Available online at www.elixirpublishers.com (Elixir International Journal)

Pollution

Elixir Pollution 92 (2016) 38697-38701

ISSN: 2229-712X

Air Quality Monitoring at Some Selected Traffic Junction of Jhansi, Central India

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ARTICLE INFO

Article history:
Received: 4 February 2016;
Received in revised form:
29 February 2016;
Accepted: 2 March 2016;

Keywords
RSPM,
Sulphur dioxide,
Nitrogen dioxide,
Air pollution and Jhansi

ABSTRACT
Jhansi is well known district of Bundelkhand region of Uttar Pradesh with a geographical area of 502.75 thousand hectares. The population of the city is near about 4 lacks for the last two decades due to mismanagement of traffic systems and mushrooming of vehicles chock most of the street and road of the city which lead to significant increase in air pollutants. In the present study, ambient air quality was monitored by high volume sampler in Jhansi city of central India. The six sampling sites were classified in different zones i.e. commercial, residential and sensitive and important ambient air quality parameters (RSPM, SOx and NOx) were monitored on hourly basis from January to June 2014. The results revealed that the concentration of the SO_2, NO_2 and RSPM from all sampling sites were ranged between 9.4 to 12.7 µg/m^3, 20.5 to 34 µg/m^3, 258.7 to 273 µg/m^3 respectively. All the parameters (SO_2, and NO_2) were found below the permissible limits of NAAQS (National Ambient Air Quality Standard) except RSPM in the study sites.

Introduction

The earth is the only planet known in the entire universe capable of supporting life. This unique property of the planet is due to the presence of a blanket of air around it, called atmosphere. Air is the ocean we breathe. It supplies us with oxygen, which is essential for our body to live. Every day, the average person inhale about 20,000 liters of air. Every day we inhales dangerous chemicals that have found their way into air. Air is one of the five essentials i.e. air, water, food, heat, light, for human beings **(**Ganesh *et al.,* 2012**).** Even though air is abundantly present over the surface of the earth, but it contains a lot of impurities. Various types of contaminants are entering into the atmosphere of the earth by the natural and man-made or anthropogenic activities. Air pollution means any solid, liquid or gaseous substances (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human being or other living creatures or plant or property or environment. In the name of pollution control by dilution millions of tons of a variety of toxic air pollutants are released into the atmosphere by man which are transported to places several thousands of kilometers away from the source through atmospheric circulation systems causing irreparable damage to the quality of air on the continental and global scale. The impacts of air pollution on the biosphere and the quality of life have drawn considerable public attention, and air pollution problem is being considered and tacked on a global scale (Ganesh *et al.,* 2012).

Air pollution has long been recognized as a potentially lethal form of pollution. Entry of pollutants into the atmosphere occurs in the form of gases or particles. Continuous mixing, transformation and trans-boundary transportation of air pollutants make air quality of a locality unpredictable (Kaushik *et al.,* 2006). Over the last decade, the Asian countries have undergone a substantial growth in development and urbanization coupled with motorization and increase in energy use. A considerable rise has occurred in the types and number of emission sources of air pollutants in the region (Gurjar *et al.,* 2008). Intense industrial activity, large population, and unprecedented rise in motor vehicle usage are posing a severe environmental impact in the region (Hopke *et al.,* 2008). As a consequence, air pollution has emerged as a significant threat to the environment, quality of life, and health of the population in Asia, especially in South Asia where emission control technologies and strategies are not always being adopted. Considerable evidence is available that poor air quality is playing havoc with the health of the population in the region (WHO 2002a). Urban air pollution is estimated to be responsible for 865,000 premature deaths every year and about 60% of these deaths occur in Asia (World Health 2006). Elevated concentrations of pollutants have been found in various countries throughout Asia : India (Jain and Khare 2008; Oanh *et al.,* 2006), Bangladesh (Begum *et al.,* 2006), Thailand (Oanh *et al.,* 2006; Oanh and Zhang 2004/06), Philippines (Cassidy *et al.,* 2007; Oanh *et al.,* 2006), Malaysia (Omar *et al.,* 2007), Korea (Pandey *et al.,* 2008), Vietnam (Oanh *et al.,* 2006), Indonesia (Oanh *et al.,* 2006), and China (Chan and Yao 2008). The WHO/UNEP report (1992) reveals air pollution problems in metropolitan cities of India as they are heading the list of the most polluted cities of the world. India has 23 major cities of over 1 million people and ambient air pollution levels exceed the WHO standards in many of them (Gupta *et. al.,* 2002). The single most important factor responsible for the deterioration of air quality in the cities is the exponential increase in the number of vehicles. Vehicular pollution contributes to 70 % of total pollution in Delhi, 52 % in Mumbai and 30 % in Calcutta (C.P.C.B., 2003; Gokhale and Patil, 2004; Ravindra *et al.,* 2005). The vehicle fleets in our country are old and poorly maintained roads are narrow and the number of two stroke engines, thus increasing the significance of motor vehicles as a pollutants source (Pandey,

