# ENVIS-IITM NEWSLETTER

## Indian Institute of Tropical Meteorology, Pune

### Atmospheric Pollution & Climate Change

(The project of Ministry of Environment, Forest & Climate Change, Govt. of India)

# Delhi Emission Inventory 2018



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**Contents**



# Editorial

*Clean air is a basic necessity for human health and well-being. When the local concentrations of air pollutants exceed certain threshold limit, it can have adverse effect on the health of human beings, plants and animals. Most of the mega-cities all over the world are experiencing the deterioration of air quality, including National Capital Territory of Delhi. After 8 years, Indian Institute of Tropical Meteorology (IITM) Pune under the Ministry of Earth Sciences along with experts and researchers from Utkal University, Bhubneshwar, School of Planning and Architecture, Environmental Information System (ENVIS) Resource Partners of MoEFCC, CPCB, IMD and DPCC ; is conducting an emission inventory campaign. Emission Inventory is a comprehensive listing by local sources of air pollutant emissions and amount of air pollutants released into air as a result of a specific process in a particular geographic region during a specific time period. This is one of the most critical factors required for air pollution forecasting models along with meteorological input to forecast the air quality and frame the mitigation strategy. Quality of forecasting depends on accuracy and reliability of emission estimation. Emission inventories could also be used for air quality management and formulating environmental policy. To deeply understand the air pollution scenario of Delhi, this emission inventory will identify the latest sources of pollution which are contributing towards the "poor' air quality.*

*IITM being a ENVIS RP, this newsletter is providing the inside glimpses of the ongoing emission inventory at Delhi.*

***- Dr. Gufran Beig***

## Air Pollution Scenario in Delhi NCR

Air pollution is one of the major problems faced by many urban cities across the country. Delhi is no exception as it harbors the right mix of sources which can create an unacceptable urban air pollution scenario. Since last few decades each year Delhi is facing severe air pollution episodes especially during winters. Delhi is most populous city in the country, which is land locked & also has extreme urban temperatures; and increasing population are leading to emission of abundant air pollutants. Though Delhi is having extensive air quality monitoring systems from many governmental and private organizations the sources of air pollution varies each year. To know the ground level sources of emissions an intensive emission inventory (EI) is needed.

**Figure 1: Smog over Delhi-NCR**

"***Emission inventory is a scientific way to identify aggregated local source contribution and their region-specific spatial distribution within a confined boundary. It is a more effective tool to identify hot spots and plan control measures," explains Prof. Gufran Beig, Project Director, SAFAR at IITM,Pune"***

SAFAR- System for Air Quality and Weather Forecasting was first time launched in Delhi during Commonwealth Games held in 2010. Before launching the air quality monitoring system, in 2009 SAFAR's first ever emission inventory campaign was conducted. After 8 years of air quality monitoring, emission inventory campaign and changes in environmental protection laws, even today Delhi is setting examples for worst extreme air pollution events.

In recent 8 years many changes have been witnessed by Delhi, again population explosion (projected population for 2016 for Delhi is 21285000- India Stats) took place and the resources consumed were tremendous, anthropogenic emission have increased extensively. It has come to a time to measure this change and examine the strategies used in Air Quality Monitoring Systems for Delhi NCR.

The two emission inventories over the span of 8 years have been conducted by the Indian Institute of Tropical Meteorology (IITM), Pune under the Ministry of Earth Sciences collaboration with other stakeholders.

The Emission Inventory conducted this year was in collaboration with Indian Meteorological Department, Central Pollution Control Board, Delhi Pollution Control Board, Utkal University- Bhubaneshwar and School of Planning and Architecture, Delhi.

## Developing an Emission Inventory

Emission Inventory is the first step towards understanding the sources and their strength. These sources depending upon where they are located, at what elevation they emit, what is their frequency and duration of emission, etc. can provide the major information about the character of a city in terms of air pollution. Emissions from all


**Figure 2: Domain of Interest for present Emission Inventory Study over**

sources, if identified and also quantified for a particular location and time, can be effectively used for dispersion modeling purposes. Such simulation is able to provide the predicted levels of air pollutants in the ambient air of a city grid for a future year based on growth rate of the sources. Development of emission inventory is a complex process due to numerous, diverse and widely dispersed emission sources in city like Delhi and its adjacent region and requires huge amount of high-resolution activity data, emission factors along with knowledge of fundamental scientific processes.

Emission Inventory tools and techniques vary widely depending upon the type and quality of data available in the city. Primary surveys combined with available information from varied sources in the city are used for estimation of all major activities, which are polluting the air. These are used in conjunction with Emission Factor for building Emission Inventory. The study for this year's EI involved

preparation of detailed emission inventory with estimation of emissions from various activities such as vehicular, industrial, residential, commercial, etc.

