URBAN AIR QUALITY. A COMPARATIVE STUDY OF MAJOR EUROPEAN CAPITALS

Cristina ALPOPI
Academy of Economic Studies, Piata Romana, 6, Bucharest, Romania
sofiac@man.ase.ro

Sofia Elena COLESCA
Academy of Economic Studies, Piata Romana, 6, Bucharest, Romania
alpopic@man.ase.ro

Abstract
In this article, the authors made a comparative analysis of air quality in several European capitals, with the goal to identify the place occupied by Bucharest among the most polluted cities in the European Union. For this analysis we used data reported by various member states, as well as data provided by the Romanian National Network of Air Quality. The comparative analysis presents the last years evolution for the concentration of the most important substances involved in the atmospheric pollution process, emphasizing the place occupied by Bucharest city according to the quality index value of the cities.
Keywords: air quality, European capitals, comparative analysis, pollution, urban environment.

1. INTRODUCTION

Air quality protection is a key element in ensuring sustainable livelihoods for both present and future generations. Pollution from urban atmosphere is due to air pollutant emissions and transmissions. Emissions of sulfur dioxide have as main cause the activities in the steel industry, the oil refineries, the motor vehicles, the thermo-electric power stations. Nitrogen oxide emissions are largely caused by electricity and thermal industry, road traffic and manufacturing industries. Engine emissions from road traffic are an important source of pollution around the world, as there are no data available in Romania for the share held by each mode of transport pollution. During transmission, the pollutants are dispersed, diluted and subjected to photochemical reactions. The air pollution in the environment varies in time and space.

Air pollution involve living organisms emanation of harmful substances in the atmosphere. Types of pollutants that contribute most heavily to air pollution are oxides of sulphur and nitrogen, chloro-fluoro-carbides, carbon dioxide, carbon monoxide and soot. Air pollution can affect aquatic and terrestrial ecosystems if pollutants dissolve in water or precipitate as rain.

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Primary pollutants are those emitted directly into the atmosphere (sulphur dioxide, nitrogen oxides, soot particles), while secondary pollutants are produced by reactions between primary pollutants. Ozone, for example, is formed over the urban areas by reactions between primary pollutants and normal builders of the atmosphere. Carbon monoxide and nitrogen oxides are the main pollutants emitted from burning fuel. Soot and sulphur dioxide are the primary pollutants produced mainly by burning fossil fuels in electric power stations, such as oil and coal. Every year over 1 billion tons of such material enters the atmosphere composition by these processes.

Industry and transports are consuming lots of fossil fuels. The consumption of these fuels, eliminates in the atmosphere pollutant substances containing carbon, sulphur and nitrogen. Combustion of carbon, oil and gasoline is responsible for most air pollutants. For example over 80% of sulphur dioxide and 50% of nitrogen dioxide emitted into the atmosphere in the U.S. are products of fossil fuels, electric power stations, industrial boilers and residual furnaces. 80% of carbon monoxide and 40% of nitrogen oxide and hydrocarbons result from the combustion of gas and diesel fuel. Other polluting materials may have as source issue metals industry (iron, zinc, lead, copper), petroliferous refineries, cement plants and those in which nitric acid and sulphuric acid are obtained. These chemicals interact with each other but also with ultraviolet rays in sunlight dangerous intensities.

Thus, the atmosphere is affected by a variety of solid, liquid and gaseous substances. Therefore, air pollution is the worst problem, with effects on short, medium and long term.

Atmospheric condition is highlighted through the pollution of impact with different pollutants, the quality of precipitation, the state of atmospheric ozone, the dynamics of greenhouse gases emissions and some manifestations of climate changes. Air quality monitoring involves tracking the items included in the four categories of issues: sources and emissions of air pollutants, the transfer of pollutants in the atmosphere, concentrations level of air pollutants and their spatial-temporal distribution and the effects of air pollutants on human as well as biotic and abiotic environment.

To improve air quality and also protect the atmosphere are required control measures for pollutants emissions. To assess the pollution degree of the atmosphere are calculated pollutants emissions to determine ambient air quality. Emissions are measured by appropriate methods of assessment, specific to each pollutant in part based on emission factors and activity indicators.

Most sensitive air pollution control strategies involve methods that reduce, collect, capture or retain pollutants before they are released into the atmosphere. From an ecologic perspective, the best method is to reduce emissions by burning a small amount of fuel. Therefore improving urban air quality can also be obtained by determining people to use public transport instead of private cars.

2. LITERATURE REVIEW

Literature abounds in studies on air quality and protection . Below is presented a selection of works that have dealt with this topic and also the main ideas that emerge from these works.

Baldasano, Valera and Jimenez (2003) present an assessment of air quality in major cities from developed countries and developing countries, bringing in a comparison of values recorded by different pollutants with values recommended by World Health Organization and also with limits recommended by the European Union. The presented situation indicates a decrease in the level of sulphur dioxide in the world, excepting some cities in Central America and some Asian cities. Sulphur dioxide is maintained at a level very close to the values recommended by World Health Organization, worldwide. In general, the worldwide trend is to reduce the concentrations of pollutants, considering the powerful constraints imposed by local governments and international organizations. However, in poor countries and those with low middle-income per capita concentrations of air pollutants remain high and the trend is to increase their level, making the problem even worse.

Shiva Nagendra, Venugopal and Jones (2007) analyzed the air quality in the city of Bangalore from India in 1999-2005, using statistical data provided by several air quality monitoring stations. Following this analysis it results that concentrations values of pollutants SO2 and NOx have increased. The traffic growth in recent years has led to increasing emissions and deteriorating environmental quality and human health in several major cities in India, of which Bangalore. Concentrations of pollutants in the major intersections and arterial streets in the city exceed the admitted limits.

Murena (2004), following data collection and analysis from various air monitoring stations bewtwen 2001-2002, developed and implemented a daily air pollution index in order to highlight the effects of air pollution on health status population.