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et al., 1998; Khioyangbam, R. S. 2010). Assessed the status of respiratory morbidity in Delhi over the four year period from 2000-2003. An attempt was to make to investigate the role of important pollutants (SO_2, NO_2 and RSPM) and various meteorological factors (Temperature, relative humidity and wind speed) in being responsible for respiratory admissions on account of asthma and emphysema (Agrawal 2006). Pollution in the Jhansi city has associated serious moderate health problems due to high level of respirable suspended particulate matter (RSPM) (Ganesh, *et al.*, 2012; Abhimanyu *et al.*, 2012; Saurabh *et al.*, 2013). At least 500,000 premature deaths and 4 to 5 million new cases of bronchitis are reported each year (WHO, 1992). Further 4% to 8% of premature deaths on a global scale are due to exposure to high levels of particulate matter in ambient air (WHO, 2000).To monitor the quality of air in different cities of India, a network of air quality monitoring stations has been established by National Environmental Engineering Research Institute (NEERI), Nagpur in cities where its zonal lab is present. However, there is no air monitoring station of NEERI in Jhansi (Chauhan *et al.*, 2013). Therefore In the present study, ambient air quality was monitored at different traffic junction of Jhansi city to assess the prevailing concentration of the RSPM, SOx and NOx.

Materials and Methods

Study Area

The district is situated in the South West corner of the region at 24º11' - 25º57' N latitude and 78º10' - 79º23' E longitudes. The western area of the district is covered with hillocks. Jhansi is a city of Uttar Pradesh state of northern India. Jhansi is a major road and rail junction, and is the administrative seat of Jhansi District and Jhansi Division. The original walled city grew up around its stone fort, which crowns a neighboring rock. The National Highway Development Project, initiated by the government of India has sparked Jhansi development. The North-South Corridor connecting Kashmir to KanyaKumari passes through Jhansi. The East-West corridor also goes through this city, so there has been a sudden rush to infrastructure and real estate development in the city (Chauhan*et al.*, 2013). Six air quality monitoring locations representing different actives areas i.e. three in commercial two in residense and one sensitive were selected for the study as summarized in table 1 and fig 1.

Table 1. Air quality monitoring locations representing different active areas.

S.No.	Classification of monitoring sites	Monitoring sites
1.	Commercial (C)	Manick Chowk
2.		Sadar Bazaar
3.		Bus Stand
4.	Residential (R)	Shivaji Nagar
5.		Virangana Nagar
6.	Sensitive (S)	Bundelkhand University

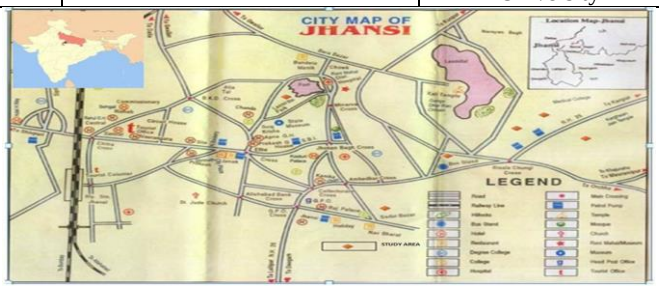

Fig 1. Map shows the sampling station for monitoring of air quality representing different active areas.

Analytical design

Respirable dust sampler (RDS) with gaseous sampling attachment were used for measuring the concentration of RSPM, NO_2 and SO_2 in the ambient air which summarized in Table-2.

