ASSESSMENT OF NOx POLLUTION OVER MEGACITY DELHI

South Asia, home to a quarter of the world's population, has shown a sharp increase in anthropogenic emissions over the last decade, which can have serious consequences for air quality and climate (Pfister et al., 2010). India, one of the rapid growing economies in South East Asia has witnessed a strong industrial development over past few decades which has greatly contributed to its economic growth. However, the development has not been uniform; a wide sectorial and regional variability exists in industrialization, population density (Census 2011), urbanization and resource use levels.

Nitrogen oxides (NOx), one of the criterion Pollutants (US-EPA), exhibits high concentration in satellite data from OMI (ozone monitoring instrument) on board the Aura satellite. Most significant nature in the satellite data is confinement of the high concentrations over certain regions or pockets, referred as hot spots in our discussion (figure 1.1). As far as the role of Nitrogen oxides (NOx) are concerned in tropospheric chemistry they play a highly variegated role. It controls oxidising capacity of atmosphere, ozone production and hydroxyl radical concentration (Cleansing agent of the atmosphere). NOx and ozone exposure to humans can cause a decrease in lung function, throat irritation and pulmonary diseases (US-EPA). NOx has both anthropogenic and natural sources. Combustion from automobiles and thermal power plants are some of the anthropogenic sources while lightning and nitrogen fixation by microorganisms are natural sources. In India, optimised total NOX emission was 5.26 Tg/year in 2000 (Ghude-et.al, 2012, Anup et al., 2012). The transportation sector accounts for ~35% (Garg et.al, 2001). Also road transport sector NOx emission accounts for 96 % of the total transportation NOx emission (Ramachandra et.al, 2009). Delhi, one of the most prominent hotspots, is home to a large number of vehicles and has witnessed an increase of 64% to 72% in the number of vehicles and increase in petrol and diesel consumption by 400% and 300% respectively (NEERI/APC 2008). To assist States and policy makers in implementing air pollution standard, scientific tools are needed such as emission inventory and atmospheric computer models which can be used to determine how best to reduce or mitigate pollution and improve air quality (US Environmental protection agency). This study aims to quantify the emission for NO_2 in mega-city Delhi with emphasis on Vehicular emission for the period 2008-2010 and to estimate the emissions in the year 2012, 2015. Finally, it will also help to identify NOx hotspots within the study domain (Urban Delhi) along with their exceedence factor which will assist policy makers and modellers to develop location specific control strategies.

Keywords: Nitrogen Dioxide (NO_2), Emission Inventory, Regulatory Air quality model, Hotspots

EMISSION INVENTORY & AIR QUALITY MODEL

Emission inventory, one of the air pollution management tools is defined as a process of accounting for various air pollution emissions and related data. In our day to day life we estimate the amount spent on our daily commodities. Similarly amount of air pollutants can also be accounted for in air pollution. An emission inventory has many advantages such as providing vital information on the level and assessment of Air pollution also planning for its control measures and tracking its progress. In this work emission inventories were built for NOx for the years 2008 and 2010 for urban part of Delhi as depicted [figure 2]. Mainly four sectors were selected; transport sector, power plants, domestic sector and waste burning for preparing the emission inventory. As per Guttikunda et.al, 2012, most of the industrial and construction activity was mainly contributed from Gurgaon, Ghaziabad and Faridabad totalling nearly 8% of the total NOx emissions. Also the cement industries lie in the border area. Therefore we neglected these sectors as they lied outside our study domain and percentage