Jacob and Winner (2009) reviewed the recent studies that have shown the effects of climate changes by linking air quality and meteorological variables in the perturbations analysis of chemical transport models.

Carmichael (2008), explores the biggest problem of air quality, namely the ability to predict future developments. He has developed a mathematical model that takes into account aerosols, chemical composition, atmospheric dynamics and thermodynamics. These prediction models can be done on computer, although spatial and temporal aspects can be simulated. The lack of accurate and complete informations may affect the outcome of this mathematical model.

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Puliafito, Guevara & all (2003), presents a model to determine air quality in urban areas using a geographic information system. This system allows the integration, manipulation, analysis and simulation of spatial and temporal data of ambient concentration of key pollutants, in order to enable users to characterize and recognize areas with potential growth of pollution or air quality improvement. Also, the model can be used to test compliance with local standards of quality, to study the environmental impact of new industries or to determine changes regarding air quality in conditions of dense traffic.

Borrego, Martins, Tchepel & all (2006), demonstrates in their study the importance of spatial structure of urban sustainability, showing why the air quality should be considered a very important indicator in urban planning. Emission rate and very polluted air areas were analyzed for 3 imaginary cities with different urban structures, but with the same population. The “Corridor” City is characterized by the highest emissions, while the "Dispersed" City shows the lowest emission rates in the area and the "Compact" City is characterized by low emission per capita. Under photochemical simulations performed, it can be concluded that compact cities with more green areas provide better air quality compared with dispersed cities that have a lower population density, but intensive transport structures. This study demonstrates that there is a significant difference in regional photochemical pollution.

Lau, Hung, Yuen & all (2009) shows in the performed study that the degree of air pollution with carbon monoxide is directly influenced by traffic and daily cycle of CO concentration is attributed to road traffic. They took and processed the data recorded by a monitoring station of air parameters during the 7 years, given that the station is located a few meters from a major intersection in Hong Kong. Elshout, Leger, Nussio (2008), show the simplest method of air quality interpretation, which consists in using an index generally based on a number of sub-indices for each individual pollutant. There are many indices even in countries that have the same legislation, or there are even areas in the same country using different indices. For example in the UK and U.S. indices are closely related with discernible effects on the health of humans and are used to give advices in some cases exacerbated by the pollution situation.

Gurjan, Butler, Lawrence M.G. & all (2008) propose a statement of pollution indices to evaluate air emissions and air quality, especially in big cities. These indicators can help monitoring changes in terms of air quality in time and relationship with the other indices that provide informations on rapid and frequent changes of atmosphere condition in big cities. Gros, Sciare, Yu (2007) describe measurements made in a series of major cities regarding air quality, as before working on future scenarios, the models must be accompanied by measurements, as these are actual pictures of current air pollution in major cities. Then, the authors focused their attention on two major cities: Paris and Beijing, different in terms of development, sources of pollution and weather conditions. This study, that consists in comparing two different cities shows the importance of air quality in future investigations from major cities.

Guttikunda, Carmichael, Calori & all (2003), achieved a study in which studies the contribution of megacities to sulfur emission and pollution in Asia. They founded that although Asian megacities cover less than 2% of the land area, emit 16% of the total sulfur emission of Asia. The authors observed that the urban sulfur emission contribute over 30% to the regional pollution levels in many areas of Asia.

Hadipour Pourebrahim & Mahmmud (2009) focused on the relation between land use and air quality using Geographic Information System (GIS) as visualization platform. Relevant factors such as plume rise of CO, average atmospheric temperature and pressure, stack exiting velocity, estimated stack diameter, average wind speed and traffic volume were determined based on historical data and standard definition of road types.

3. AIR QUALITY IN ROMANIA

Systematic monitoring of air quality reveals that the level of atmospheric pollution remains high in many areas in Romania, exceeding the maximum permitted concentration for many hazards discharged into the environment. The most significant exceedings are recorded at suspensive and settled dusts, but also at more dangerous pollutants such as : sulphur dioxide, nitrogen oxides, heavy metals, phenols, hydrochloric acid etc.

The highest values of suspensive dusts were recorded in Arad, Ramnicu Valcea, Miercurea Ciuc, Baia Mare, Ploiesti and Zalau. There were situations, like those recorded in Baia Mare, when the frequency of exceeding the maximum permissible limit was about 40%. Settled dusts exceeds the maximum permitted concentration in many places in the country, such as: Galati, Braila, Zlatna, Hunedoara, Brasov, Ploiesti, Rovinari, Fieni, Comarnic, Barsesti. Some of the highest values were registered in Hunedoara, where was led a concentration of about 670 g / sqm / month. High concentrations of lead and cadmium powders were recorded in Baia Mare and the Copsa Mica, where frequencies exceeding of maximum allowable limits were over 85% in Baia Mare, respectively over 69% in Copsa Mica. (ANPM, n.d.).

As a member of the European Union and also as part of the UNECE Convention / CLRTAP, Romania forward annual estimates of air pollutants emissions, wich are falling under Directive 2001/81/EC on national emissions ceilings (transposed into national legislation by HG 1856 / 2005) and the convention protocols mentioned above.

Another obligation of any Member State is to keep the emissions ceilings stipulated by the Gothenburg Protocol by adopting measures to reduce the environmental impact of human activities. In this sense, our country is obliged to limit their annual national emissions of greenhouse acidifier and eutrophication and ozone precursors under 918 Kt values for sulphur dioxide (SO2), 437 Kt for nitrogen oxides (NOx), 523 kt for volatile organic compounds (NMVOC) and 210 Kt for ammonia (NH3).

