measurement stations.

The annual average values at the Bitola measurement stations are presented in Figure 20.

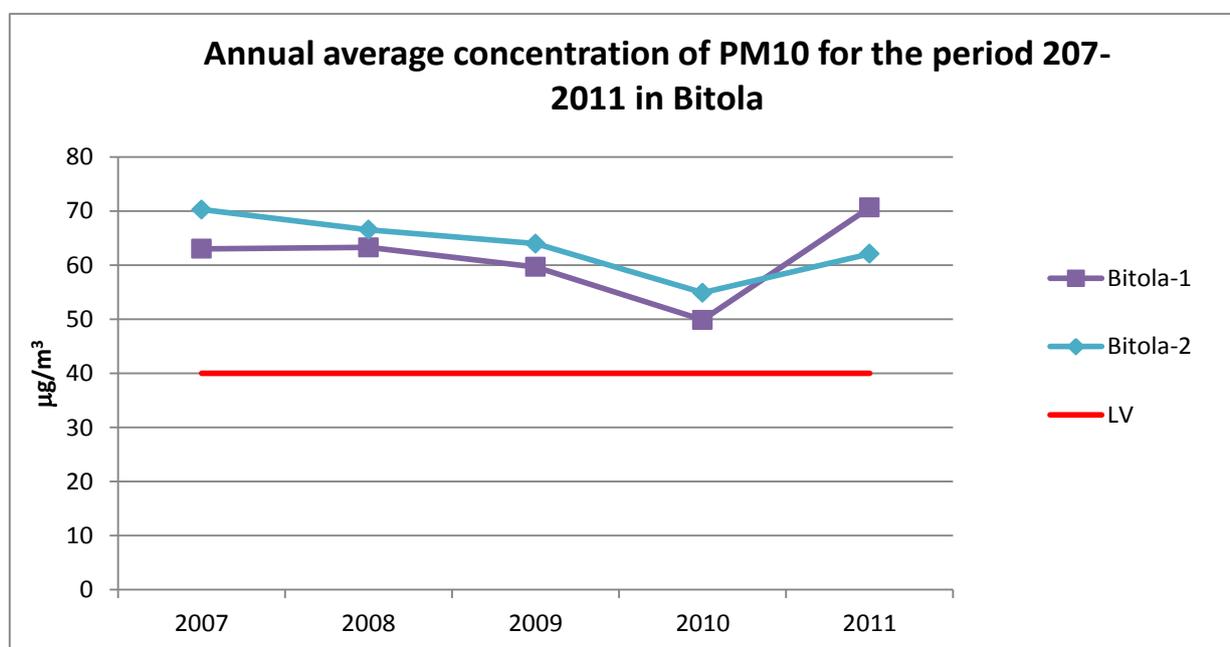


Figure 20. Annual average values of PM₁₀ at the Bitola measurement stations in years 2007-2011

The annual limit value for the protection of human health has exceeded clearly at both measurement stations.

In Figure 21 is shown the annual variation of the daily average concentrations of PM₁₀ in Bitola measurement stations in 2011. From October to January data from Bitola 2 station is not available.

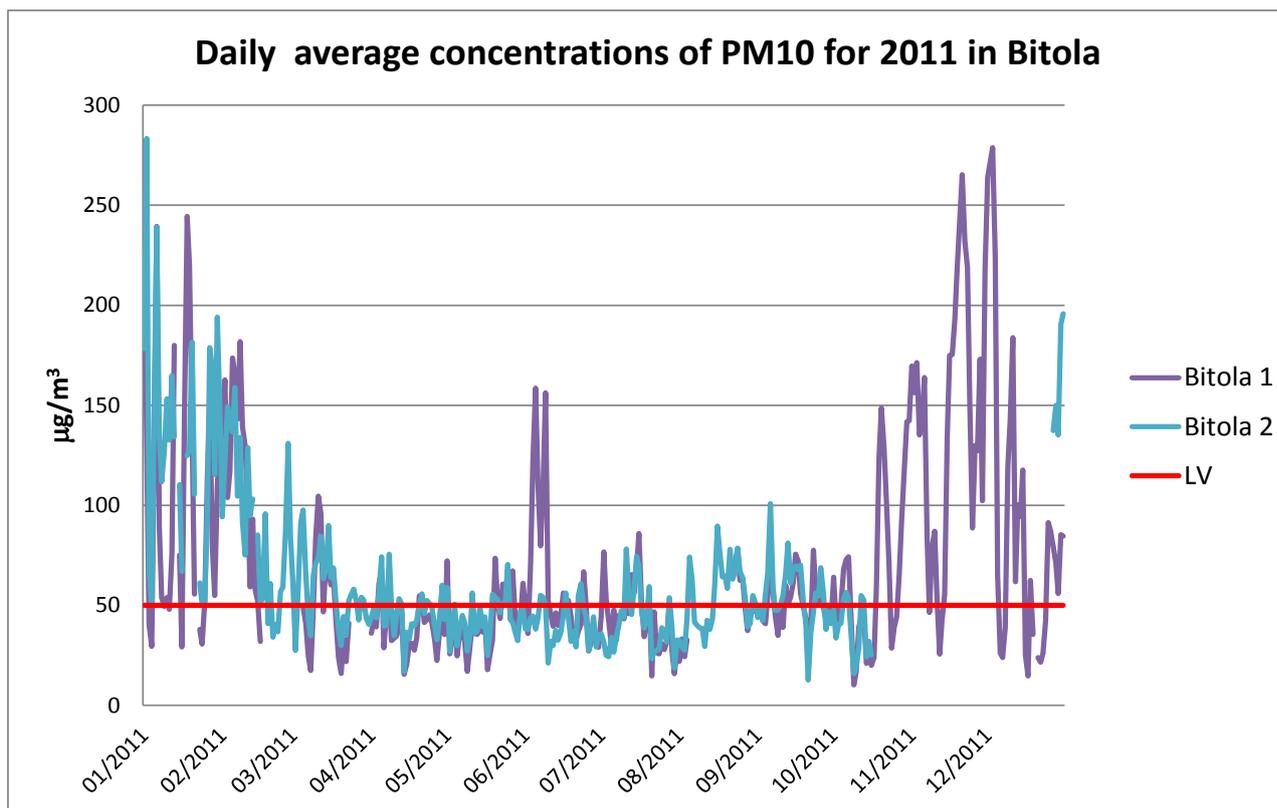


Figure 21. The daily average concentration of PM₁₀ in 2011 from Bitola measurement stations.

Except of few periods the variation of concentration is very similar at the stations, which indicates that same emissions sources and factors affect the PM₁₀ concentrations at both stations. The concentrations are very clearly higher during the winter months.

Error! Reference source not found. shows the average daily variation of PM₁₀ concentration in 2011 in Bitola air quality stations.

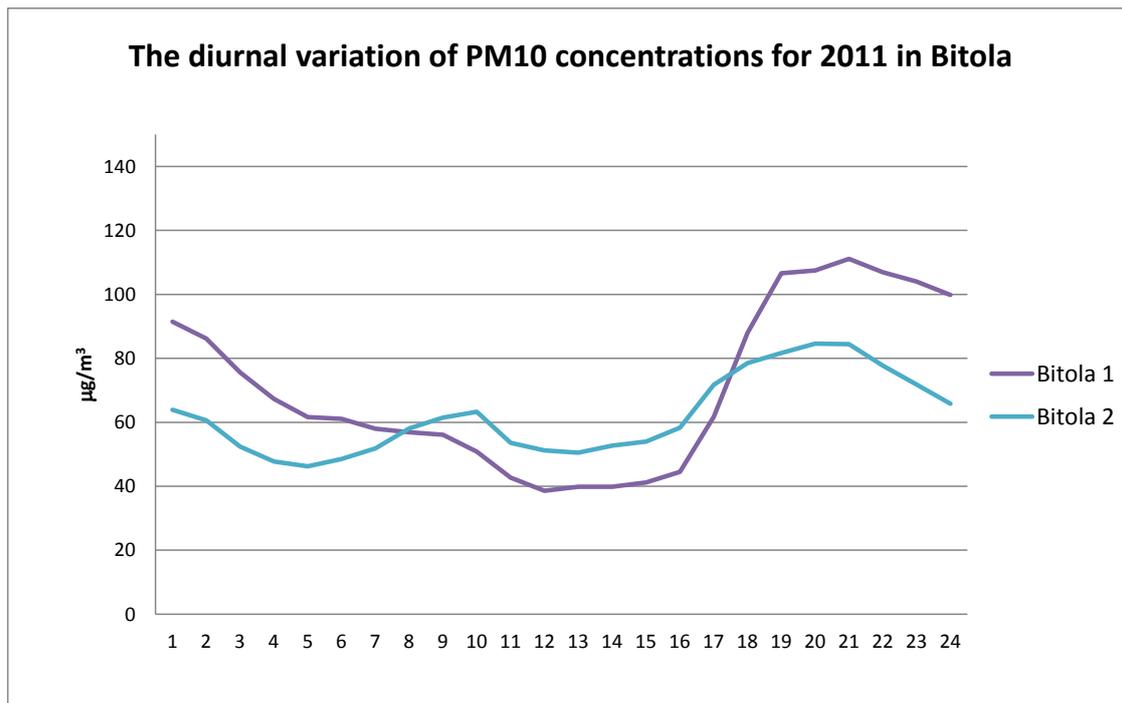


Figure 22. The daily variation of PM₁₀ concentration in 2011 at the Bitola measurement stations

It can be observed that the maximum concentration of PM₁₀ is recorded for both stations at the late afternoon, probably due to the accumulation of this pollutant at the ground level, related to thermal inversion. On the other hand in the early afternoon PM₁₀ level is generally low. In the “Bitola 2” (traffic station) the diurnal variation is less marked than in “Bitola 1” (background station). However it can be observed that during the middle hours of the day PM₁₀ level in the traffic station is higher than in the background one. This trend is probably related to the significant contribution of diurnal traffic emissions to the total level of PM₁₀. Moreover a peak of PM₁₀ can be observed in the traffic station from 8 to 10 am, during the rush hours.

Concerning the total level of PM₁₀, it should be taken into account that the formation of secondary PM can have an important part in PM₁₀ concentrations. The secondary PM affects mostly the PM₁₀ concentrations at stagnation conditions. The main reasons of the secondary PM₁₀ formation are nitrogen oxides, ammonia, and sulphur dioxide. Their reaction in the atmosphere promotes the formation of particulate composed mainly by nitrates and sulphates. An integrated policy in order to decrease the particulate matter should take into account the role of these PM precursors, promoting their reduction in the atmosphere.

4.3.4. Suspended particles with size up to 2.5 micrometers($PM_{2.5}$)

According to the current legislation, particulate matter with a diameter less than 2.5 μm ($PM_{2.5}$) is regulated by an annual limit and target value as shown in Table 2.

$PM_{2.5}$ concentrations have not been measured in Bitola. However in Skopje $PM_{2.5}$ measurements have been started in 2011. The first measurements in Skopje show that the $PM_{2.5}$ concentration can be about 70-80 % of the PM_{10} concentrations both in the city centre and at the background station. The annual average of $PM_{2.5}$ has been about the same in the centre of Skopje and at the background station during the few months, when the measurements have been going on. It is quite obvious that the annual average of $PM_{2.5}$ in Skopje exceeds the limit value of 25 $\mu g/m^3$. Moreover the ratio between $PM_{2.5}$ and PM_{10} estimated in Skopje is in line with the measurements carried out in the most part of Europe.

According to the PM_{10} annual average concentration levels measured in the last few years in Bitola, always above the 50 $\mu g/m^3$, the exceedance of the annual average of $PM_{2.5}$ is almost sure, even considering a very low $PM_{2.5}/PM_{10}$ ratio of 50 %. For this reason the fine fraction of particulate matter should be considered as a critical pollutant, suggesting a strong policy in order to reduce the particulate matter concentration in Bitola.