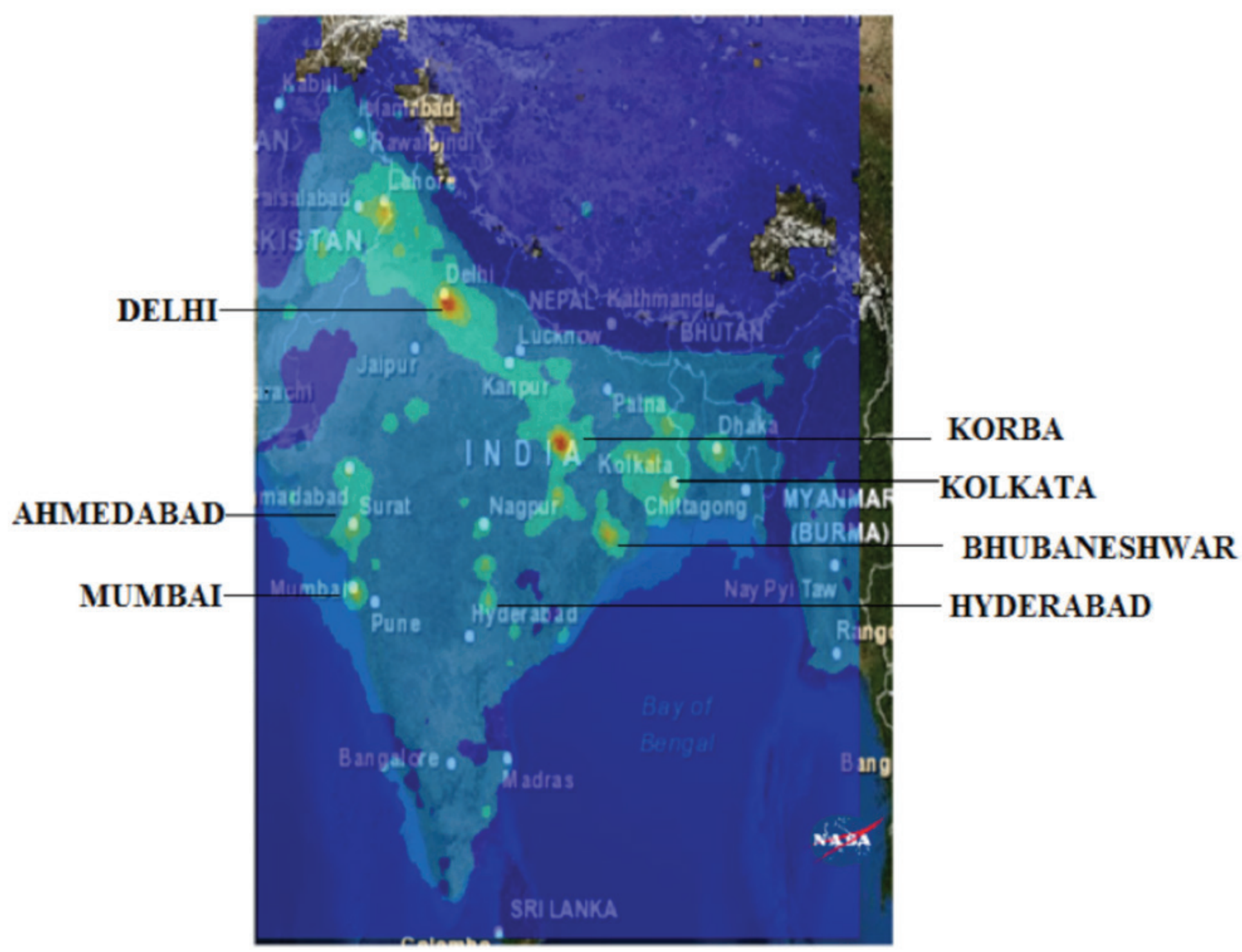

Figure 1.1 Identification Of Hotspots

Site: http://gdata2.sci.gsfc.nasa.gov/(GIOVANNI) (NASA)