Particulate matter

High volume air sampler was used for the monitoring of particulates. Before sampling, the Whatman filter GFA(20.3 cm×25.4 cm) of the high volume sampler was kept at 15–35 ◦C, 50% relative humidity for 24-h and then weighed. The filter was placed into the high volume sampler and the air was drawn through a 406.5 cm^2 portion of the filter at the flow rate of 1.70m^3/min. The rate of flow was checked with rotameter. The filter was removed after sampling for 24-h and equilibrates for another 24-h under the same or identical conditions. The filter was weighed again. The difference was the amount of particulate matter per unit volume of air. From the following equation, respirable suspended particulate matter (RSPM) was calculated.

RSPM =

$$\frac{final\ weight\ of\ filter\ paper - inintial\ weight\ of\ filter\ paper\ x1\ 000\ x\ 1000}{retention\ time + air\ flow}$$

Nitrogen oxides and sulphur dioxide

NOx and SO_2were collected by bubbling the sample in a specific absorbing (sodium tetrachloromercuate of SO_2 and sodium hydroxide for NOx) solution at an average flow rate of 0.5 min^{-1} for 4 hour monitoring. The impinger samples were put in ice boxes immediately after sampling and transferred to a refrigerator until analyzed. The concentration of NOx was measured with standard method of Modified Jacobs-Hochheiser method (1958), SO_2 was measured by Modified West and Geake method (1956).

Table 2. Methodologies for air quality monitoring by Respirable dust sampler.

Particulars	RSPM	SPM	SOx	NOx
Sampling equipment	Respirable Dust Sampler (RDS) APM 460	Respirable Dust Sampler (RDS) APM 460	RDS with gaseous sampling attachment	RDS with gaseous sampling attachment
Collection Media	Glass fibre filter paper	Dust cup	TCM (Tetrachloromercurate)	NaOH+ sodium arsenite
Flow Rate	1.0-1.3 m3 / min	1.0-1.3 m3 / min	0.5 L/min	0.5 L/min
Analytical Method	Gravimetric method	Gravimetric method	Spectrophotometry method (West and Gaeke method)	Spectrophotometery method (Jacobs-Hochheiser)
Time Frequency	8 Hourly	8 Hourly	4 Hourly	4 Hourly
Sampling Duration	continuously for 24 Hours	continuously for 24 Hours	Continuously for 24 Hours	Continuously for 24 Hours

Results

The observe RSPM, SOx and NOx, for the six month from January to June 2014, the data have compared to find out the prevailing trend of air pollution in Jhansi city. Average ambient air concentration of pollutants (µg/m^3) for different commercial, residential and sensitive areas have been also determined in the present six different sites.

Gaseous Pollutants

Sulphur dioxide can cause irritation of visibility and respiratory diseases. Healthy person are mostly affected by experience broncho-construction at 1.6 ppm of SO_2 for a few minutes exposure. Throat irritation occurs at 8-12 ppm level. 10 ppm SO_2 can cause eye irritation. At 20 ppm SO_2 concentrations may cause immediate cough and eye irritation results. Exposure ranges from 400 to 500 ppm of sulphur dioxide even for a few minutes is highly dangerous to human life (Chauhan*et al.*, 2013).

The concentration of the SO_2 recorded in the study areas have been ranged between 9.4 to 12.7 µg/m^3 (Table-3). Sensitive area has lower values of SO_2 (6.5 µg/m^3) compared to commercial and residential area value of SO_2 (9.0µg/m^3 and 6.9µg/m^3 respectively). The value of SO_2 in the commercial, residential and sensitive areas was within the prescribed value (80µg/m^3 for commercial and residential and 30µg/m^3 for sensitive area) by the National ambient air quality standards. The average values of SO_2 recorded in Manick Chowk (C), Sadar Bazar (C), Bus Stand (C), ShivaJi Nagar (R), Veranga Nanagar (R) and Bundelkhand University (S) was 12.7, 12.6, 12, 10.5, 9.7 and 9.4 µg/m^3 respectively (Fig-2).During the investigation find out that vehicles and small hotels are the main source of SO_2(Sulphur di-oxide) in the Jhansi city.