6.3.2. Ozone

According to the current legislation, ozone concentrations (O_3) are regulated by a long term objective for protection of human health and information and alert thresholds shown in Tables 3 and 4. The exceedances of the long term objective for protection of human health the Bitola measurement stations are shown in Table 12.

Table 12. Exceedance of the long term objective for protection of human health for the Bitola measurement stations

Year	Bitola 1	Bitola 2	Allowed number of exceedance
2007	60	17	25
2008	54	99	25
2009	12	51	25
2010	20	61	25
2011	9	39	25

The long term objective for protection of human health (120 $\mu g/m^3$) has been exceeded very clearly both in Bitola 1 and in Bitola 2 measurement stations.

Table 13. Number of hours above the ozone information threshold for the Bitola measurement stations

Number of hours above the ozone information threshold		
Year	Bitola 1	Bitola 2
2007	16	1
2008	5	12
2009	0	0
2010	0	8
2011	0	0

Table 14. Number of hours above the ozone alert threshold for the Bitola measurement stations

Number of hours above the ozone alert threshold		
Year	Bitola 1	Bitola 2
2007	1	1
2008	0	3
2009	0	0
2010	0	0
2011	0	0

The Maximum daily 8-hour mean within a calendar year for O₃ for the period 2007-2011 in Bitola stations are presented in the Figure 23.

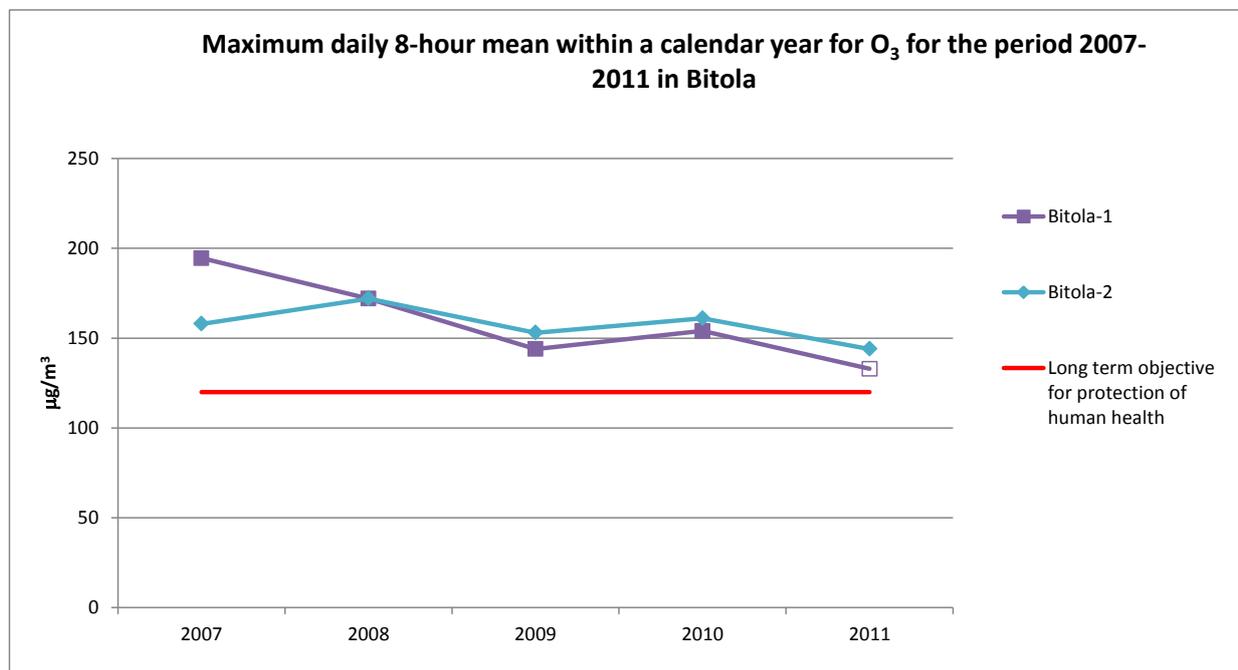


Figure 23. Maximum daily 8-hour mean within a calendar year for ozone for the period 2007 – 2011 in Bitola

From this figure we can see that the maximum daily 8-hour mean is clearly above the long term objective for protection of human health for both of the Bitola stations.

The hourly concentrations of O₃ for Bitola measurement stations in 2011 are presented in the Figure 24.

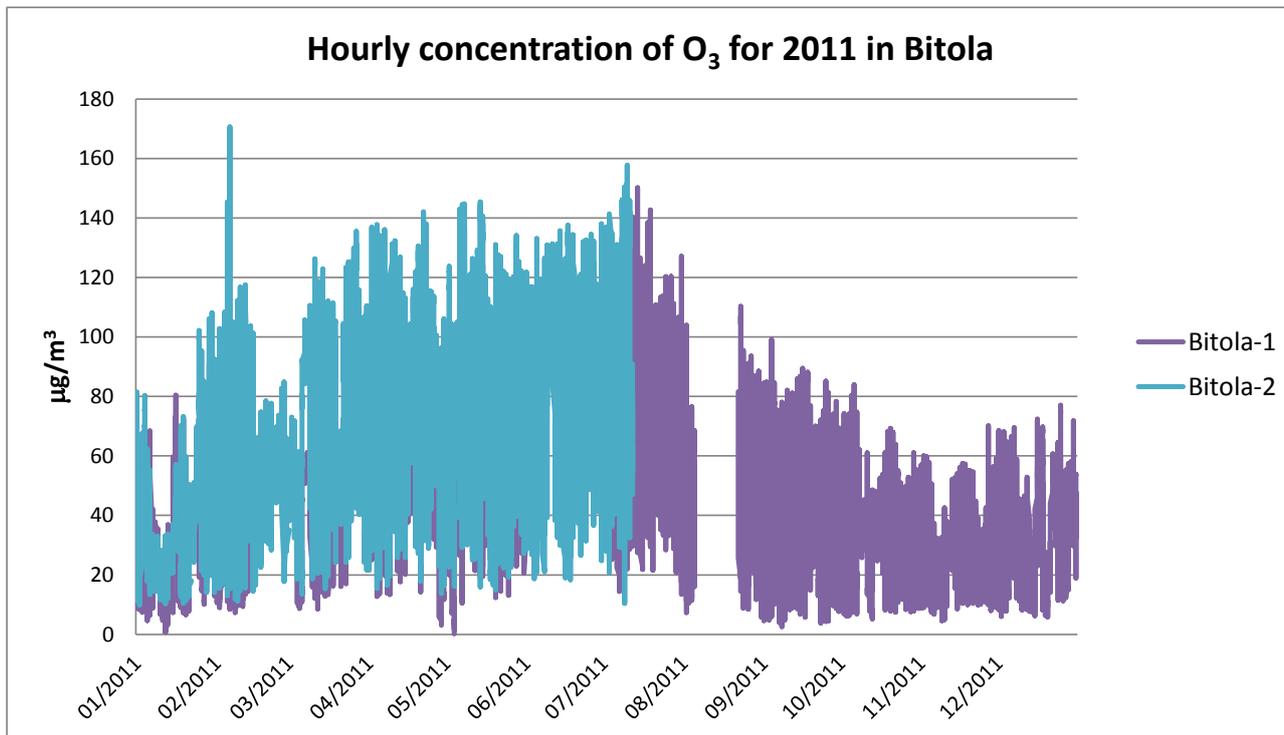


Figure 24: Hourly concentrations for ozone in Bitola stations

The maximum daily 8-hour mean for ozone for 2011 is shown in the Figure 25.

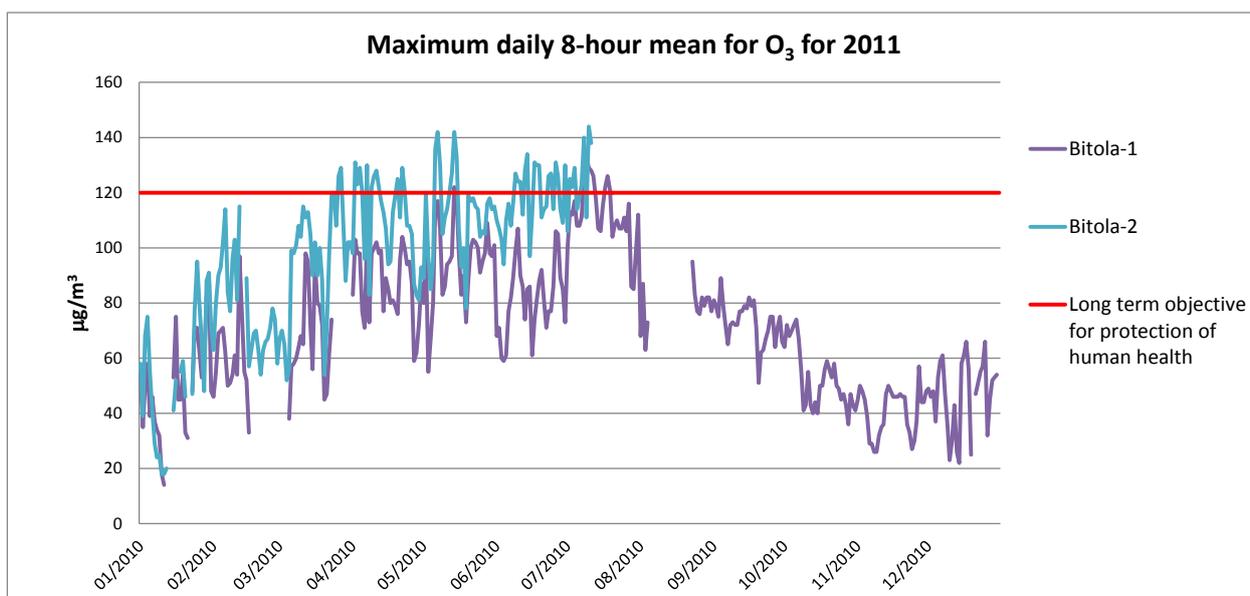


Figure 25. Maximum daily 8-hour mean for ozone for 2011

The annual average concentrations for ozone for Bitola 1 station is $51 \mu\text{g}/\text{m}^3$ and for Bitola 2 station $71 \mu\text{g}/\text{m}^3$. The maximum daily 8 hour mean for Bitola 1 station is $133 \mu\text{g}/\text{m}^3$ and for Bitola 2 $144 \mu\text{g}/\text{m}^3$. The target value is exceeded 9 times in Bitola 1 station and 39 times in Bitola 2 station.

Figure 26 shows the average annual variation of O_3 concentration in 2011 in Bitola air quality stations.