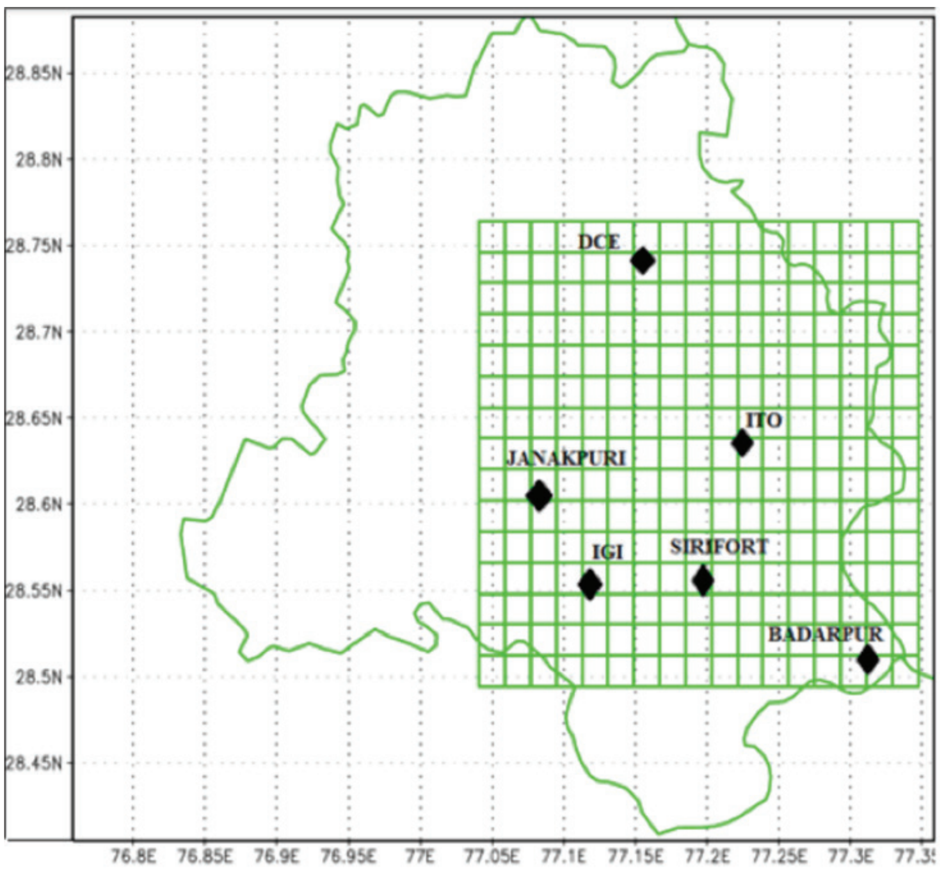

Figure 1.2 Area of Study and model Domain Urban Delhi

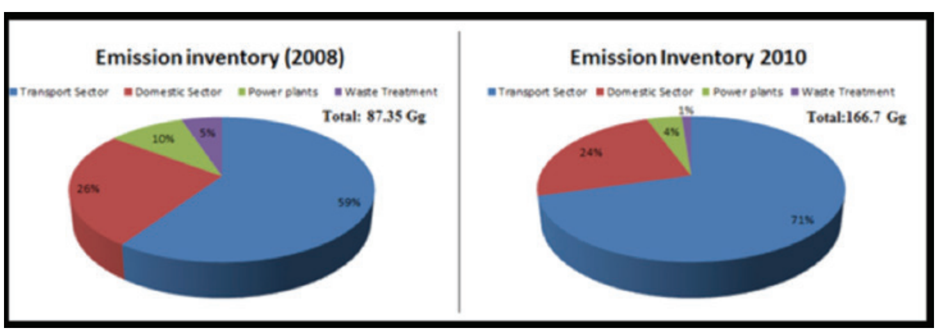

Figure 1.3 Emission Inventory for urban Delhi 2008 and 2010

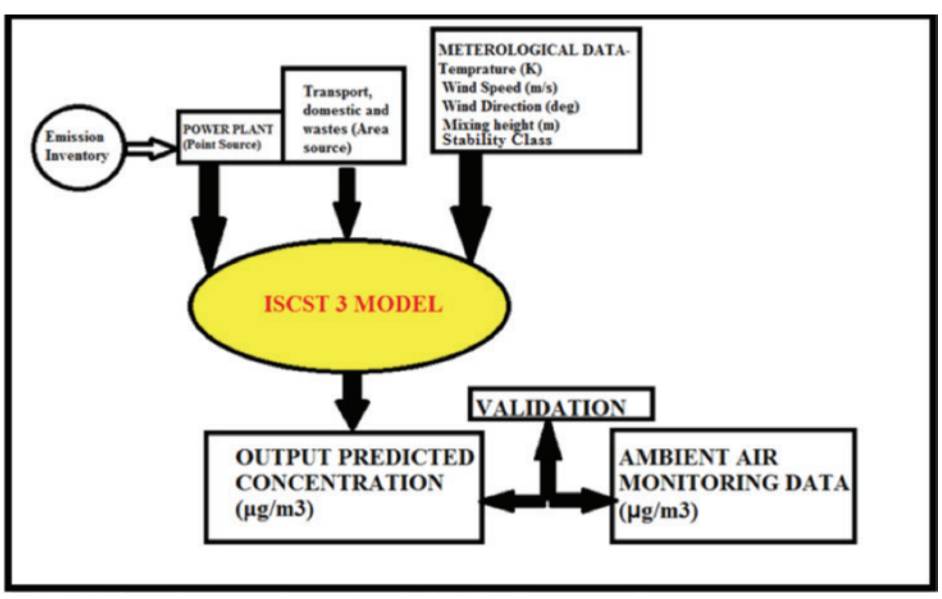

Figure 1.4 Schematic of the Working of ISCST3 Model

contribution was also insignificant. Emissions were scaled up based on the per capita annual increase and projected for 2015. An Air quality Model was selected for analysis of inventory and assessment of air pollution. ISC3 (Industrial source Complex model) developed by U.S. environment protection agency (EPA) was used for the analysis. Defining all the emission sources along hourly meteorological information was given as an input to the model for the years 2008 and 2010. Mathematical models are like stories which need to be validated, hence all the modelled simulations were validated with in-situ measurements provided by Central Pollution Control Board Air quality stations over different locations inside Delhi. According to Chang and Hanna, 2004 model performance is acceptable if the following criteria are satisfied:

-0.5<Fractional bias < 0.5 and NMSE<0.5

The Model Performance was found acceptable for both the years. A negative bias value was observed in the acceptable range which meant model had an overestimating tendency.