Emissions inventories of air pollutants are achieved with two years before the current year, following the guidelines EMEP / CORINAIR for estimating and reporting emissions data to ensure their transparency, accuracy, consistency, comparability and completeness. In the National Network of Air Quality Automatic Monitoring is realized a monitoring of the next pollutants: SO2, NO, NO2, NOx, suspensive dusts - PM10 and PM2 fractions, 5, CO, O3, benzene, lead.

In laboratories, outside of these compounds is also analyzed: NH3, H2S, phenols, Cl2, formaldehyde, H2SO4, heavy metal, total dusts, etc.

Currently in Romania, the National Network of Air Quality Monitoring (RNMCA) comprises 117 permanent air quality monitoring stations, endowed with automatic equipments to measure the concentrations of major air pollutants. RNMCA includes 38 local centers, which gather and disseminate to public information panels data from stations and transmit them after primary validation for certification of the Bucharest National Reference Laboratory (LNR). Analysis of the recorded values prove that SO2 emissions have generally recorded a continuous decline in 1995-2005, with slight increases in 2001 and 2003. After slightly increasing tendency of sulphur dioxide emissions in 2004-2006, from 765,000 tons to 826,000 tons in 2007 sulphur dioxide emissions have reached a value of 754,379 tons, as shown in the Figure 1 (ANPM, n.d.).

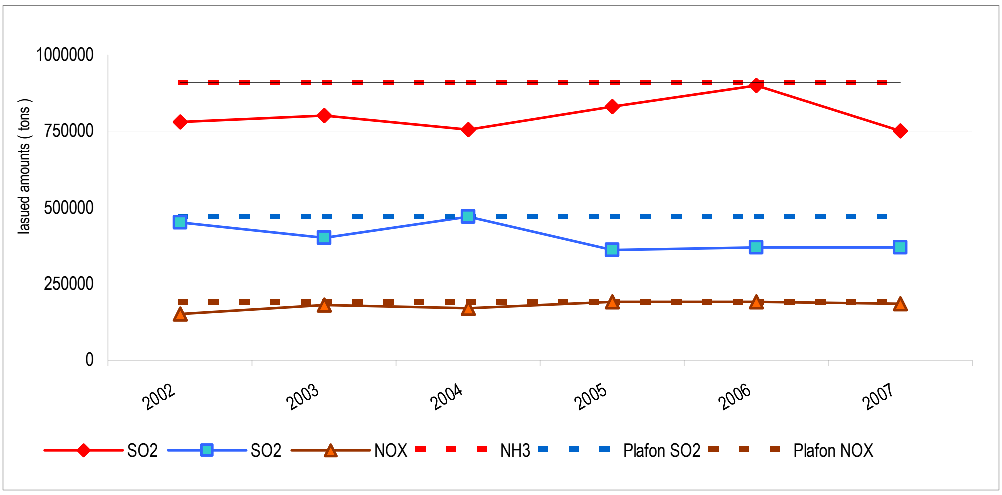

FIGURE 1 - ANNUAL EMISSIONS OF SO2, NOX AND NH3 INROMANIA

NOx emissions have been characterized in recent years, by a slightly downward trend, characteristic mainly supported by industrial installation modernization and national fleet renewal, NOx emissions decreased in 2003 compared to 2002 reaching a value of 13, 92%. In 2007, national NOx emissions have reached 330,667 tons, registering a slight increase of 1.28% over the previous year. Ammonia emissions show an increase in 2002-2007, reaching a maximum value of 204,275 tons in 2005. Starting this year, the tendency of NH3 emissions is downward,while for 2007 was registered a value of 198,184 tons.

4. ASSESSMENT OF AIR QUALITY IN EUROPE

4.1 Evolution of major air pollutants

People are adversely affected by exposure to atmospheric pollutants in ambient air. In response, the European Union has developed legislation, setting standards for health and objectives for a number of pollutants.

In accordance with EU legislation, a limit value is mandatory for its entry into force. A target value is intended to be achieved, if possible up to provided date, so it is less strict than a threshold value.

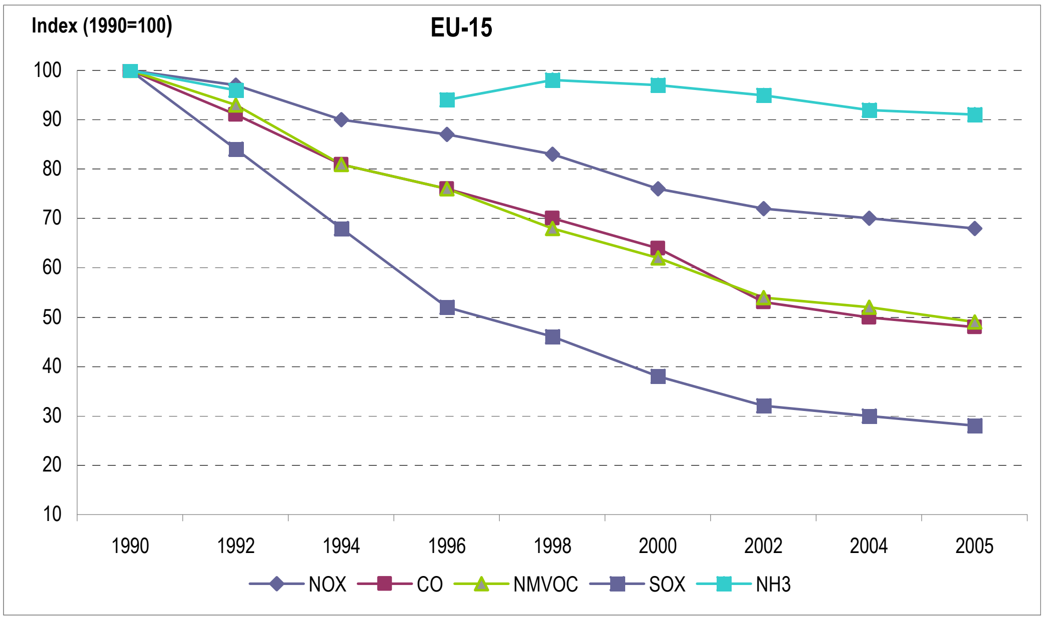

FIGURE 2- EU-15 THE ANNUAL EMISSIONS OF NOX, CO, NMVOCS, SOX AND NH3, 1990-2005

Because of gaps in terms of data reported by the EU-15 and EU-12, the trend has been calculated only for NOx, CO, NMVOCs, SOx and NH3 (Figure 2 and Figure 3). In EU-27, emissions reported by nitrogen oxides, in 2005, fell more than 34%, the sulphur dioxide by about 70% compared to 1990 and have appeared significant reductions for other pollutants.