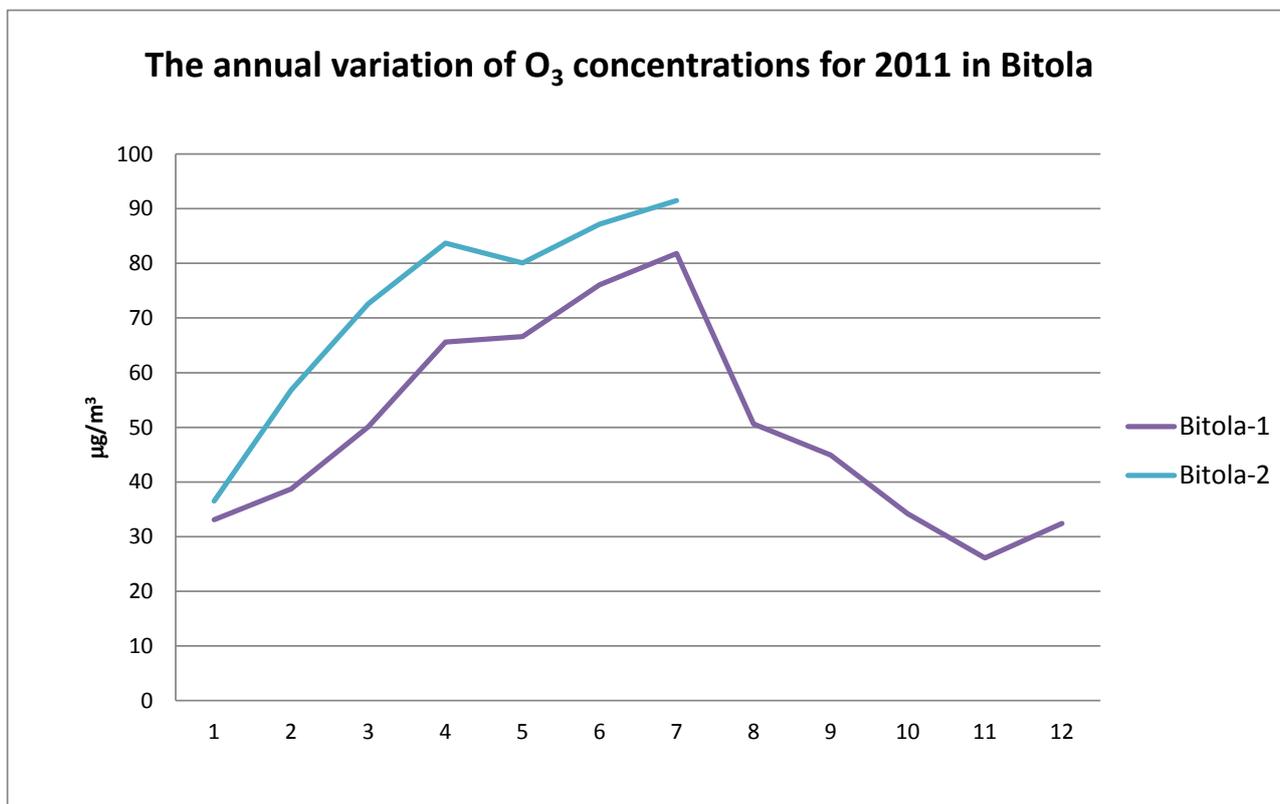


Figure 26. Annual variation of ozone concentrations for 2011 in Bitola stations.

From the figure above we can see that the concentrations are low in the winter period and are getting higher in the spring months, the maximum concentrations are in the summer period which is normal for that period of time and after that the concentrations are getting lower in the autumn. The trend of ozone in Bitola is very similar to every measuring point in the country.

6.3.3. Carbon monoxide (CO)

According to the current legislation the carbon monoxides concentrations are regulated by one limit value shown in Table 1. For the period 2007-2011, the measurements from the both Bitola stations show that there were no exceedances of the limit value except in Bitola 2 station in 2007.

The maximum daily 8-hour mean within a calendar year for CO for the period 2007-2011 in Bitola stations are presented in the Figure 27.

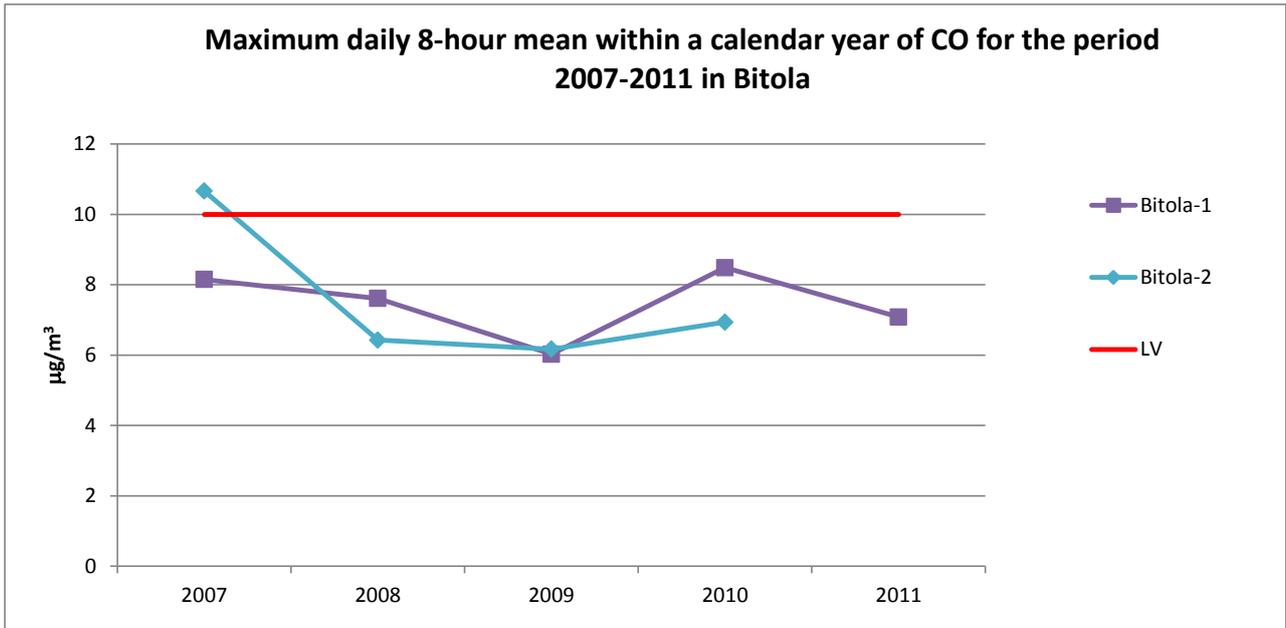


Figure 27. Maximum daily 8-hour mean within a calendar year of CO for the period 2007-2011 in Bitola.

The hourly concentrations of CO for Bitola 1 measurement station in 2011 are presented on the following figure 28. There is no data for CO from Bitola 2 station for 2011.

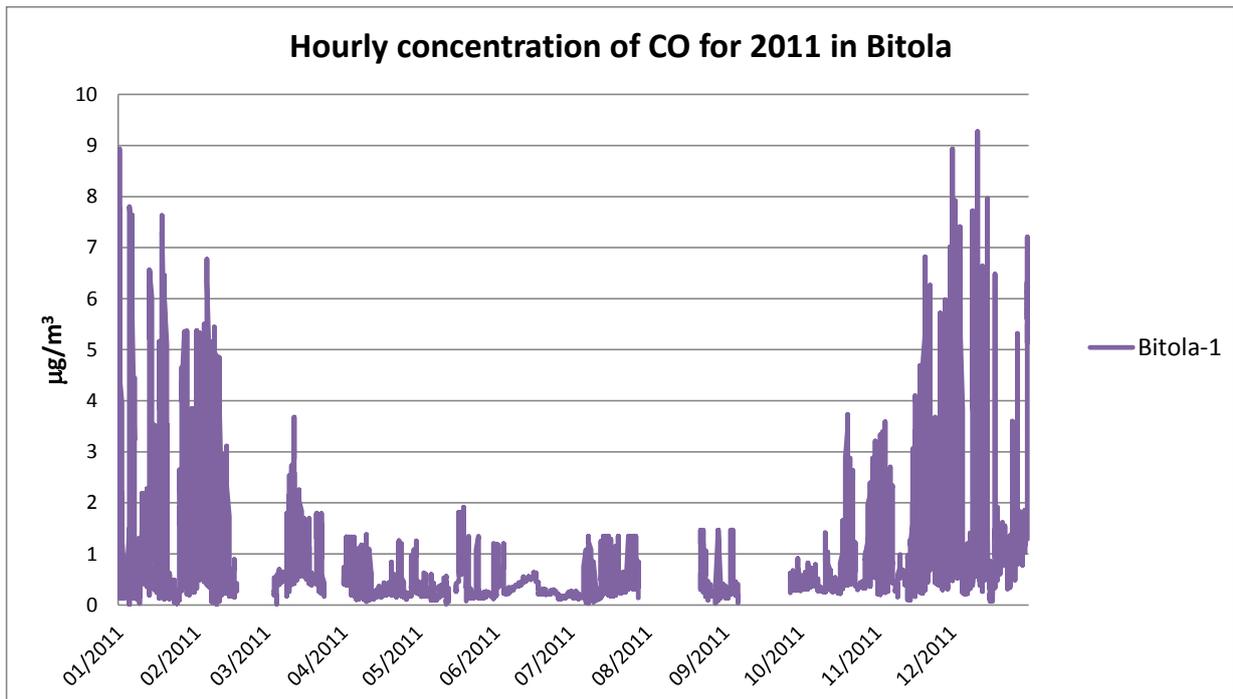


Figure 28. Maximum daily hourly mean within a calendar year of CO for the period 2007-2011 in Bitola.

The maximum daily 8-hour mean for CO for 2011 is shown in the Figure 29.

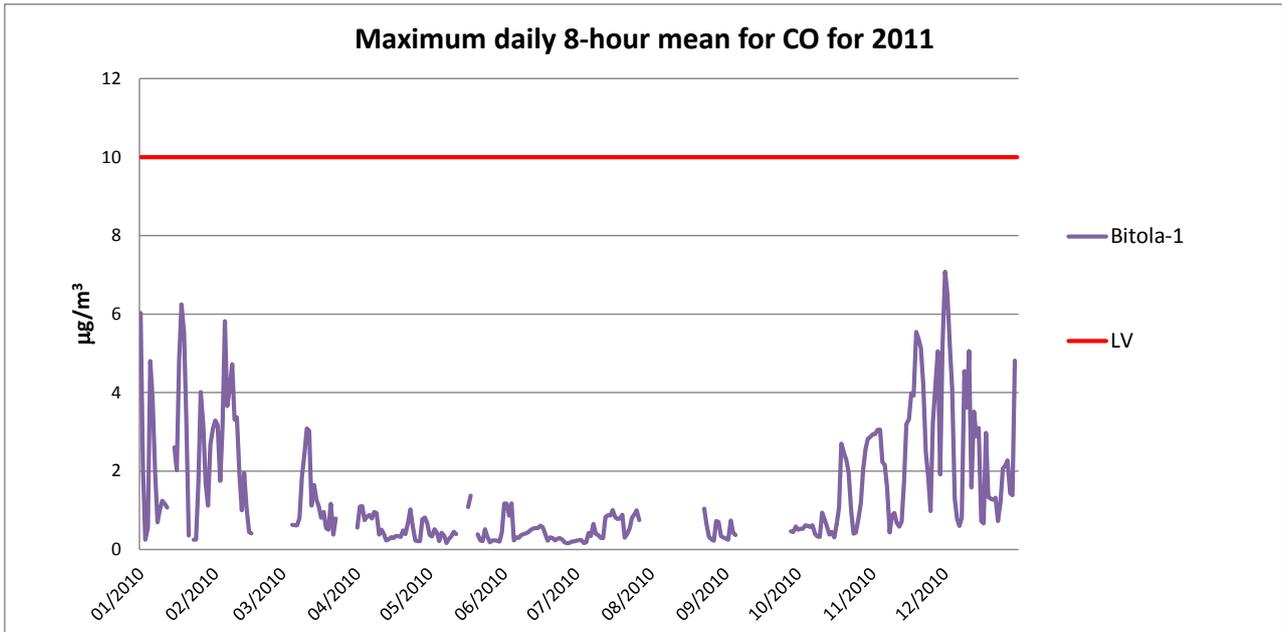


Figure 29. Maximum daily 8-hour mean for CO for 2011

The annual average concentration for Bitola 1 is $0.8 \text{ mg}/\text{m}^3$. The maximum daily 8 hour mean is $7.1 \text{ mg}/\text{m}^3$. There are no exceedances over the limit value for Bitola 1 station.

Figure 30 shows the average annual variation of CO concentration in 2011 in Bitola 1 air quality station.