Nitric oxide (NO) and nitrogen dioxide (NO2) are also of interest to the concern of human health. NO is not irritating and it will not cause any adverse health effects at atmospheric concentrations. But when NO undergoes oxidation to NO_2, it poses health hazards as oxidant hemoglobin having 300000 times more affinity for absorbing NO_2 than O_2, which reduce oxygen carrying capacity of the blood. Nitrogen dioxide at high-level exposures in the range of 150 ppm (285 mg/m3) and above may be fatal to humans (Chauhan *et al.*, 2013).The concentration of the NO_2 recorded in the study areas have been ranged between 20 to 34 µg/m^3 (Table-3). Sensitive area has lower values of NO_2 (9 µg/m^3) compared to commercial and residential area value of NO_2 (12µg/m^3 and 10µg/m^3 respectively). The value of NO_2 in the commercial, residential and sensitive areas was within the prescribed value (80µg/m^3 for commercial and residential and 30µg/m^3 for sensitive area) by the National ambient air quality standards. The average values of NO_2 recorded in Manick Chowk (C), Sadar Bazar ((C), Bus Stand (C), Shiva Ji Nagar (R), Verangana Nagar (R) and Bundelkhand University (S) have been traced 34, 30, 26, 24, 22.5 and 20.5 µg/m^3 respectively (Fig-2).

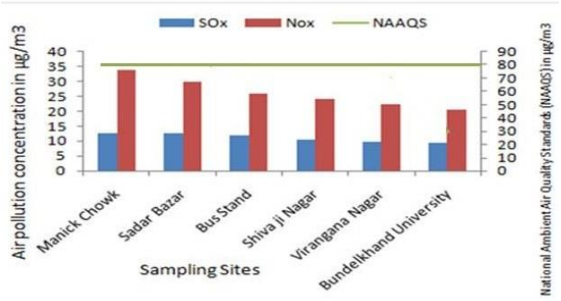

Fig-2. Showing average concentration of gaseous pollutant at different sites of city and comparison with prescribed National Ambient Air Quality Standards (NAAQS).

During the investigation find out that vehicles are the main source of NO_2 (Nitrogen di oxide) in the Jhansi city.

Respirable suspended Particulate Matter (RSPM)

The increase in particulate matter level causes serious atmospheric pollution that in turn causes severe health problems. These particles enter into respiratory system and are responsible for asthma, painful breathing chronic bronchitis, decreased lung functions and allergy. Particles containing fungi, viral or bacterial pathogen loading in ambient air may play a role in transmission of infectious diseases. The recent study has experienced that road transport is a major source of PM10 with other significant contribution from power plant combustion process and non combustion process in addition of road dust refuse burning and marine aerosol (Chow *et al.*, 1994).

The concentration of the RSPM monitored in the study areas were ranged within 258.7 to 273.5 µg/m^3 (Table-3). Sensitive area has lower values of RSPM (90 µg/m^3) compared to commercial and residential area value of RSPM (100µg/m^3 and 90µg/m^3 respectively). The value of RSPM in the commercial, residential and sensitive areas was within the prescribed value (200µg/m^3 for commercial and residential and 100 µg/m^3 for sensitive area) by the National ambient air quality standards. The average values of RSPM recorded in Manickchowk (C), Sadar Bazar (C), Bus Stand (C), Shiva Ji Nagar (R), Verangana Nagar (R) and Bundelkhand University (S) have been traced 273, 271, 267, 263, 261 and 258 µg/m^3 respectively (Fig-3). During the investigation find out that crusher plants are the main source of RSPM (respirable Suspended particulate Matter) in the Jhansi city.

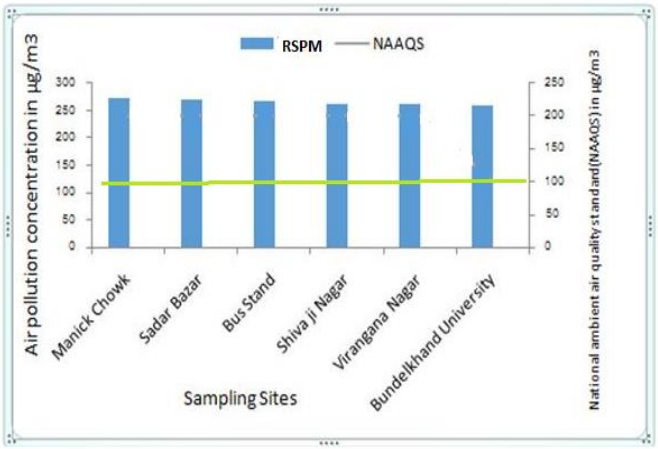

Fig-3. Showing average concentration of RSPM at different sites of city and comparison with prescribed National Ambient Air Quality Standards (NAAQS).