The largest reduction was achieved for SOx emissions (72% in EU15 and 65% in EU-12), followed by CO (53% in EU-15 and 41% in EU-12) , NMVOC (47% in EU-15 and 10% EU-12) and NOx (33% in EU-15 and 40% in EU-12). NH3 emissions in EU-15 decreased by 11.8% in 1990-2005 (ANPM, n.d.)

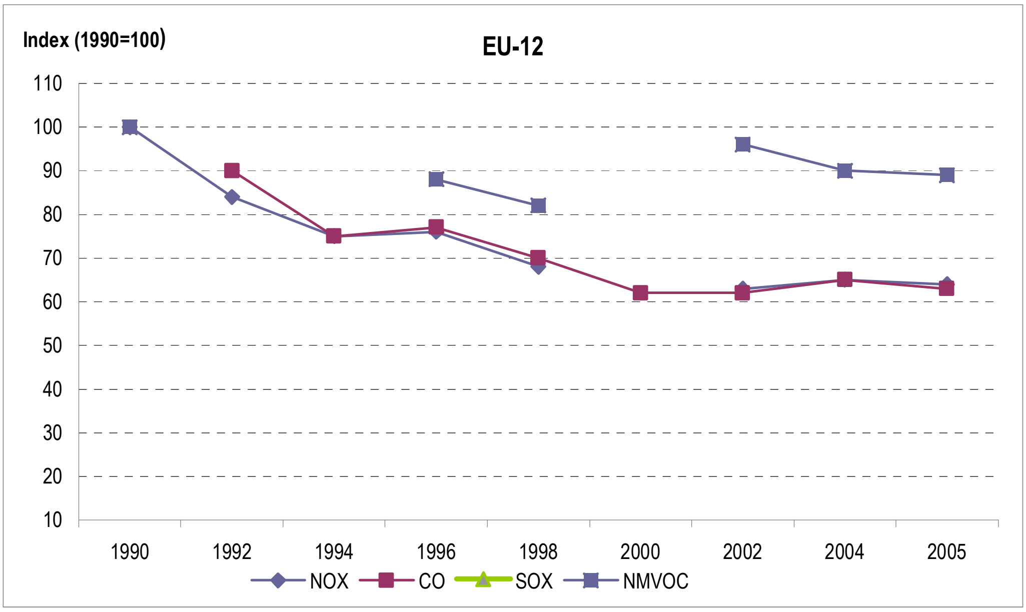

FIGURE 3 - EU-12 - THE ANNUAL EMISSIONS OF NOX, CO, NMVOCS, SOX AND NH3, 1990-2005

4.2. Air quality indicators at European level

CITEAIR (n.d.) developed the first indicators of air quality in Europe. An important feature of these indicators is that they differ in high traffic areas compared with residential ones, with low traffic. Common Air Quality Index (CAQI) is intended to design and compare air quality in real time, hourly or daily. CAQI has 5 levels, using a scale from 0 (very low) to > 100 (very high) and associated colors variegate from light green to red. Common Air Quality Index annual average (YACAQI) uses a different approach. If index is greater than 1.0 means that for one or more pollutant limit values are not respected. If the index is less than 1 means that relatively, the limit values are respected.

To present the situation of air quality in European Cities, in an understandable manner, all detailed measurements are processed in a single digit relative: CAQI. Three different indices were developed to allow comparison of three different time scales:

- an index that describes the air quality that day, based on updated values at each hour;

- an index that shows the general situation of air quality for the previous day, based on updated values once a day;
- a general index, which represents the general air quality conditions throughout the year and compare them with European standards on air quality. This index is calculated using the pollutants average, compared with annual limit values and updated each year.

The index calculated at each hour has 5 levels and uses a scale from 0 (very low) to 100 (very high). These are based on three pollutants that represents a major concern in Europe: PM10 (suspensive dusts), NO2 (nitrogen dioxide), O3 (ozone) and will be able to consider other two additional pollutants: CO (carbon monoxide) and SO2 (sulphur dioxide), if the data are also available.

Index calculation is based on an analysis about a number of air quality indices. To make an easier comparison between cities, regardless of their network monitoring, are defined two situations: residential areas with low traffic and high traffic areas.

Indices values are updated every hour (for those cities that provide oral data) and are also presented the values from the previous day.

Air quality index (AQI) is a number used by government agencies to characterize air quality in a given space. As AQI's value increases, it is possible that a large percentage of the population shows a deterioration of health. To calculate the AQI are required pollutants concentration values. Function used to convert this concentration in AQI varies by type of pollutant and is different from country to country. Air quality index values are divided into categories and each gamma is given a descriptor and a color code. AQI's value may increase due to no dilution of air emissions with fresh air. Stagnant air, often caused by an anticyclone, or temperature inversion, or no wind, make that the atmosphere remain polluted in that area.

4.3. Air quality in some European capitals

In Amsterdam, the two pollutants that often exceeded the limit values in 1999-2006 are NO2 and PM10. Ozone has raised concerns only in long periods of high temperatures, while benzene, CO, SO2 and lead, have not exceeded the maximum admitted values. During 2006-2009, only to NO2 were exceeded the European standards and only in high traffic areas. For PM10, ozone and SO2, in 2006-2009, the annual average values were framed in limited amounts in all areas of the city. In the Figure 4 is illustrated the evolution of air quality index in 2006-2009, in two areas of the city (CITEAIR , 2007).