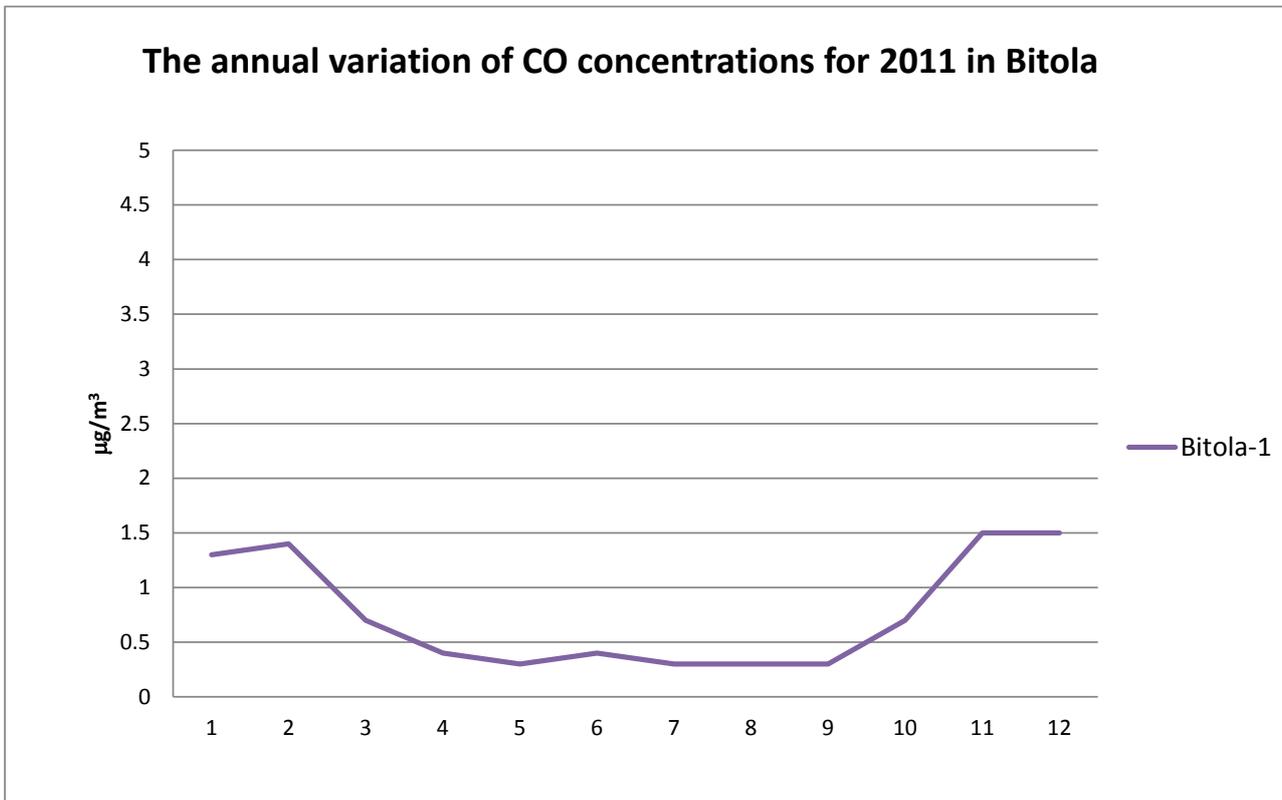


Figure 30. The annual variation of CO concentrations for 2011 in Bitola.

From the Figure 30 we can see that the concentrations of CO are higher during the winter period of the year. This can be because of the higher density of traffic, heating of the individual houses with incomplete combustion of solid and liquid fuels.

6.3.4. Benzene, PAH, lead and other metals

For benzene, PAH, lead and other metals regulated by the air quality directives 2008/50/EC and 2004/107/EC there are no measurements from Bitola. Some measurements for benzene and PAH have been made in other parts of the country during the last year(s). Based on these very preliminary measurements and general information of the concentrations of these substances it may be assumed benzene and lead concentrations don't exceed the limit values. It may also be assumed that arsenic, cadmium and nickel concentrations are below the target values. Knowledge of PAH concentrations is poor. Benzo(a)pyrene is very often connected to small-scale wood combustion, as well as benzene. So it is possible that PAH and benzene concentrations are higher in areas, where small-scale wood combustion is common.

6.3.5. Dispersion model calculations for REK Bitola

REK Bitola as the major emission source in the region and the whole country. The dispersion of nitrogen oxides and sulphur dioxide emissions from REK Bitola have been calculated using UDM-FMI dispersion model for point sources developed in the Finnish Meteorological Institute.

As the result of the dispersion modelling calculations, the SO₂ concentrations caused by the REK Bitola are shown as dispersion maps in the Figures 31-33. The maximum modelled concentrations caused by the emissions from REK Bitola are represented in the Table 15. According to the modelling calculations the maximum concentrations are below the limit values set for SO₂ concentrations. The maximum concentrations of the study area are 16 % of the critical level for vegetation protection, 25 % of the limit value for daily concentration and 44 % of the limit value for hourly concentrations.

Table 15. Maximum modelled SO₂ concentration of the study area.

	Maximum modelled concentration µg/m ³	Limit value/critical level
Annual average concentration	3.1	20 µg/m ^{3*}
Daily average concentration	31.6	125 µg/m ³ (not to be exceeded more than 3 times a calendar year)
Hourly average concentration	152.3	350 µg/m ³ (not to be exceeded more than 24 times a calendar year)

*Critical level for protection of vegetation

The highest concentrations occur approximately 2-8 km south or eastward direction from the plant (Figures 31-33). The city of Bitola is located in approximately 14 km west from the plant and due to the prevailing wind directions, the highest concentrations from REK Bitola are not occurring in the city. According to the model calculations the SO₂ concentrations caused by the emissions from REK Bitola in the city of Bitola are less than 0.5 µg/m³ for annual average, less than 10 µg/m³ for daily averages and less than 30 µg/m³ for hourly averages.

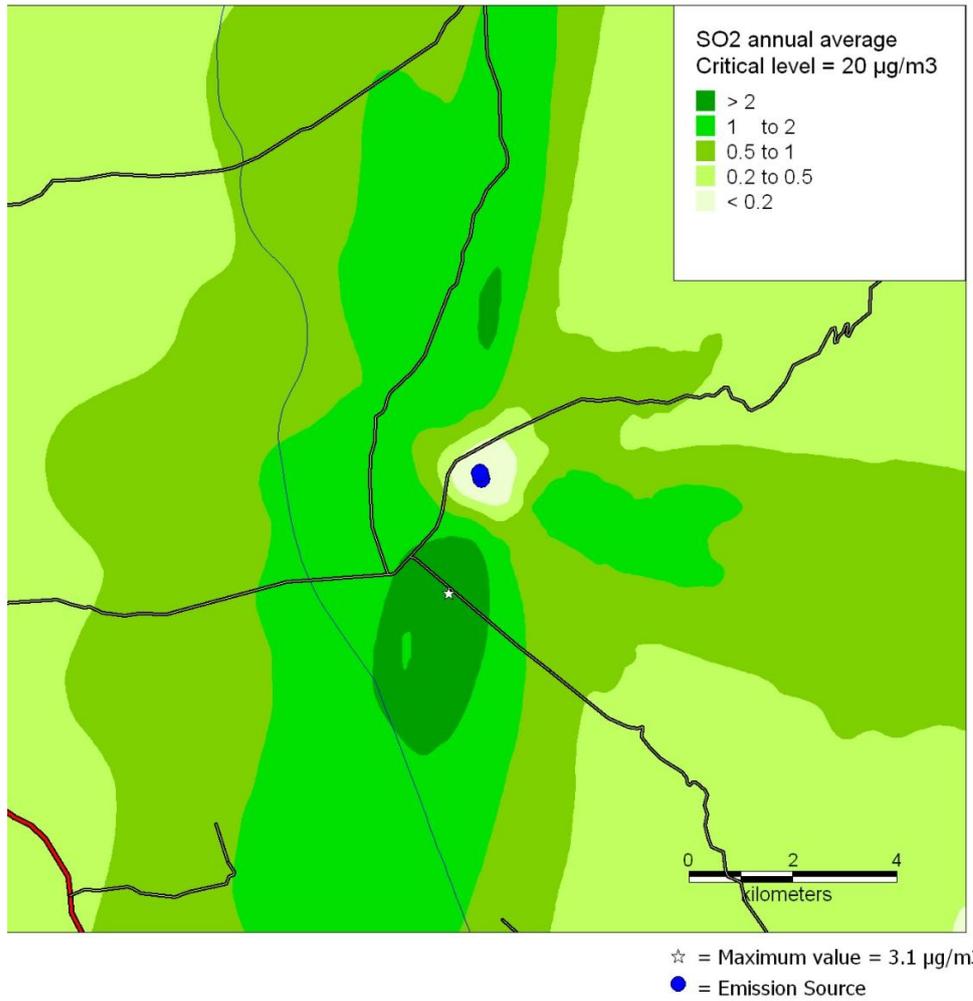


Figure 31. Annual average concentration of SO₂ caused by REK Bitola.

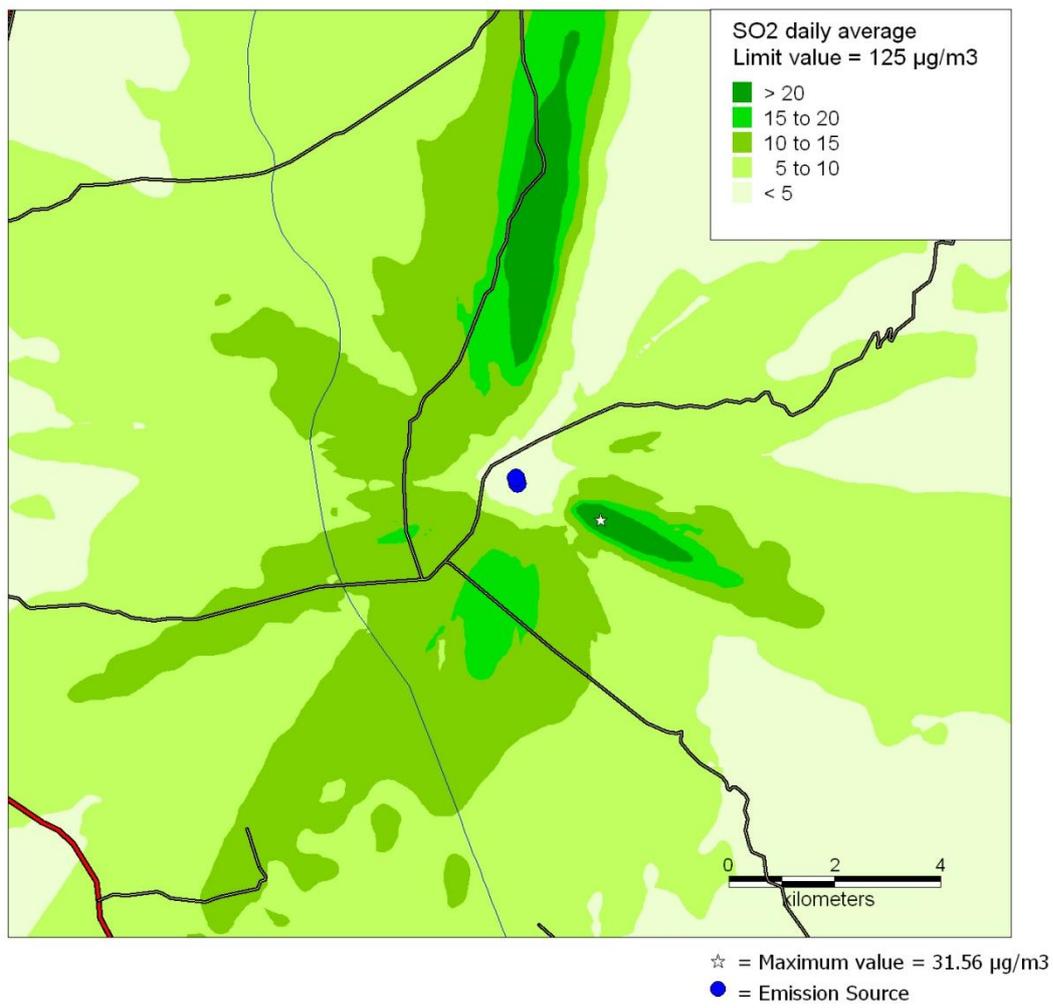


Figure 32.4th highest daily average concentration of SO₂ caused by REK Bitola.