Keywords: Emission Inventory, ISC3 (Industrial source Complex model), Validation

RESULTS AND DISCUSSION

As elucidated by the satellite data, results from the model for a smaller domain at a higher resolution showed more hotspots within the Megacity city. The regions exceeding the CPCB annual standard of 40µg/m^3 are identified as hotspots. The hotspots are abbreviated as MP-Mangolpuri, KB-Karol Bagh, SDG-Safdarjang, UDV- Udyog Vihar, KG-Kashmeri Gate, ITO-Income Tax Office, SF- Sirifort, MHR- Mehrauli, OKL-Okhla Industrial area and BP- Badarpur. As per our 2008 analysis we obtained eight regions of hotspots in which following locations were identified namely Mangolpuri, Karol Bagh, Safdarjang Airport, Sirifort, Udyog Vihar, Mehrauli, Kashmeri Gate, ITO and Badarpur. As per our 2010 and 2012 analysis we obtained nine regions of hotspots in which following locations were identified namely Mangolpuri, Karol Bagh, Safdarjang Airport, Sirifort, Udyog Vihar, Kashmeri Gate, ITO, Okhla industrial area, Badarpur. It can be observed that there has been an increasing trend of concentrations from 2008 to 2010. Concentrations have increased over the entire study domain including the hotspot. The annual average concentrations for 2008, 2010 and 2012 were 32.09µg/m^3, 33.86 µg/m^3 and 38.90 µg/m^3 respectively.