In Berlin, the air quality analysis shows that generally the air is cleaner in this city. Sulphur dioxide level declined in recent years, but nitrogen oxide has not yet reached a satisfactory level. During 2005-2008, only to NO2 the annual average value was exceeded and only in high traffic areas. In residential areas, the concentrations of PM10 and ozone exceeded the maximum admitted values in 2006 and 2007. In the Figure 5 is presented the evolution of air quality index, in Berlin, 2005-2008 (CITEAIR , 2007).

In Brussels, three air pollutants are actually raising problems compared with European standards: fine suspensive particles (PM10 and PM2, 5), tropospheric ozone (formed from volatile organic compounds and nitrogen oxides) and nitrogen dioxide (NO2). However, sulphur dioxide (SO2), lead and benzene - air pollutants associated with fossil fuels, do not exceed the standards recommended by the European Union. Thus, in 2008, concentrations of nitrogen dioxide, suspensive dusts, ozone and benzene are well below the admitted limit of maximum concentration values. During 2006-2008, in high traffic areas corresponding values for NO 2 concentration exceeded the admitted limits, and for PM10 only in the range 2007-2008. In residential areas, values were framed in the European standards for all five pollutants: NO2, PM10, SO2, ozone and benzene. In the Figure 6 we can see the evolution of air quality index in Brussels in 2006-2008 (CITEAIR , 2007).

In recent years, the types of pollutants affecting air quality in London has changed considerably, primarily with the increasing numbers of motor vehicles and the decline of coal use for domestic heating and industrial processes. The success in controlling CO and SO2 concentrations contrasts with NO2, PM10 and O3. During 2006-2008 the concentrations of pollutants for nitrogen dioxide exceeded European standards in all areas of the city. Schedule, is seen the evolution of air quality index in the period 2006-2008, in London. In the Figure 7 we can see the evolution of air quality index, in 2006-2008, in London (CITEAIR , 2007)