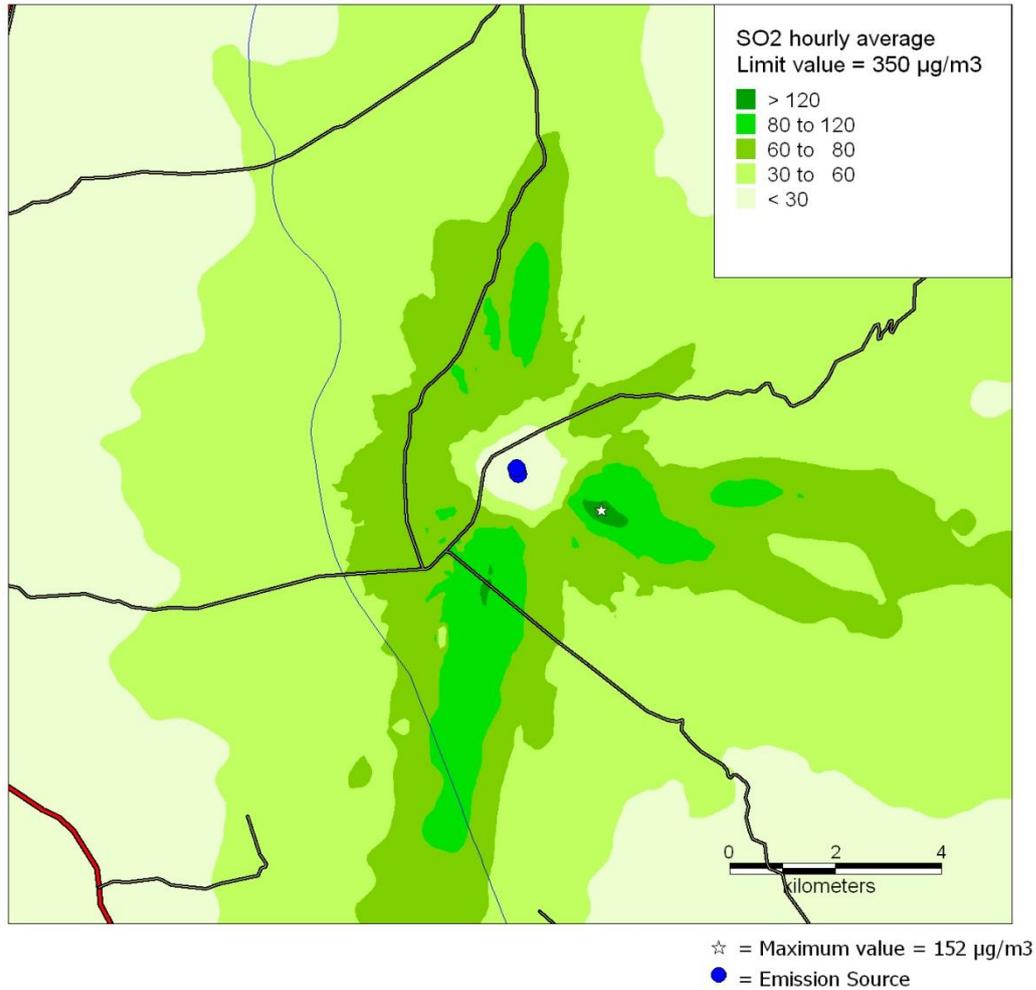


Figure 33.25th highest hourly average concentration of SO₂ caused by REK Bitola

As the result of the dispersion modelling calculations, the NO₂ concentrations caused by the REK Bitola are shown as dispersion maps in the figures 34-35. The maximum modelled concentrations caused by the emissions from REK Bitola are represented in the Table 16. According to the modelling calculations the maximum concentrations are below the limit values set for NO₂ concentrations. The maximum concentrations are 1 % of the limit value for annual average concentration and 7 % of the limit value for hourly concentration. The highest concentrations occur approximately 7 km south of the plant.

Table 16. Maximum modelled NO₂ concentration of the study area.

	Maximum modelled concentration µg/m ³	Limit value
Annual average concentration	0.3	40 µg/m ³
Hourly average concentration	14.4	200 µg/m ³ (not to be exceeded more than 18 times a calendar year)

The highest concentrations occur approximately 8 km south from the plant (Figures 34-35). The city of Bitola is located in approximately 14 km west from the plant and due to the prevailing wind directions, the highest concentrations from REK Bitola are not occurring in the city. According to the model calculations the NO₂ concentrations caused by the emissions from REK Bitola in the city of Bitola are less than 0.1 µg/m³ for annual average and less than 5 µg/m³ for hourly averages.

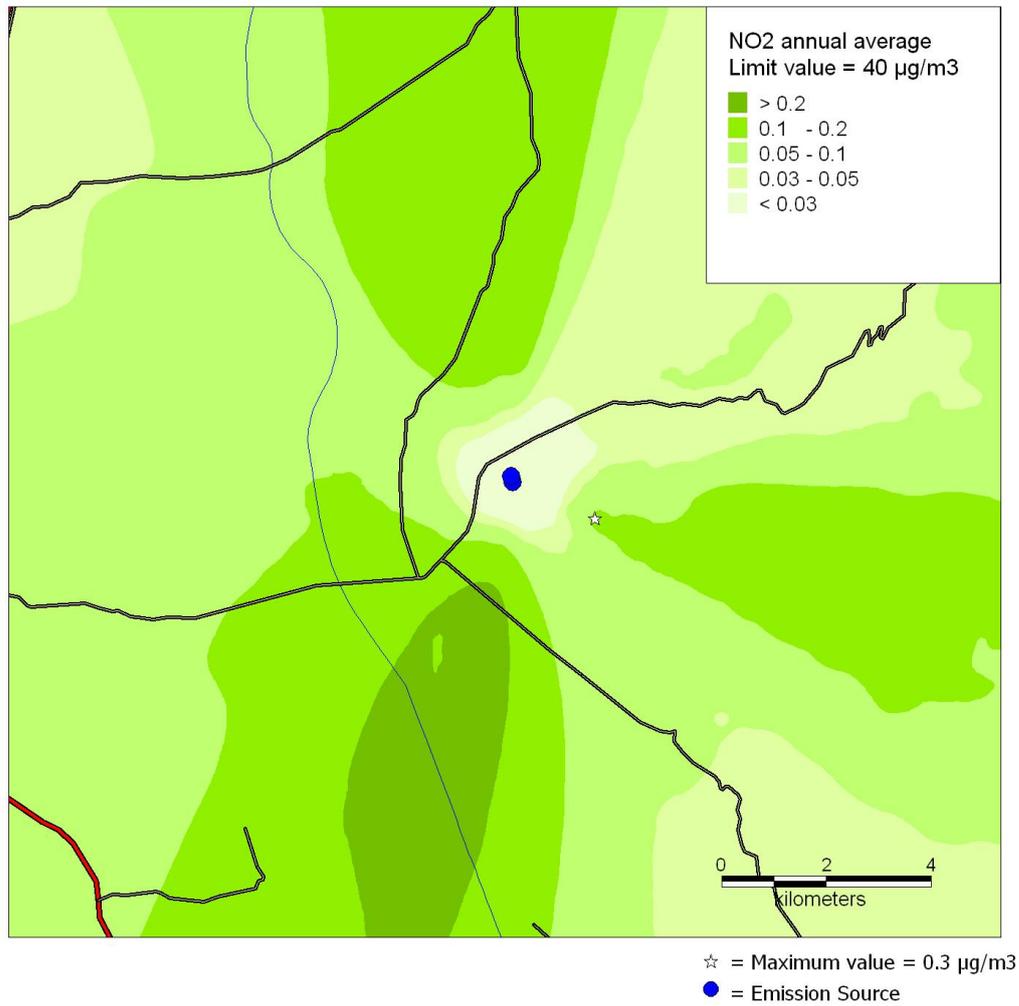


Figure 34. Annual average concentration of NO₂ caused by REK Bitola

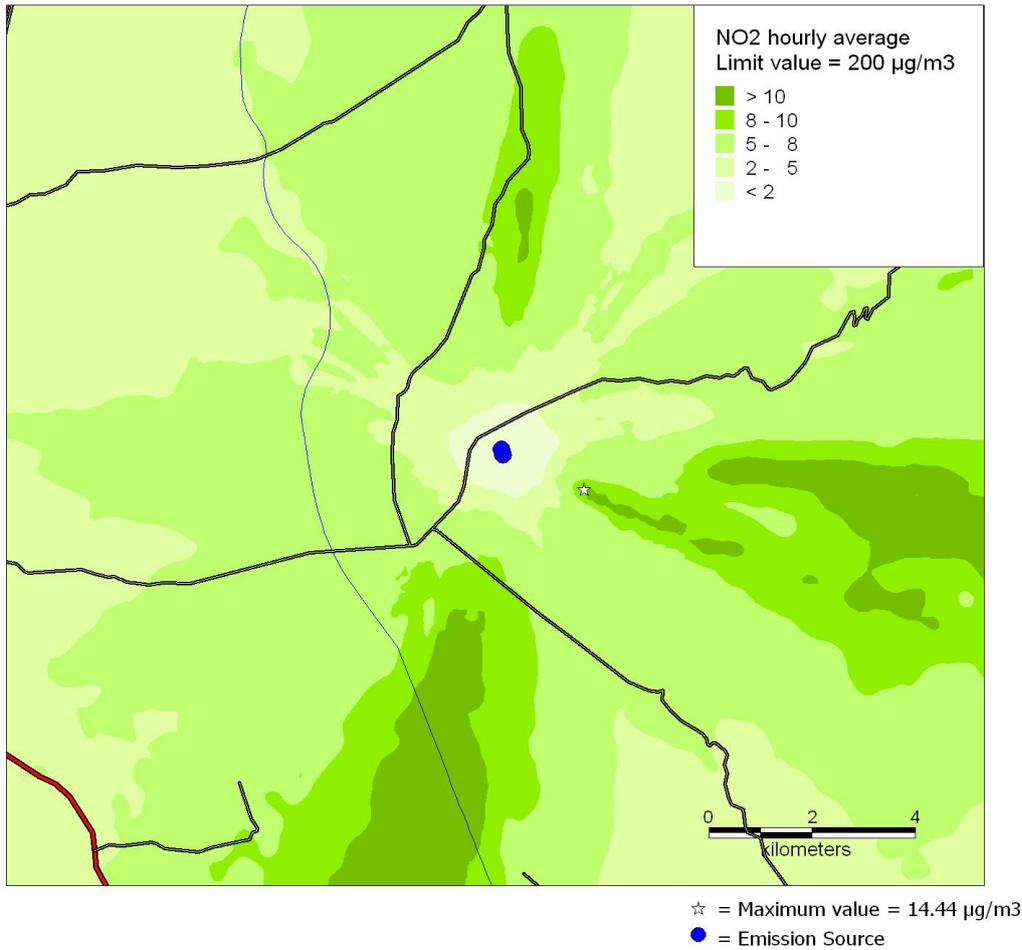


Figure 35.19th highest hourly average concentration of NO₂ caused by REK Bitola

As a conclusion based on the model calculations it can be noticed that although REK Bitola has very high emissions, its effects on SO₂ and NO₂ concentrations in the city area of Bitola remain very limited. This is mainly caused by the high emission height and the prevailing wind directions.