Air Quality monitoring is not as simple as it looks; it's debatable to represent city air quality based on single station value or single hour data. To provide an AQI representative of a city, single station data is not suitable. It may even mislead as it will be biased towards a particular activity or environment. As per international guidelines, correct way to know ONE index for a city air quality is to consider different microenvironments. The emission inventory helps in knowing and understanding these microenvironments and the sources of air emissions in it. Ground level data about emissions from as many as 26 different sources of pollution was collected throughout the city, as part of a three-month campaign to prepare an emission inventory. The similar exercise was undertaken in 2010 just before the Commonwealth Games. Since then, significant changes have occurred in land use and demography. Many new sources were now quantified. For a typical metro city Background; Commercial; Urban complex; Sub-urban; Residential; Industrial; Road side; Traffic junction etc. are the microenvironments covered in the monitoring network.

## Delhi Emission Inventory 2018

This year a mega emission inventory campaign involving around 150 students under the supervision of group of scientists mapped all possible local sources of air pollution with around 37,500 hours of work. The main focus of the campaign is to generate missing primary data, validate some uncertain secondary data and to collect the available secondary data.

| No. | Sectors | Important Factors and data |
|---|---|---|
| 1 | Transport | • Category, Fuel Type & Quantity<br>• Vehicle/hour/Road type/VKT |
| 2 | Slum | • Type and Fuel used Quantity for cooking |
| 3 | Brick Industry | • Type, Technology and Fuel used Quantity |
| 4 | Street Vendor | • Type and Fuel Quantity<br>• Coal for Tandoor |
| 5 | Hotel (Dhabas) | • Type of Fuel & Quantity used for cooking |
| 6 | Construction Sites | • Type of Fuel & Quantity used for cooking activity |
| 7 | Speed Breaker | • No. of Speed Breakers per Km<br>• Road Type |
| 8 | Major Hospitals | • Number of outdoor patients<br>• Vehicle load and DG sets |
| 9 | Tourist places | • Tourist Load, Vehicle load |
| 10 | Shopping Malls | • No. of vehicle parked |
| 11 | Traffic Junctions | • No. of Traffic Junctions |
| 12 | Railway Stations | • Passenger load<br>• Vehicle load in station area |
| 13 | Airport | • Vehicle No. (Delhi & Out-side vehicle No.) |
| 14 | Industry | • Type, Technology and Fuel used |
| 15 | Local Transport (Ola/Uber/Taxi) | • Km run per day and Numbers |
| 16 | Household | • Type of fuel used |
| 17 | Waste Burning | • Quantity per capita |
| 18 | Biomedical Waste | • Quantity generated |
| 19 | Power plant | • Technology used, Coal used |
| 20 | Crematorium | • Spatial locations, No. of Cases |
| 21 | Large hotels | • Fuel used for cooking |
| 22 | Large school/college | • Students no. & Travel load |
| 23 | Wind Blown Road Dust | • Road condition, vehicle load etc. |
| 24 | Diesel Generator | • Fuel used for no. of hours |
| 25 | Mobile tower | • Fuel Used & numbers |
| 26 | Routine Milk & Vegetable Van | • No of vehicle (outside) |

**Figure3:**

***Dr.M. Rajeevan, Secretary, Ministry of Earth Sciences (MOES), Govt. of India, flagged off the SAFAR mega emission inventory campaign for Delhi on 12th April 2018. The campaign will go on for 2 months and result will be a comprehensive Emission Inventory Report.***

The final product- the report will consists with 400m x 400m high-resolution emission inventory of Delhi and fringe area of eight important air pollutants (PM2.5, PM10, NOx, CO, SO2, BC, OC, VOCs) is being prepared.

Emissions are estimated for two specific regions- (a) The geographical area of Delhi city only and (b) Delhi city area along with surrounding regions measuring 70x65 $km^2$. Ground level activity data about emissions from as many as 26 different sources of pollution were collected.

## The Methodology for Emission Inventory

This year Emission Inventory was designed with optimization of Top-Down and Bottom-Up approaches to fulfill the following requirements: Identification of all major emission sources and reliable estimation of emission quantities of significant pollutants like PM10, NOx, $SO_2$, CO, etc. Adequate representation of various factors influencing emissions, such as, land use, socio-economic structure, spatial & temporal distribution of source activities vis-à-vis pollutants. Evaluation of time weighted emissions and their distribution for modeling needs.

**Figure 4:** ***Data Collection and slum surveys by conducting personal interviews***

Besides using data from secondary sources of information, activity data were also obtained, wherever necessary, through primary surveys covering, questionnaire surveys, personal interviews, house-to-house surveys, actual traffic counts, etc. While this approach provides reasonable quality of data on emission estimates, resolutions with respect to time and space are limited in view of resources and available time-frame. In cities, except for a few large point sources, most of the sources being low-level sources may have zone of maximum impact. Therefore, it was reasonable to assume that in addition to large point source, if any, air quality monitoring locations would mostly capture the contribution of sources located within the zone of influence. As such, greater emphasis was laid on primary surveys around monitoring locations.