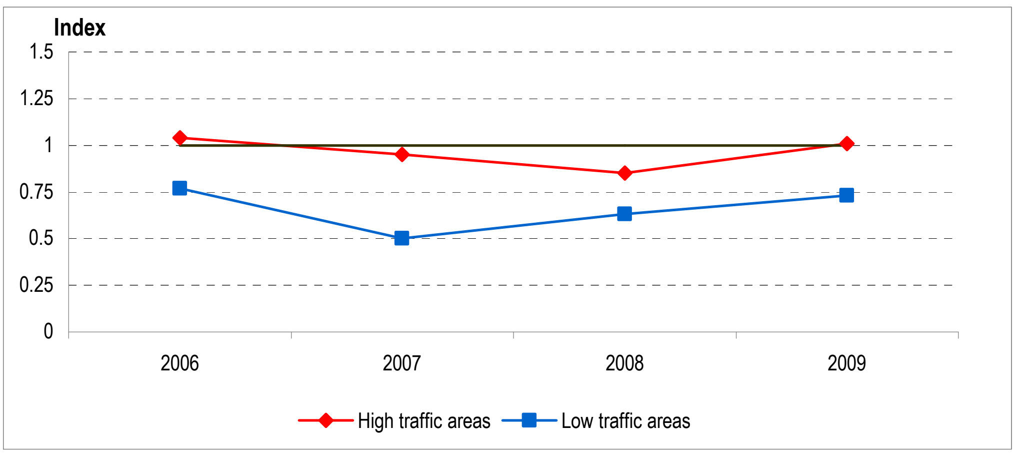

FIGURE 4 - AIR QUALITY INDEX (CITY INDEX) IN AMSTERDAM, 2006-2009

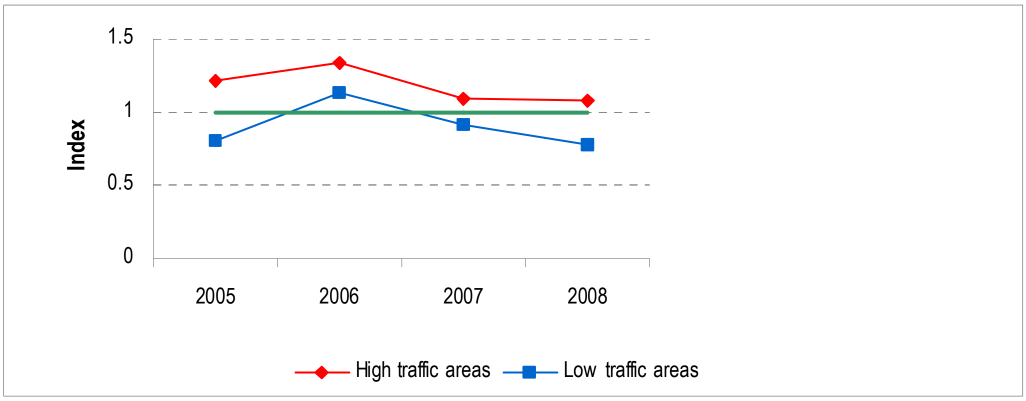

FIGURE 5 - AIR QUALITY INDEX IN BERLIN, 2005-2008

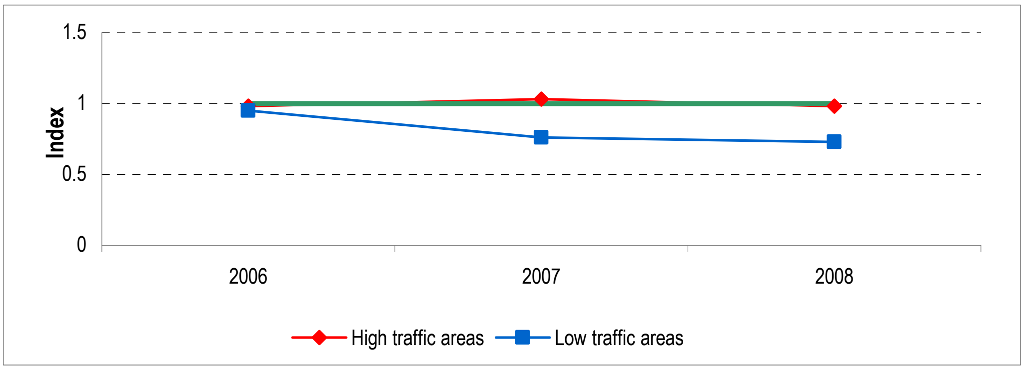

FIGURE 6 - AIR QUALITY INDEX IN BRUSSELS, IN 2006-2008

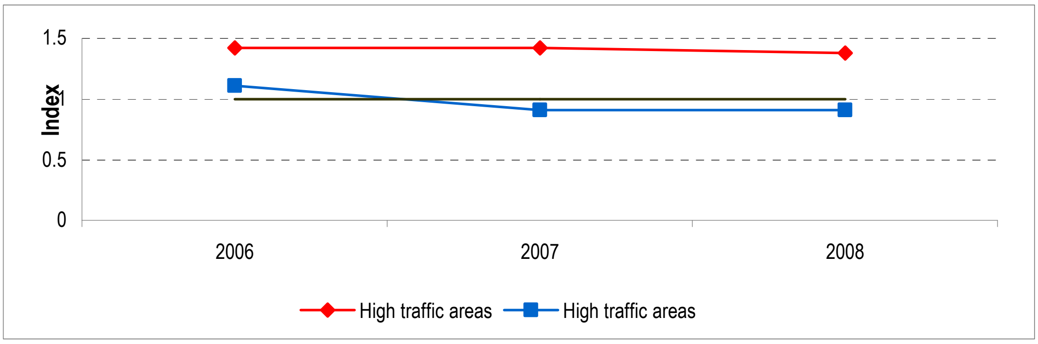

FIGURE 7 - AIR QUALITY INDEX IN LONDON, IN 2006-2008,

Air Quality in Oslo varies both seasonally and geographically. All parts of the city shows a high quality of air in the summer, but in winter it varies throughout the entire city. Parts of the city located at lower altitude are the most exposed to air pollution. The main contribution of air pollution comes from traffic (50-70%). Between 2006-2008 only the annual average NO2 concentrations exceeded the European standard in polluted areas of the city, with high traffic. All other concentrations are framed in the limit values in all areas of the town and the city's quality index register, in all this years, values less than 1.

In Paris, the metropolitan area is responsible for 68% of regional NOx emissions, for 71.5% of hydrocarbons emission and 77% of suspensive dusts emissions. In this area there are three main sources of pollution: transportation, public and private heating and industry. From all these, public transport is by far the major problem, being responsible for 59% of nitrogen dioxide emissions (NO2), 38% of volatile organic compounds (NMVOC) and 37% of suspensive dusts (PM10). During 2003-2009 the concentrations values of NO2 and PM10 have far exceeded the EU standards in areas with heavy traffic of the city, but even in residential areas with low traffic the concentrations values of NO2 and ozone have exceeded the maximum limits. Figure 8 highlights the evolution of air quality index in Paris, in 2003-2009 (CITEAIR , 2007).

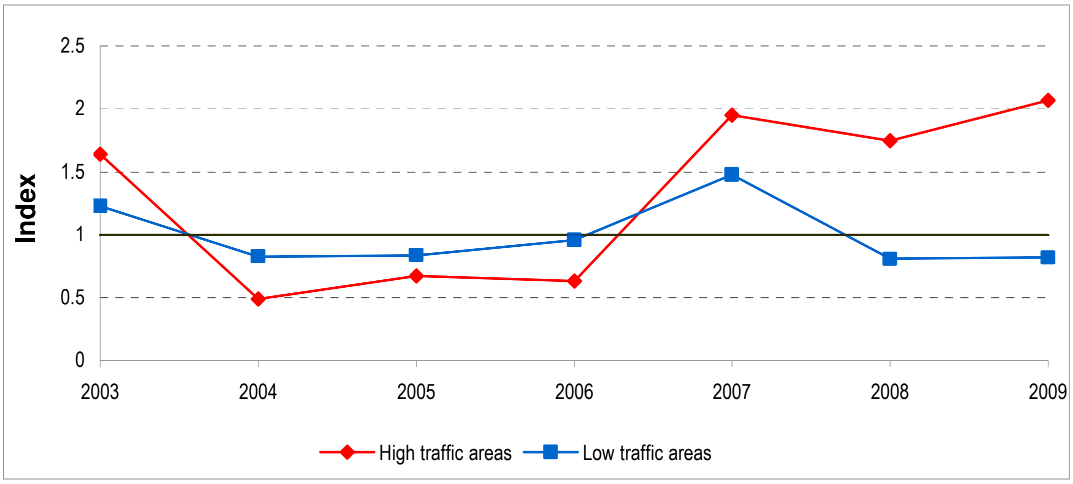

FIGURE 8 - AIR QUALITY INDEX IN PARIS, IN 2003-2009

In Prague, as well as other European Capitals, the traffic is considered the main source of air pollution with compounds such as: PM10, nitrogen dioxide, carbon monoxide, benzene and ozone. The cars number per thousand inhabitants increased twice in 1990-2000. Traffic is the producer of about 80-90% of total pollutants emissions (NO2, benzene, CO). Significant decrease of annual average concentration of NO2, hasn't continued after 1991 and the situation has stagnated. In recent years there has been a gradual and moderate increase of NO2 pollution, which has been observed since 2003. About about suspensive dusts and sulphur dioxide, the trend was downward until 1999, but after 2000,has appeared an increasing tendency for most pollutants. Figure 9 shows the evolution of air quality index in Prague in 2003-2005.