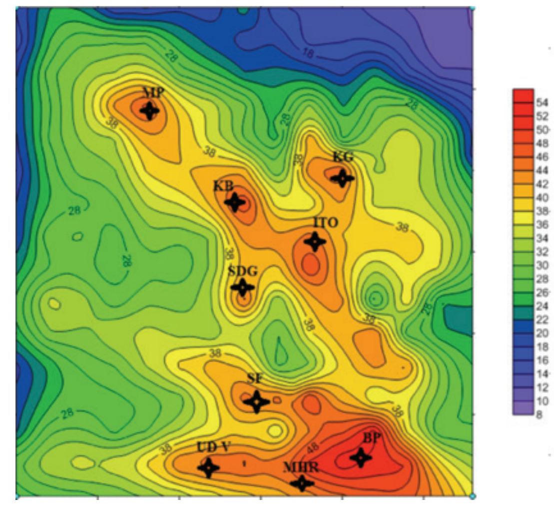

Figure 1.5: Annual NO2concentration contour (µg/m3) for 2008

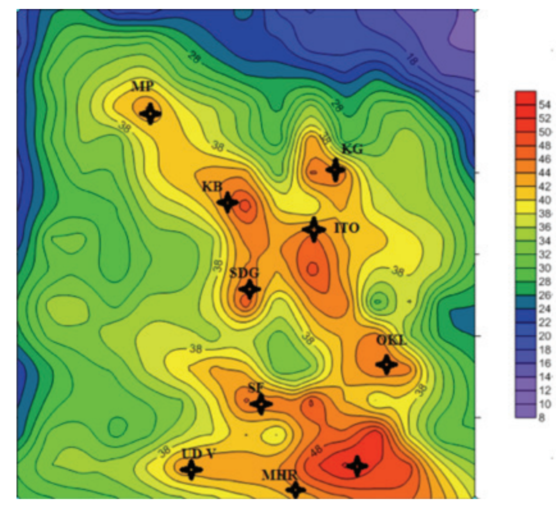

Figure 1.6: Annual NO2concentration contour (µg/m3) for 2010

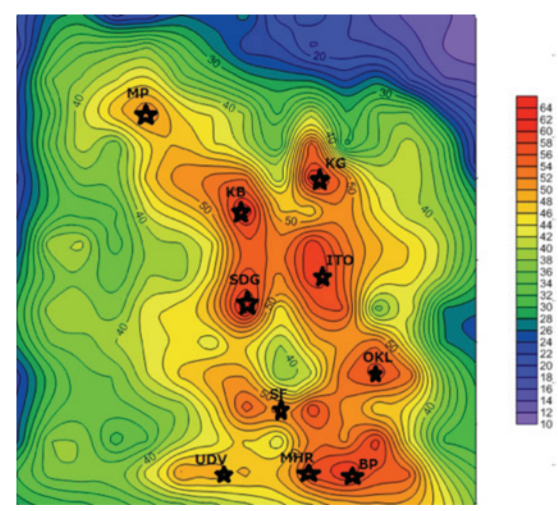

Figure 1.7: Annual NO2concentration contour (µg/m3) for 2012

CONCLUSION

Hotspots were located with help of Remote sensing data (Ozone monitoring instrument) and analysis was done for the most critical NOx hotspot found in India, namely Megacity Delhi. Air Quality Modelling using ISCST3 model was implemented effectively to assess the emission inventory. Emission inventory has been prepared for NO_2 for years 2008, 2010 and projected for 2012. Nine and ten hotspots were identified in Delhi for 2008 and 2010 respectively as they exceeded the annual ambient air quality standard. Based on these trends more futuristic emission scenarios can be constructed and model can be simulated for different so called "what if scenarios" to assess the impact of mitigation strategies and also to check the effectiveness of existing policy measures undertaken to tackle Air Pollution.

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