Table 3. Average concentration (µg/m^3) of RSPM, SOx and NOx at sampling sites.

S. No.	Sites → / Parameters ↓		Manick chowk	Sadar Bazar	Bus Stand	Shiva Ji Nagar	Veerangana Nagar	Bundelkhand university
1	SOx (µg/m^3)	Mean	12.7	12.6	12.0	10.5	9.7	9.4
		Max	15.8	14.7	15.0	13.0	12.5	12.4
		Min	9.5	10.5	9.0	8.0	6.9	6.5
2	NOx (µg/m^3)	Mean	34	30	26	24	22.5	20.5
		Max	50	45	40	38	35	32
		Min	18	15	12	10	10	9
3	RSPM (µg/m^3)	Mean	273.5	271.5	267.5	263.2	261.2	258.7
		Max	447.5	443.5	435.5	436.5	422.5	427.5
		Min	100	100	100	90	100	90

Table 4. National ambient air quality standards for 24 time weighed average.

Pollutants		Concentration in ambient air (µg/m3)	
	Sensitive area	Industrial area	Residential area
SO2	80	80	80
NO2	80	80	80
RSPM	100	100	100

Discussion

It is observed that presence of respirable suspended particulate matter (RSPM) are very high at commercial and residential area. The road transport is a major source of RSPM with other significant contribution from non combustion process in addition of road dust. RSPM has been considered as very fine particles also exceeding the limits except in few cases when compared with prescribed limits. It clearly indicates that free movement of transportation directly reflects presence of fine particles of respirable fraction. Concentration of RSPM is higher at site no. 1 and 2 when compare with site 3, 4 and 5 and percentage weight fraction at site No.5 is less when compare with other sites. Presence of fine and very fine particles in ambient air penetrate deep into the respiratory system. The higher values of Sox and NOx recorded at Sadar bazaar, Manick chowk and Bus stand due to higher vehicles movement. It causes health effect on road side petty business people also reflects on indoor air quality of closed residential area including on traffic police on duty. Hence special attention to be given for free flow of traffic as well as maintenance of road should carry out on late night of the day.

Conclusion

Monitoring of air pollutants such as SO_2, NO_2 and RSPM at six locations were measured during January to June 2014. The concentration of gaseous pollutants SO_2 and NO_2 were within the prescribed NAAQS limit at all the locations. The RSPM levels at the monitoring locations of commercial, residential and sensitive area were higher than the NAAQS. The increasing trend for the RSPM was found at all the location in the month of January to June at all sites. It may be due to stone crushing and road activity transpiration. So the overall result indicates that RSPM is one of the major causes for the deterioration of ambient air quality of the Jhansi city.

Acknowledgement

The authors are thankful to Institute of Environment and Development Studies (IEDS), Bundelkhand University, Jhansi, India for providing laboratory facilities during the work.

References

[1] Agrawal R, J. Girija., A. sneh, and Marimuthu P., (2006) Assessing Respiratory Morbidity through Pollution Status and meteorological Condition for Delhi, Air, Water & Soil Pollution Vol. 132. No. 3-4.

[2] Begum BA, Biswas SK, Hopke PK (2006) Temporal variations and spatial distribution of ambient PM2.5 and PM10 concentrations in Dhaka, Bangladesh. Sci Total Environ 358:36–45

[3] C.P.C.B.: (2003) 'Parivesh: Polycyclic Aromatic Hydrocarbons (PAHs) in air and their effects on human health' November 2003, Central Pollution Control Board, Ministry of Environment and Forest, Delhi-32, Page 20. (http://www.cpcb.delhi.nic.in/ph/ch81103.htm).

[4] Cassidy BE, Alabanza-Akers MA, Akers TA et al (2007) Particulate matter and carbon monoxide multiple regression models using environmental characteristics in a high diesel-use area of Baguio City, Philippines. Sci Total Environ 381:47–58

[5] Chan CK, Yao X (2008) Air pollution in mega cities in China. Atmos Environ 42:1–42

[6] Chauhan S. V., Singh, B., Ganesh, S. and Zaidi, J.(2013).Air quality status of ommercial and sensitive area of Jhansi city, Bundelkhand ,U.P., India.International Journal of Advanced Scientific and Technical Research, Issue 3 volume 6,427-440.