The situation analysis of air pollution in Rome, shows that traffic is mainly responsible for high concentrations of pollutants. This is the main source of carbon monoxide (CO), benzene (C6H6) and suspensive dusts (PM10). High concentrations are recorded near high traffic areas, while concentrations in other areas do not exceed the admitted limits. During 2003-2008 the concentrations of NO2, PM10 exceeded the European standards of these values in areas with intense traffic of the city. And also, in residential areas were exceed the maximum admitted levels for nitrogen dioxide, suspensive dusts and ozone. Figure 10 shows the evolution of air quality index in Rome, during 2003-2008 (CITEAIR, 2007).

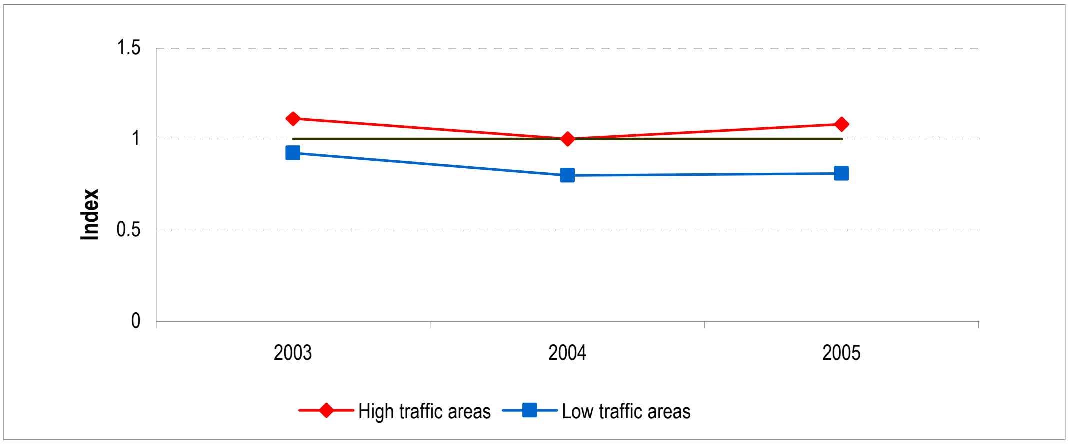

FIGURE 9 - AIR QUALITY INDEX IN PRAGUE, 2003-2005

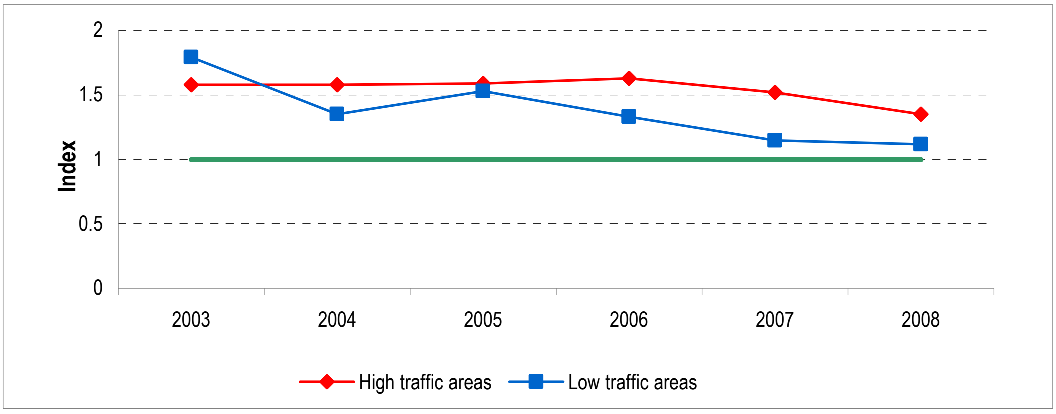

FIGURE 10 - AIR QUALITY INDEX IN ROME, IN 2003-2008

Bucharest ranks the first place in the most recent top of polluted cities from the European Union, surpassing Sofia, Athens and Rome. According to data collected from monitoring stations, the main source of air pollution in Romanian Capital is traffic, responsible for 70% of impurities in the air. Electric power stations, industry, construction sites and some private domestic heating installations occupy these four places in the ranking order.

Annual average level of NO2 in areas with heavy traffic increased in 2007 over 2006, but fell in 2008. In other areas, it has maintained its downward trend. Suspensive particles are increasingly concentrated in the atmosphere because of very rapid enlargement of the fleet. In terms of SO2, it fell in residential, but had an oscillating trend in high traffic areas. Thus, in these parts of the town, SO2 level fell in 2007 and will increase in 2008 almost to the level recorded in 2006 (CITEAIR , 2007).

Considering all these indicators, and others, it was calculated for Bucharest and other European capitals, an air quality index in the city. He grew up in residential areas during 2006-2008, and in areas heavily traveled by cars fell in 2008 compared to 2007, but after a huge increase in 2007. This trend could be observed in the Table 1. (CITEAIR , 2007).

TABLE 1 - EVOLUTION OF POLLUTANTS CONCENTRATIONS AND CITY'S INDEX FOR BUCHAREST

Year	Annual Average NO_2		Annual Average Suspensive dusts		Annual Average SO_2		City Index	
	High Traffic Areas	Residential Areas	High Traffic Areas	Residenti al Areas	High Traffic Areas	Residential Areas	High Traffic Areas	Residential Areas
2006	2.60	1.76	1.22	0.95	0.32	0.34	1.65	1.43
2007	2.70	1.65	1.45	1.00	0.27	0.34	1.95	1.50
2008	2.63	1.60	1.57	1.20	0.30	0.31	1.80	1.63

5. CONCLUSIONS

Analyzing the various studies presented in literature and considering the data indicated above for the 9 European capitals it can be drawn the following conclusions:

In case of nitrogen dioxide pollution, Bucharest is one of the most polluted capitals, is surpassed only by London in 2009 and followed by Rome and Paris. With most cities, the tendency is to increase pollution by nitrogen dioxide in areas with heavy traffic and drop it in residential areas.