7. CONCLUSION OF THE AIR QUALITY IN BITOLA

7.1 Critical pollutants

This chapter points out the overall air quality in Bitola region and the critical pollutants based on the information gained from the emissions, air quality data analysis and the dispersion model calculations of REK Bitola and other assumptions made in paragraphs 5 and 6. It also includes conclusions concerning the main emission sectors that may be responsible for the prevailing air quality. These conclusions concerning the air quality and emissions are basis for the measures included in chapter 8 to reduce the ambient air concentration of the most critical pollutants.

The results of the air quality analysis are summarized in table 17.

Table 17. Overall air quality assessment of Bitola.

Pollutant	Indicator	Bitola 1	Bitola 2	Overall
NO ₂	Hourly Limit Value for the Protection of Human Health			
	Annual Limit Value for the Protection of Human Health			
SO ₂	Hourly Limit Value for the Protection of Human Health			
	Daily Limit Value for the Protection of Human Health			
CO	Maximum daily 8 hour mean			
O ₃	Information threshold (1 hour averaging period)			
	Alarm threshold (1 hour averaging period)			
	Target value for the protection of human health (Maximum daily eight-hour mean)			
	Long term objective for the protection of human health (Maximum daily eight-hour mean within a calendar year)			
PM ₁₀	Daily Limit Value for the Protection of Human Health			
	Annual Limit Value for the Protection of Human Health			
PM _{2,5}	Annual Limit Value for the Protection of Human Health			
Benzene	Annual Limit Value for the Protection of Human Health			
PAH	Annual Target Value for the Protection of Human Health			
Lead	Annual Limit Value for the Protection of Human Health			

	Limit/objective not exceeded
	Limit/objective exceeded
	Uncertain situation
	Data not available

The air quality assessment for NO₂, SO₂, CO, O₃, PM₁₀ and PM_{2.5} was carried out using the limit/target values defined by 2008/50/EC Directive and for the protection of human health. The assessment is based on the five year data from 2007 to 2011. For benzene, lead and PAH the

assessment is based on general knowledge of the concentrations of these substances in the country or the neighbouring countries.

Assessment of the critical pollutants in Bitola includes several uncertainties, which are linked to uncertainties in emission inventories and air quality measurement data. Uncertainties in emission inventories are described in chapter 5. Air quality measurement data has been validated as well as possible. However there are lacks in data representativeness: there is no acceptable data for certain periods of time and sometimes the quality of the data is poor. For some important pollutants there is very little data or no data at all from Bitola. This concerns especially PM_{2.5}, benzene and PAH.

It can be observed that the most critical pollutant in Bitola region is the suspended particulate PM₁₀ concentrations exceed both the daily and annual limit value in both measurement stations. Due to the origin and the characteristics of this pollutant a medium or long term strategy with structural measures is required in order to reduce its concentration in the atmosphere. Because it is very obvious that secondary PM₁₀ has great significance in total PM₁₀, the measures must include actions to reduce emission of the precursors of secondary PM₁₀, i.e. NO_x, SO₂, VOC ja NH₃ emissions.

There is no data available concerning the PM_{2.5} concentrations. Nevertheless due to the likely significant contribution of the PM_{2.5} fraction to the total PM₁₀, an integrated policy is needed in order to reduce both the PM₁₀ and PM_{2.5} emissions. Also the primary measurement data from Skopje suggests that the annual limit value for PM_{2.5} may exceed also in Bitola.

Concerning ozone no exceedences for the acute pollution indicators are recorded in Bitola. On the other hand the long term objective is exceeded in both station and the possibility of an exceedence of the target value should be taken into account especially for Bitola 2 measurement station. According to this situation a medium-long term strategy is needed in order to reduce the overall concentrations of this pollutant. Because ozone is just a secondary pollutant in the atmosphere, the measures to decrease ozone concentrations must concern the precursors, i.e. NO_x and VOC emissions.

For CO there has been a slight exceedence of the 8 hour limit value in 2007. The exceedence has been only very slight and after 2007 the concentrations have been below the limit value. So in this program it has been estimated that the CO levels nowadays are below the limit value and there is no need for separate measures concerning CO emissions.

Moreover it can be observed that there is no data available about lead, benzene and PAH levels in Bitola. The lack of data also concerns micropollutants arsenic, nickel and cadmium regulated by the Directive 2004/107/EC. For this reason a conservative approach is adopted, considering these pollutants as potentially critical. However it is assumed that the measures that are planned to decrease the PM₁₀ and PM_{2.5} concentrations are enough also to decrease the concentrations of these pollutants.

No exceedance of critical levels (limit values) are recorded for nitrogen dioxide, sulphur dioxide and carbon monoxide during the previous five years. So these pollutants are not classified critical in Bitola. But as mentioned above that the NO_x and SO₂ are precursors for either secondary PM₁₀

and/or O₃, they are this way included in the program. This is the reason why also the reduction of NH₃ emissions is included in the program, although otherwise they are not dealt in the program.

The air quality measurements made in two monitoring stations of Bitola indicate that the concentrations of the pollutants do not differ very much between the stations. This indicates that in many cases the air quality in the city may be affected by common emission sources. Based on this it may be assumed that almost all of the population of Bitola is exposed to the same level of pollutants and that the exceedance of limit values, especially PM₁₀, concerns the whole city area.

However it must be noticed that there is no air quality data concerning the major residential areas, where people spend most of their time of the day. The present air quality measurement stations are located either in the city centre in traffic area or in industrial area outside the city's central area.

7.2 Critical emission sectors

Because there are not significant differences between the air quality data at the two monitoring stations of Bitola, it may indicate that in many cases the air quality in the region could be affected by common emission sources. Especially in the case of PM even the back-ground concentrations can be significantly high and long-range transport may also affect on the local level.

Except for REK Bitola no dispersion model calculations are available, which could show in more detailed, which emission sources are responsible for the highest concentrations of pollutions in the city area. Because this lack of emission source apportionment it has not been possible to focus the measures in chapter 7 to certain emission sectors particularly. The importance of different emission sectors is mainly based on the assumptions made in chapter 5, where the results of the emission inventories are presented. However in the same time the uncertainties concerning the emission inventories should be taken into consideration. It should also be noticed that the impact of long-range transport of pollutants has not been able to evaluate in this context.

8. POLICIES AND MEASURES TO IMPROVE AIR QUALITY IN BITOLA

8.1. Objectives of the program

The overall objective of this program is to improve the air quality in Bitola so that human health and the environment are protected according to the air quality legislation. In order to fulfil the overall objective three further types of objectives are defined:

- Strategic Objectives;
- Specific Objectives;
- Common Objectives.

Long-term strategic objectives are strictly related to exceedances of limit and target values defined in the air quality legislation. The air quality assessment strongly indicates that it will require very strong and long-lasting measures to decrease PM₁₀ concentrations dramatically, and therefore for PM₁₀ there is also a **short-term strategic objective**. The strategic objectives of the program are presented in table 18.

Table 18. Strategic objectives of the program

Long-term strategic objectives
PM ₁₀ concentrations do not exceed the daily or annual limit value
O ₃ concentrations do not exceed the long-term target value for the protection of human health
Short-term strategic objective
PM ₁₀ concentrations start to decrease gradually

Specific objectives define the emissions that need to be reduced to meet the strategic objectives. Concerning PM₁₀, due to the relevance of the secondary fraction to the total concentration of particulate matter, an integrated approach is required in order to reduce the level of PM₁₀ in the atmosphere. For this reason, in order to fulfil the PM₁₀ limit values, the emission reduction of also other pollutants (so called precursors) is needed. Table 19 shows the specific objectives for the PM₁₀ level reduction. In the specific objectives it is also included PM_{2.5}, although there so far is no evidence that the limit values of PM_{2.5} surely exceed in Bitola. But because measures that affect PM₁₀ emissions also usually affect PM_{2.5} emissions, these two PM fractions are treated together.

Table 19. Specific objectives for PM₁₀ concentration reduction

Specific Objective	PM₁₀ fraction covered
PM ₁₀ emission reduction	Primary particulate matter
PM _{2.5} emission reduction	
Nitrogen Oxides (NO _x) emission reduction	Secondary particulate matter
Sulphur Oxides (SO _x) emission reduction	
Volatile Organic Compounds (VOCs) emission reduction	
Ammonia (NH ₃) emission reduction	

Concerning ozone, due to the secondary origin of this pollutant, the specific objectives are focused on the emission reduction of ozone precursors. Table 20 shows the specific objectives for the ozone level reduction.

Table 20. Specific objectives for ozone concentration reduction

Specific Objective
Nitrogen Oxides (NO _x) emission reduction
Volatile Organic Compounds (VOCs) emission reduction

Common objectives are intended to enhance e.g. the air quality assessment in Bitola, public awareness of air quality and air quality information. These objectives are presented in Table 21.

Table 21. Common objectives of the air quality plan

Common objectives
<ul style="list-style-type: none">- Assuring good maintenance and QC/QA of the monitoring network in Bitola- assuring that emission inventories are representative and comprehensive- gaining information about the concentration of pollutants not yet monitored in the area, especially PM_{2.5}, benzene and PAH- promoting public awareness of local air quality and factors that affect it- promoting the integration between air quality and other environmental policies- promoting the public participation to the air quality issues.

8.2. Measures to improve air quality

8.2.1. General

The measures to improve local air quality in Bitola that are presented here are based on the emission inventories and air quality data assessment. Because it has not been possible to assess the effects of the different emission sectors on local air quality, the measures cover all the major emission sectors. On the other hand that is also the reason, why most of the measures are presented in a quite general level. The measures presented here need to be defined later in the planning processes. Also the costs and responsible authorities must be defined later when the measures are in a more detailed level.

The measures are divided into three categories, short-term, long-term and common measures. The short-term measures are ones that can be put into force quite quickly and without significant extra resources and funding. The short-term measures are important so that some progress in air quality improvement issues can be taken and seen at the local level in a short time.

Most of the measures to decrease the emissions and the concentration of the critical pollutants take a longer time and need still planning and also funding has to be guaranteed. So it is obvious that the implementation of these measures takes very easily at least a few years. That is why they are called as long-term measures.

The common measures are activities that must be taken to improve local air quality assessment and also to promote public awareness of air quality in general. Many of them form a basis for a continuous and effective air quality policy in general level.

Many of the measures presented here will potentially affect emissions of several pollutants at the same time. At this phase this can be considered useful, because the measures at the first point are quite general and because the resources and possibilities at the local level are limited. Later on when the measures concerning single emissions are more detailed and their feasibility is better known, focus of the measures can be more specific.

The measures to improve air quality in Bitola by local level activities are listed below. A detailed description of the measures is in Annex 1.

Short-term measures

1. Improved supervision of regulations concerning waste burning, burning of farming residues and wild fires;
2. Public information of pollution caused by waste burning, burning of farming residues and wild fires;
3. Information of public in air quality issues;
4. Guidelines for the use of wood in small ovens;
5. Improved dust removal at construction and demolition sites;
6. Improved street cleaning;
7. Promotion of energy efficiency.

Long-term measures

8. Up-to date emission limits at national level taking into account for example the requirements from the industrial emission directive ;
9. Application of BAT and BEP;
10. Regular emission monitoring and reporting and supervision of major industrial plants and power plants;
11. Application of district heating in Bitola;
12. Promotion the use and availability of clean fuels;
13. Promotion of hydro power, solar energy, wind energy and geothermal energy;
14. Implementation of energy efficiency measures;
15. Environmental friendly traffic system in the city centre of Bitola;
16. Digestion or combustion of biodegradable waste and combustion of non-recyclable dry waste.

Common Measures

17. Integration of air quality improvement to other policies;
18. Improved maintenance and improvement of air quality measurements;
19. Accurate and up-to date emission inventories;
20. Dispersion model calculations made for each emission sector;
21. Inclusion of Environmental Impact Assessment (EIA) in the main land use and traffic planning processes.