[7] Ganesh, S., Zaidi, J and Pal, A. (2012). Assessment of Ambient Air Quality of Jhansi City, Uttar Pradesh, India. J Search and Research, Vol-III No. (2) : 45-50.

[8] Gokhale, S.B. and Patil, R.S. (2004). Size distribution of aerosols (PM10) and Lead (Pb) near traffic intersections in Mumbai (India), *Environ. Monit. Assess*. 95, 311-324.

[9] Gupta, H.K., Gupta VB, Rao, C.V.C, Gajghate, D.G. and Hasan, M.Z.(2002). 'Urban air quality and its management strategy for a metropolitan city of India', *Bull. Environ. Contam.Toxicol.*68, 347-354.

[10] Gurjar BR, Butler TM, Lawrence MG. (2008). Evaluation of emissions and air quality in megacities. Atmos Environ 42:1593–1606.

[11] Hopke PK, Cohen DD, Begum BA . (2008). Urban air quality in the Asian region. Science of the Total Environment 404:103–112.

[12] Jacobs, M. B., Hochheiser, (1958**).** S. Continuous sampling and ultra micro determination of nitrogen dioxide in air. Analyst Chem. **30**: 426-428

[13] Jain S, Khare M (2008) Urban air quality in mega cities: a case study of Delhi City using vulnerability analysis. Environ Monit Assess 136:257–265

[14]Kaushik C.P, Ravindra K, Yadav K, Mehta S and Haritash A K (2006) . Assessment of ambient air quality in urban centers of Haryana (India) in relation of different anthropogenic activities and health risks. Environ. Monit. Assess. 122: 27-40

[15] Khoiyangbam, R. S., (2010) Air Quality in School located along the national highway in Jhansi city. Rele.Res.In Scic.and tech. 2 (4): 63-68.

[16] Oanh NTK, Upadhyay N, Zhuang YH et al (2006) Particulate air pollution in six Asian cities: spatial and temporal distributions, and associated sources. Atmos Environ 40:3367–3380

[17] Oanh NTK, Zhang BN (2004/06) Photochemical smog modeling for assessment of potential impacts of different management strategies on air quality of the Bangkok Metropolitan Region,Thailand. J Air Waste ManagAssoc 54:1321–1338.

[18] Omar N, Bin Abas MR, Rahman NA et al (2007) Levels and distributions of organic source tracers in air and roadside dust particles of Kuala Lumpur, Malaysia. Environ Geo 52:1485–1500.

[19] Pandey SK, Kim KH, Chung SY et al (2008) Long-term study of NOx behavior at urban roadside and background locations in Seoul, Korea. Atmos Environ 42:607–622.

[20] Pandey, A. Kumar.; Pal, A.; Singh, N.; Yunus, M. (1998); Status of ambient air quality in Lucknow city', Indian Journal of Environmental Protection, , Vol. 19, No.3, pp. 181-184

[21] Ravindra, K., Wauters, E., Taygi, S. K., Mor S., and Grieken R. V.: (2005) Assessment of air quality after the implementation of CNG as fuel in public transport in Delhi, India.*Environ. Monit.Asses.*, In press.

[22] Saurabh K. Y., Vinit, K., Singh , M.M., Jain, K. A., Sharma, D and Zaidi, Jamshed.(2013) Status of ambient air quality of the residential, commercial, heavy traffic street and sensitive areas of Jhansi city, Bundelkhand (India).International Journal of Advanced Scientific and Technical Research, Issue 3 volume 2, 132-145.
[23] West, P W and Gaeke, G. C (1956) Fixation of SOx as a sulfatomecurate (II) and subsequent colorimetric estimation. Analyst Chem. 1956, 28: 1816-1819.
[24] WHO (1992) Urban air pollution in mega-cities of the world. World Health Organization and United Nations Environment Programme, Blackwell Publishers, 108 Cowley Road, Oxford OX4 1JF Cambridge, UK.
[25] WHO (2002a) The world health report 2002—reducing risks, promoting healthy life. Switzerland, Geneva.
[26] WHO (2006) Air quality guidelines global update 2005. WHO Regional Office for Europe, Copenhagen.
[27] WHO/UNEP Report: (1992)Urban air pollution in mega-cities of the world. World Health Organisation and United Nations Environment Programme.Blackwell Publishers, 108 Cowley Road, Oxford OX4 1JF Cambridge, UK.