In case of suspensive dusts, Bucharest is the most polluted capital of the analysis, is followed by Rome, Paris and Prague. To remember is that both in terms of NO2 level, and regarding the level of suspensive dusts, Paris presents better than Bucharest, in residential areas. The annual trend is to decrease or slight increase, but Paris is noticed again by the spectacular increase in the level of suspensive dusts in 2009, for high traffic areas, just after an important reduction in 2008.

In terms of sulphur dioxide pollution, and here the leader was Bucharest in 2008, being followed by Paris, London, Brussels, Berlin, in the case of high traffic areas and Brussels, Oslo, Paris in residential areas. During 2006-2007, the most polluted city in this regard was Paris, followed by Brussels and Bucharest. But we can say that the cities analyzed here are at a level close to standards, where data exist for the same years and the trend is generally decreasing pollution.

City index from traffic areas dropped in all capitals analyzed, except Bucharest and Paris. They are also the cities with the highest index, followed by Rome. In residential areas, the highest indices are registered in Bucharest, Rome, followed by Paris. This could be observed in Figure 11 and Figure 12.

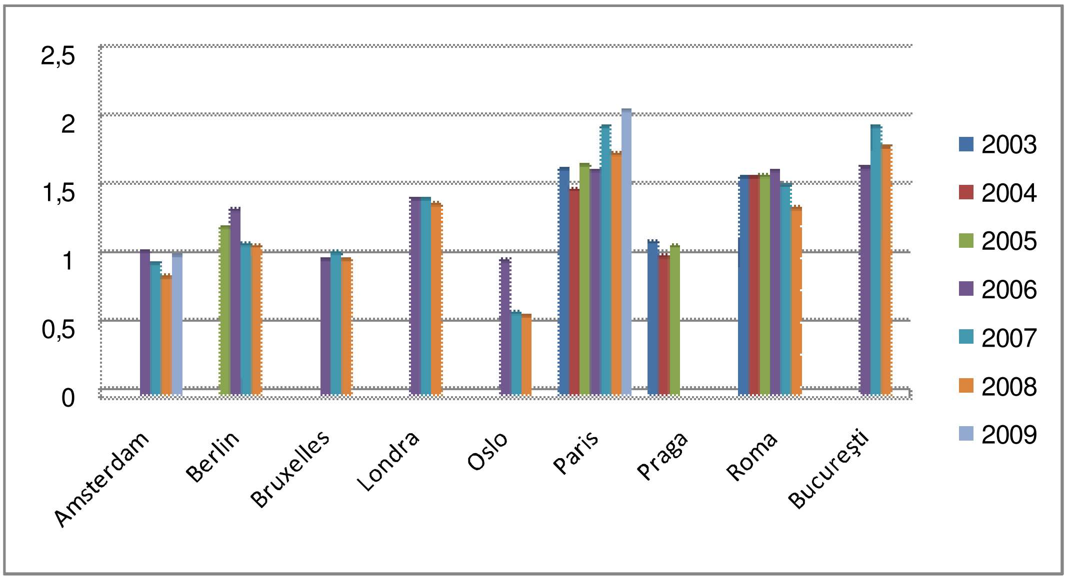

FIGURE 11 - CITY INDEX IN HIGH TRAFFIC AREAS OF EUROPEAN CAPITALS

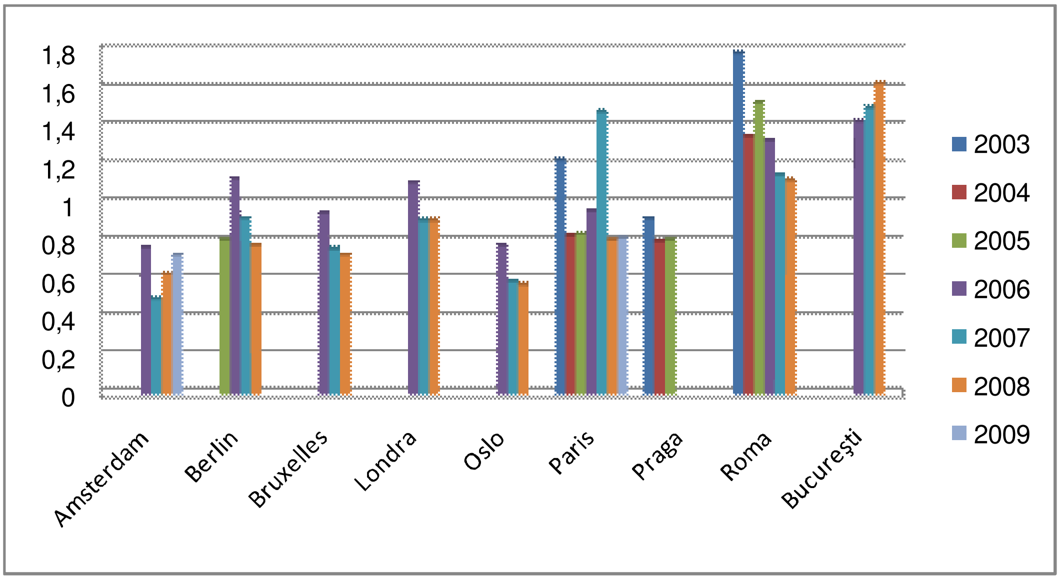

FIGURE 12 – CITY INDEX IN RESIDENTIAL AREAS OF EUROPEAN CAPITALS

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