9. CONCLUSIONS AND RECOMMENDATIONS

Local air quality plan is a document, which describes the targets for air quality improvement in a region or a city. The targets are the basis for local measures to improve air quality and to decrease emissions of the major pollutants. The plan is primary based on assessment of local air quality and the major emission sectors. The plan may be considered as a strategy for the air quality improvement, but to be effective it should also contain real actions.

This program for improvement of air quality in Bitola is based on the best available data of the air quality situation in Bitola and its adjacent surrounding. As described in the text the assessment of local air quality and the emissions includes many uncertainties, which have to be taken into account when implementing the plan and the measures. It also has to be remembered that at the same time that this plan was formulated, national programs and targets for air quality improvement were in consideration. So in the future there may be a need to harmonize the national, regional and local measures in a more detailed way.

Also the environmental administration and its policies and legislation are still developing and that may in the long run give a need to analyze the measures for air quality improvement in a more efficient way.

However despite of these uncertainties this pilot program should be discussed and adopted at the local level in Bitola and some decisions should be made in order to define how to start implementing the measures included in the program. As soon as the knowledge of the air quality situation and the emissions and effectiveness of the different measures increase, the local administration should be prepared to evaluate the program and to specify the targets and the

measures. It is also important to start to clarify funding of the measures and other possibilities to implement the measures in real life.

Because of many uncertainties mentioned above the measures in the program are divided into short-term and long-term measures along with some common measures. Because many of the long-term measures will need time and more detailed planning etc., it would be important to start to implementing the short-term measures as soon as practically possible. Implementation of the long-term measures can start after they have been planned detailed enough and when their implementation is guaranteed also in other ways (e.x. necessary funding is decided).

A periodic check of the implementation of the measures should be done regularly at the local level with the Ministry supervision. The coordination between local and central level administration is recommended in order to check the effectiveness of the measures adopted in a particular zone and to assess the impact of each action undertaken for the air pollution reduction. Moreover the exchange of information between the local and the central level is fundamental also in order to synchronize the measures at local and at national level.

For this purpose some **basic briefings** between the Ministry and the local administration are recommended, for instance every year, in order to point out how the activities are affecting. During these meetings the following information should be shared concerning:

- the overall situation concerning the planned activities reported by the local staff;
- the existence of possible problems, related to the implementation of the measures, due to different reasons (economic, logistic, social, etc.);
- the valuable opinion of the local experts concerning the measures in progress and their effectiveness at the local level;
- the implementation of measures at central level (e.g. emissions reduction, update of the emission inventories, results of modelling studies, analysis of the air quality dataset).

The results of the basic briefings should be taken into account in order to solve in the short time some minor problems related to the measures and to prepare the **plan review**. According to the characteristics of the present plan (a pilot program), a first review of the document is strongly recommended in a relatively short period, after **two years (2014)**. During this period it should be possible to gain enhanced information concerning the emission sources in Bitola. Moreover some studies still in progress should be completed (dispersion modelling etc.). According to this more detailed information an improved assessment process could be made in order to define an updated set of structural measures to be adopted in the medium-long period for the air pollution improvement.

The plan review process could be structured in the following steps:

1. Update of air quality data and emission information: this activity concerns the chapters 5 and 6 of the present plan, with possible modifications in chapter 7. The role of MEPP in the information update process is fundamental. Concerning the emissions, a comparison between the original situation and the future situation is recommended.
2. Rethinking of the possible measures to be implemented: this activity is extremely important and a joint work between local and central experts is strongly recommended. In the measures rethinking process the following aspects should be taken into account:
 - Conclusions gained by the first reviewing activity (assessment of the air quality situation, identification of the most critical pollutants, definition of the main emission sources, definition of the main intervention sectors);
 - Assessment of the effectiveness of the measures. The experience gained during the 2012-2014 period will be very valuable in order to assess the role of the measures adopted to improve the air quality. The opinion of the local administration in Bitola

- will be essential in order to evaluate the real contribute of each measure, its social and economical impact and the related benefits;
- Coordination of the national and local measures. The reviewed local plan should be coordinated with the national programme for emission reductions. The local air quality plan should represent a sort of conformation of the national guidelines for the air quality improvement at the local level. The coordination between national and local scale measures is a basic requirement in order to reduce effectively some critic pollutants like PM and ozone.
3. Review of the key measures to be adopted: this final step should be made taking into account all the conclusions collected in the previous steps. The key measures should be defined (or confirmed if already adopted in the original plan) according to the emission targets, the estimated effectiveness, the funds needed for the implementation etc. Especially for the local measures the role of the local administration in the definition the measures is central. Moreover each measure should be described in a dedicated table as made in the present document. The information about the responsible authority, the implementation time, the estimated costs and air quality benefits must be included in the tables.

After the first review of the plan, the ordinary check of the activities is strongly recommended every 6 months and the plan should be in force for **5 years** before starting a new reviewing process.

ANNEX 1: DESCRIPRION OF AIR QUALITY IMPROVEMENT MEASURES

Short-term measures

MEASURE NO	1
MEASURE NAME	Improved supervision of regulations concerning waste burning, burning of farming residues and wild fires
Description of the measure	There are regulations and guidelines concerning waste burning and burning of farming residues and also concerning wild fires. However these activities are still quite common and occasionally may affect local air quality quite much. Local authorities should pay more attention to these activities and take legal actions against performers of these activities.
Objective of the measure	To decrease diffuse emissions at local level. These emissions are especially connected to back-ground concentrations of PM ₁₀ .
Target pollutant	Primary pollutants are PM ₁₀ and PM _{2.5} , but also VOCs and PAHs are affected.
Change in concentration	In general level the impact is small, but locally may be significant at certain periods of time, and especially for acute episodes of pollution.
Air quality benefits	Small or medium
Other impacts	Improves general awareness of citizens in air quality issues.
Implementation	
Responsible authority	Municipal environmental unit
Time of implementation	Immediately
Costs	Needs no extra funding. At the contrary possible fines collected could improve the local level fund for environmental issues.
Other requirements	Requires some time resources at the municipal level.

MEASURE NO	2
MEASURE NAME	Public information of pollution caused by waste burning, burning of farming residues and wild fires
Description of the measure	There are regulations and guidelines concerning waste burning and burning of farming residues and also concerning wild fires. However these activities are still quite common and occasionally may affect local air quality quite much. To raise public awareness in these issues local information campaigns could be organized. These information activities support measure 1.
Objective of the measure	To decrease diffuse emissions at local level. These emissions are especially connected to back-ground concentrations of PM ₁₀ .
Target pollutant	Primary pollutants are PM ₁₀ and PM _{2.5} , but also VOCs and PAHs are affected.
Change in concentration	In general level the impact is small, but locally may be significant at certain periods of time, and especially for acute episodes of pollution.
Air quality benefits	Small or medium
Other impacts	Improves general awareness of citizens in air quality issues.
Implementation	

Responsible authority	Municipal environmental unit
Time of implementation	Immediately. It is beneficial if the information campaigns are carried out at the same time as the measure 1.
Costs	Mainly minor material costs
Other requirements	Information campaigns need careful planning to be efficient.

MEASURE NO	3
MEASURE NAME	Information of public in air quality issues
Description of the measure	General information of air pollutants, their origin, their effects and ways to avoid emissions can be given to citizens and also to companies. It is also important to inform, where one can find data of local air quality, especially after the national air quality portal is in use. Information can be delivered through media (newspapers, radio, TV), in internet, in schools etc.
Objective of the measure	Aim is to improve citizen's general knowledge of air quality issues.
Target pollutant	All
Change in concentration	Small
Air quality benefits	Small in short time scale, but can be larger in long term
Other impacts	At the same time raises public awareness of environmental issues in general
Implementation	
Responsible authority	Mainly local environmental unit. But support must be given also from national level, especially in order to coordinate similar initiatives in different parts of Country.
Time of implementation	1-2 years
Costs	Needs some funding to produce information material.
Other requirements	It would be useful to produce material for the whole country at the same time.

MEASURE NO	4
MEASURE NAME	Guidelines for the use of wood in small ovens
Description of the measure	Domestic heating is one of the major emission sectors in Bitola and the use of wood seems to be an important source for PM emissions. To reduce emissions it is important that combustion circumstances are as good as possible and that the wood used is of good quality. Information and guidelines concerning domestic heating units and especially the use of wood is an important way to guarantee that the emissions are as low as possible.
Objective of the measure	To improve air quality in the central parts of the city of Bitola, especially in residential areas.
Target pollutant	PM ₁₀ and PM _{2.5} , but also benzene and PAHs are affected.
Change in concentration	Medium

Air quality benefits	Medium
Other impacts	
Implementation	
Responsible authority	Local environmental unit and/or the municipality of Bitola in general, but support should be given also from national level
Time of implementation	1-2 years
Costs	Needs some funding to produce information material
Other requirements	It would be useful to produce material for the whole country at the same time

MEASURE NO	5
MEASURE NAME	Improved dust removal at construction and demolition sites
Description of the measure	High concentrations of PM ₁₀ are a common air quality problem in Bitola. Dust emissions from local construction and demolition sites may be a significant local emission source, although the impacts may be temporary at each site.
Objective of the measure	Aim is to reduce local PM ₁₀ concentrations in the city area.
Target pollutant	PM ₁₀
Change in concentration	Locally large, regionally small
Air quality benefits	Locally large, regionally small
Other impacts	
Implementation	
Responsible authority	Local environmental unit, Municipality of Bitola, construction and demolition companies
Time of implementation	Immediately
Costs	Costs for dust removal are generally low
Other requirements	May need some supervision by local authorities

MEASURE NO	6
MEASURE NAME	Improved street cleaning
Description of the measure	High concentrations of PM ₁₀ are a common air quality problem in Bitola. Dust emissions from street and pavement surfaces and also from courtyards (resuspension) may be a significant local emission source, although the impacts may be temporary at each site.
Objective of the measure	Aim is to reduce local PM ₁₀ concentrations in the city area.
Target pollutant	PM ₁₀
Change in concentration	Locally even large, regionally small
Air quality	Locally even large, regionally small

benefits	
Other impacts	May improve the general cityscape.
Implementation	
Responsible authority	Local environmental unit, Municipality of Bitola, private companies, estate owners
Time of implementation	Immediately
Costs	Moderate (for cleaning equipment and work)
Other requirements	May need some supervision by local authorities

MEASURE NO	7
MEASURE NAME	Promotion of energy efficiency
Description of the measure	Better energy efficiency generally reduces all emissions to air. Promotion of energy efficiency at the local level may at first mean e.g. information campaigns to citizens, estate owners and companies. Some benefits may be gained, if new or repaired buildings are so called low-energy or passive buildings.
Objective of the measure	Aim is to generally affect so that energy consumption e.g. in buildings is low and by that mean also the emissions to air are smaller.
Target pollutant	All
Change in concentration	Small at first, even large in the long-term
Air quality benefits	Small at first, even large in the long-term
Other impacts	Reduces the need of natural resources (fossil fuels), promoting also a campaign for the sustainable use of energy with money saving for citizens
Implementation	
Responsible authority	Municipality of Bitola, but needs support from the national level
Time of implementation	1-3 years
Costs	Medium at the start
Other requirements	General knowledge of energy efficiency issues must be improved. Personal may need training and some information material must be prepared.

Long-term measures

MEASURE NO	8
MEASURE NAME	Up-to date emission limits for IED installations and SME's
Description of the measure	Usually the most efficient way to reduce emissions from industry and energy production is to apply stricter emission limits. The major industrial and energy plants in Bitola do not have up-to date emission limits at the moment, because so far they don't have environmental permits according to the present legislation. Authorities in the permit processes must apply new and modern emission limits, which are based on the most recent guidelines or limit values.
Objective of	Aim is to reduce the emissions to a level, which is in accordance with the present

the measure	legislation and guidelines, and take into account that the emissions do not cause harmful effects at the local level.
Target pollutant	All, but especially PM ₁₀ , NO _x , SO ₂ and VOC.
Change in concentration	Varies from installation to installation, but locally may be even medium.
Air quality benefits	Varies from installation to installation, but locally may be even medium.
Other impacts	
Implementation	The measure concerns mainly REK Bitola, the sugar and yeast factory, the asphalt stations and the printing house in Bitola.
Responsible authority	National and local environmental administration responsible for permits
Time of implementation	2-5 years
Costs	Direct costs minimal. Indirect costs for industry may be significant. To this end a progressive improvement plan should be arranged between local administration and companies in order to improve progressively the plants, diluting the costs over a longer period.
Other requirements	Implementation of the new limit values for emissions considering time-table must be realistic, but also short enough.