An optimized activity framework was followed as depicted in detailed in-situ primary surveys within zone of influence around each monitoring location were planned to identify all significant pollution sources (e.g. construction activities, industries fuel use, domestic fuel combustions, size and activities of DG sets, etc) and also to collect activity data through personal interviews. Diurnal traffic count surveys on different categories of roads along with personal interviews at parking lots/petrol pumps with vehicle owners for obtaining data on vintage, fuel use, vehicle kilometer traveled (VKT) per day, etc. Use of refined Emission Factors (EF) for vehicular exhaust emissions. Selection of appropriate EF for non-vehicular emission sources

i.e. roadside dust, domestic fuel combustions, industries, construction activities, etc. ⍰

The data being collected promises to be more accurate than what was collected in 2010 because it will include all possible sources of emissions—from crop burning to wood burning in crematoria—and also because of finer grids in which it is being collected. The city has been divided into grids measuring 400 metre X 400 metre.

**Figure 5:** ***Some Glimpses of Ongoing Survey for Transport Sector and Slum Regions of Delhi.***

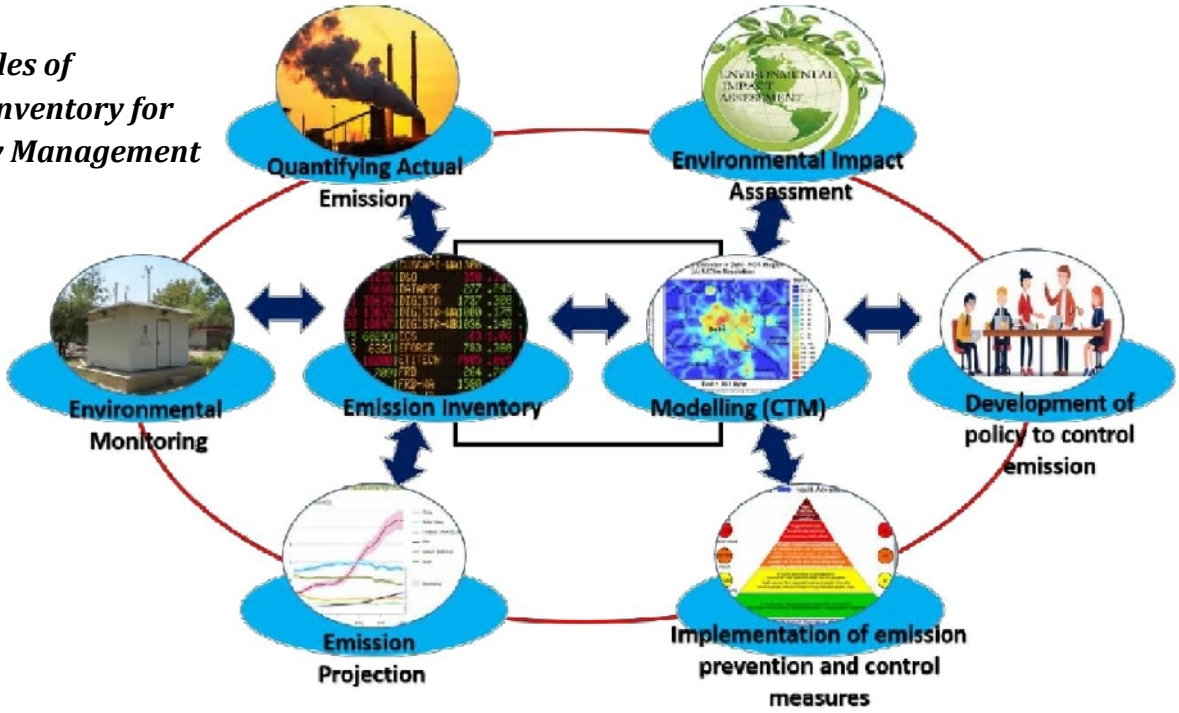
***Students speak to people to understand air pollution sources.***

While industry and transport sectors are apparent sources of air pollution, there are scores of other contributors to deteriorating air quality. Preparing a detailed emission inventory can give a clearer picture, instead of the 'source apportionment' approach.

In each of the grids, activities contributing to air pollution will be mapped. In each grid, pollution will be mapped in terms of sources such as slums, small-scale industries, road conditions, traffic congestion, vendors, population density, vehicle density, road conditions and potential of dust lifting based on paved and unpaved areas. The new sectors and factors, which are being targeted for mapping include the condition of roads, pattern of transport flow from surrounding regions, construction activity, aviation, practices of immigrant workers and changing lifestyles, cooking habits etc.

***"Once we have ward-wise and even smaller level datasets which could be mapped in terms of defined data available for broader boundaries, we will use Geographical Information System (GIS)-based statistical model with inputs from remote sensing satellite images as well as commercially available Google Live maps to develop the inventory. It will thus reflect both primary and secondary data sets for each grid," said Prof Gufran Beig. The emission campaign will be a useful input for the SAFAR air quality forecasting system.***

**Figure 6:** ***Roles of Emission Inventory for Air Quality Management***

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