MEASURE NO	9
MEASURE NAME	Application of BAT and BEP
Description of the measure	Best Available Technology (BAT) and Best Environmental Practice (BEP) are in addition to permits an important method to guarantee that emission levels of industrial and power plants and other installations are as low as feasible. BAT and good maintenance practices can be applied in environmental permits, but also separately. This measure is in connection to measure 8.
Objective of the measure	Aim is to reduce the emission limits to a level which is technically and economically feasible at each industrial sector.
Target pollutant	All, but especially PM ₁₀ , NO _x , SO ₂ , VOC and NH ₃ (concerning farming).
Change in concentration	Varies from installation to installation, but locally may be even medium.
Air quality benefits	Varies from installation to installation, but locally may be even medium.
Other impacts	
Implementation	
Responsible authority	National and local environmental administration responsible for permits and supervision of installations.
Time of implementation	2-5 years
Costs	Direct costs minimal. Indirect costs for industry may be significant.
Other requirements	Requires follow-up of the BAT and BEP in different sectors.

MEASURE NO	10
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MEASURE NAME	Regular emission monitoring and reporting and supervision of major industrial plants and power plants
Description of the measure	Appropriate emission monitoring and reporting is one basis for reliable emission surveillance and emission data base. It is also important that major industrial and power plants that have influence on local air quality are inspected regularly so that e.g. it can be guaranteed that the emission limits are not exceeded.
Objective of the measure	To guarantee that the emissions are not exceeding the limit values and that the emission data is reliable.
Target pollutant	All
Change in concentration	Small
Air quality benefits	Medium
Other impacts	Provides reliable emission data for air quality planning
Implementation	
Responsible authority	National and local environmental administration responsible for supervision of installations.
Time of implementation	2-3 years
Costs	Direct costs minor.
Other requirements	Supervising personnel need to have required knowledge

MEASURE NO	11
MEASURE NAME	Application of district heating in Bitola
Description of the measure	In previous years there has been in Bitola a limited district heating network. REK Bitola could provide to the city of Bitola steam heating, which would replace most of the small ovens and boilers now used for heating of the buildings. Feasibility studies have been made of this possibility.
Objective of the measure	To replace most of the small ovens and boilers that now are used for heating of the buildings.
Target pollutant	Especially PM ₁₀ , PM _{2,5} , NO _x and SO ₂ , but also VOCs and PAHs are affected.
Change in concentration	Large
Air quality benefits	Large
Other impacts	Operating efficiency of the REK Bitola power plant is raised significantly.
Implementation	
Responsible authority	REK Bitola and the Municipality of Bitola
Time of implementation	
Costs	Significant
Other requirements	To be efficient the measure requires that a major part of the individual residential, public, commercial and industrial buildings are connected to the district heating network. The implementation of the measure may need some subsidize from the municipality.

MEASURE NO	12
MEASURE NAME	Promotion the use and availability of clean fuels
Description of the measure	The municipality of Bitola could promote the use and availability of clean fuels (low-sulphur, low-VOC, gas, biogas) in its own activities (heating of municipal buildings, use of cars). It also could require in contracts with the private companies that they e.g. use clean fuels in their own equipment and vehicles.
Objective of the measure	The decrease emissions especially from machinery, traffic and heating. In this way public administration may at the local level give an example to private sector of environmentally friendly activities.
Target pollutant	All
Change in concentration	Small
Air quality benefits	Small at start, may be greater later on.
Other impacts	
Implementation	
Responsible authority	The Municipality of Bitola
Time of implementation	2-5 years
Costs	Medium
Other requirements	It must be guaranteed that clean fuels are available at reasonable price and that the vehicles and equipment are able to use the modern fuels.

MEASURE NO	13
MEASURE NAME	Promotion of hydro power, solar energy, wind energy and geothermal energy
Description of the measure	The Municipality of Bitola could promote the use of hydro power, solar energy, wind energy and geothermal energy in its own activities (heating of municipal buildings and electricity used in municipal activities). It also could also promote these environmental friendly energy sources in general level (e.g. public information, energy efficiency consultation).
Objective of the measure	The decrease emissions from energy use. In this way public administration could also at the local level give an example to private sector of environmentally friendly activities.
Target pollutant	All
Change in concentration	Small at first. If changes in the use of fossil fuels are large, also changes in concentrations of pollutants may be significant later on.
Air quality benefits	Small at start, may be greater later on.
Other impacts	Also other environmental benefits may be gained at the same.
Implementation	
Responsible authority	The Municipality of Bitola

Time of implementation	2-5 years
Costs	May vary a lot depending on the scale.
Other requirements	Alternative energy sources must be available at a reasonable price. Measures may need public financial support or other forms of public support.

MEASURE NO	14
MEASURE NAME	Implementation of energy efficiency measures
Description of the measure	Instead of just general measures to decrease energy efficiency in general level, more detailed measures may be taken to increase energy efficiency more specifically, e.g., in public buildings, in the use of electricity and in transportation. These measures could be energy efficiency surveys, replacement of old equipment with modern one, new lightning systems etc.
Objective of the measure	By decreasing the use of energy also the emissions of all major pollutants decrease.
Target pollutant	All
Change in concentration	Small at first, but may be significant later on, if the measures are effective and comprehensive.
Air quality benefits	Small at first, but may be significant later on.
Other impacts	By decreasing the use of energy also economical benefits may be achieved.
Implementation	
Responsible authority	The Municipality of Bitola
Time of implementation	2-5 years
Costs	May vary a lot from small to significant depending on the different activities taken.
Other requirements	Requires systematic work to find out the possibilities to decrease energy use and to find out more energy efficient solutions. Activities require funding.

MEASURE NO	15
MEASURE NAME	Environmental friendly traffic system in the city centre of Bitola
Description of the measure	Promotion of public transport, promotion of walking and cycling, effective parking policy and ENZ (environmental neutral zones) in the central city area of Bitola could decrease emissions from traffic, mainly private cars. The aim of the measures is to decrease traffic volumes in the city.
Objective of the measure	By decreasing traffic in the city area also the emissions to air decrease.
Target pollutant	All but especially NO ₂ and PM.
Change in concentration	Medium if the measures decrease traffic significantly.
Air quality benefits	Medium, but can be large in certain parts of the city.
Other impacts	The same measures usually decrease traffic noise.
Implementation	

Responsible authority	The Municipality of Bitola
Time of implementation	2-5 years
Costs	Measures to improve public transport may be cost significantly, but on the other hand e.g. measures concerning parking policy are quite cheap to implement.
Other requirements	Measures concerning traffic require careful planning and also funding needs to be guaranteed.

MEASURE NO	16
MEASURE NAME	Digestion or combustion of biodegradable waste and combustion of non-recyclable dry waste
Description of the measure	By collecting the biodegradable and non-recyclable waste fractions effectively and treating them in modern waste treatment plants decreases emissions to air. Modern waste treatment systems decrease emissions from landfills and also emissions from illegal burning of waste and farming residues.
Objective of the measure	To decrease emissions from landfills and also emissions from illegal burning of waste and farming residues.
Target pollutant	All but especially PM, VOCs, PAH and methane.
Change in concentration	May be locally medium.
Air quality benefits	Medium.
Other impacts	Decreases also other effects of landfills (water and ground water pollution) and decreases general untidiness of the environment.
Implementation	
Responsible authority	The Municipality of Bitola
Time of implementation	2-5 years
Costs	Significant
Other requirements	Requires up-to-date waste legislation and it's supervision. Funding must be guaranteed. May also need public information to support the requirements.

Common Measures

MEASURE NO	17
MEASURE NAME	Integration of air quality improvement to other policies
Description of the measure	Effects on air quality and emissions are included in all other policies that may affect air quality. These kinds of policies are especially climate policy, local traffic planning and local land use planning.
Objective of the measure	To ensure that air quality policies are in accordance with other policies and that common benefits are gained by different policies.
Target pollutant	All
Change in concentration	May be significant in long-range.

Air quality benefits	May be significant in long-range.
Other impacts	Optimizes environmental benefits
Implementation	
Responsible authority	The Municipality of Bitola
Time of implementation	2-5 years
Costs	Small
Other requirements	Requires that the bodies that are responsible for each sector have the basic knowledge of air quality issues. Requires co-operation in the administration.

MEASURE NO	18
MEASURE NAME	Improved maintenance and improvement of air quality measurements
Description of the measure	National and local air quality monitoring and assessment is organized so that all necessary information of air quality is available. QA/QC of the measurements is in an acceptable level so that the data is reliable. Air quality assessment also produces information of new compounds like PM _{2.5} and PAHs.
Objective of the measure	To make sure that all necessary data is available when planning measures to improve local air quality and that the data is reliable and up-to-date.
Target pollutant	All
Change in concentration	No direct effects on concentrations
Air quality benefits	Large
Other impacts	Improves cost-effectiveness
Implementation	
Responsible authority	The Ministry of Environment and Physical Planning together with the local environmental unit
Time of implementation	1-3 years
Costs	Increases costs of air quality measurements somewhat
Other requirements	Common view of the targets between the ministry and the local administration is needed. According to the current air quality situation the priority in maintaining the equipment should be given to the instruments for the critical pollutants monitoring (especially PM and ozone). Moreover an effort should be made in order to gain a basic knowledge concerning air quality levels of PM _{2.5} , Benzene, PAHs and trace metals in Bitola.

MEASURE NO	19
MEASURE NAME	Accurate and up-to date emission inventories
Description of the measure	Emission database is up-dated each year and also emissions from non-point sources (traffic, heating, SMEs) are calculated regularly
Objective of the measure	Emission database is basis for air quality assessment and also for the measures to improve local air quality.
Target pollutant	All

Change in concentration	No direct effects on concentrations
Air quality benefits	Large
Other impacts	
Implementation	
Responsible authority	The Ministry of Environment and Physical Planning together with the local environmental unit
Time of implementation	1-3 years
Costs	Insignificant
Other requirements	

MEASURE NO	20
MEASURE NAME	Dispersion model calculations made for each emission sector
Description of the measure	There are up-to date model calculations for each significant emission sector, at least major industrial and power plants, traffic and heating.
Objective of the measure	Model calculations make it possible to assess what is the influence of each sector on local air quality.
Target pollutant	Mainly PM, NO ₂ and SO ₂ .
Change in concentration	No direct effects on concentrations
Air quality benefits	Large
Other impacts	
Implementation	
Responsible authority	The Ministry of Environment and Physical Planning together with the local environmental unit and the local industry
Time of implementation	1-3 years
Costs	Medium
Other requirements	

MEASURE NO	21
MEASURE NAME	Inclusion of Environmental impact assessment (EIA) in the main land use and traffic planning processes
Description of the measure	Before making decision of the major traffic and land use plans all relevant environmental impacts are assessed so that they can be taken into account in decision making.
Objective of the measure	To makes sure that all necessary air quality impacts are known, when decisions are made concerning the major plans.
Target pollutant	All
Change in concentration	May vary from case to case

Air quality benefits	Medium
Other impacts	All environmental impacts are assessed at the same time
Implementation	
Responsible authority	The Municipality of Bitola
Time of implementation	1-5 years
Costs	Medium
Other requirements	Requires that there is enough knowledge of all the relevant environmental impacts in the administration.