CE 213A
Introduction to Environmental Science

Unit 2: Environmental Pollution
A. Air Pollution

Dr. Anubha Goel

FB 319, anubha@iitk.ac.in, x 7027

Schedule : LEC Mon Wed Fri 5:10 – 6 pm

Objective

Learn about pollution causing processes, major sources; effects on health and environment; control measures and model transport in

A. Air,
B. Water , and
C. Soil

Noise pollution also covered.

Content: A. Air Pollution

- ***Outdoor Air Pollution***
  - *Monitoring* air Quality
  - parameters; standards for regulated pollutants: NAAQS
  - Communication of status of air quality - AQI
- **Effects of air pollution on health and environment**
- **Sources of ambient air pollution**
- **Major air pollutants**
  - Types of air pollutants, Characterization
    - Primary, secondary,
    - Criteria, HAPS
  - major processes at sources that lead to air pollutant emissions
- **Smog, Acid Rain**
  - Sources and effects of acid deposition
  - Types, formation, and effects of smog

Content: A. Air Pollution

- Effect: Health impacts, acid rain, smog
  - Basics of environmental risk assessment,
- **Air pollution control techniques**
  - Overview of major devices - Cyclones, bag houses, venture scrubbers, spray towers
- **Transport phenomenon**
  - Factors affecting pollutant levels observed
  - *Meteorology - Components and Characteristics of the earth's atmosphere:*
  - : Advection, Dispersion, Plumes
- Introduction to / overview of transport models -
  - Gaussian plume modeling, dispersion modeling
  - Mass balance model

Ref. Nazaroff; Peavy Rowe Part 2

Air pollution occurs when….

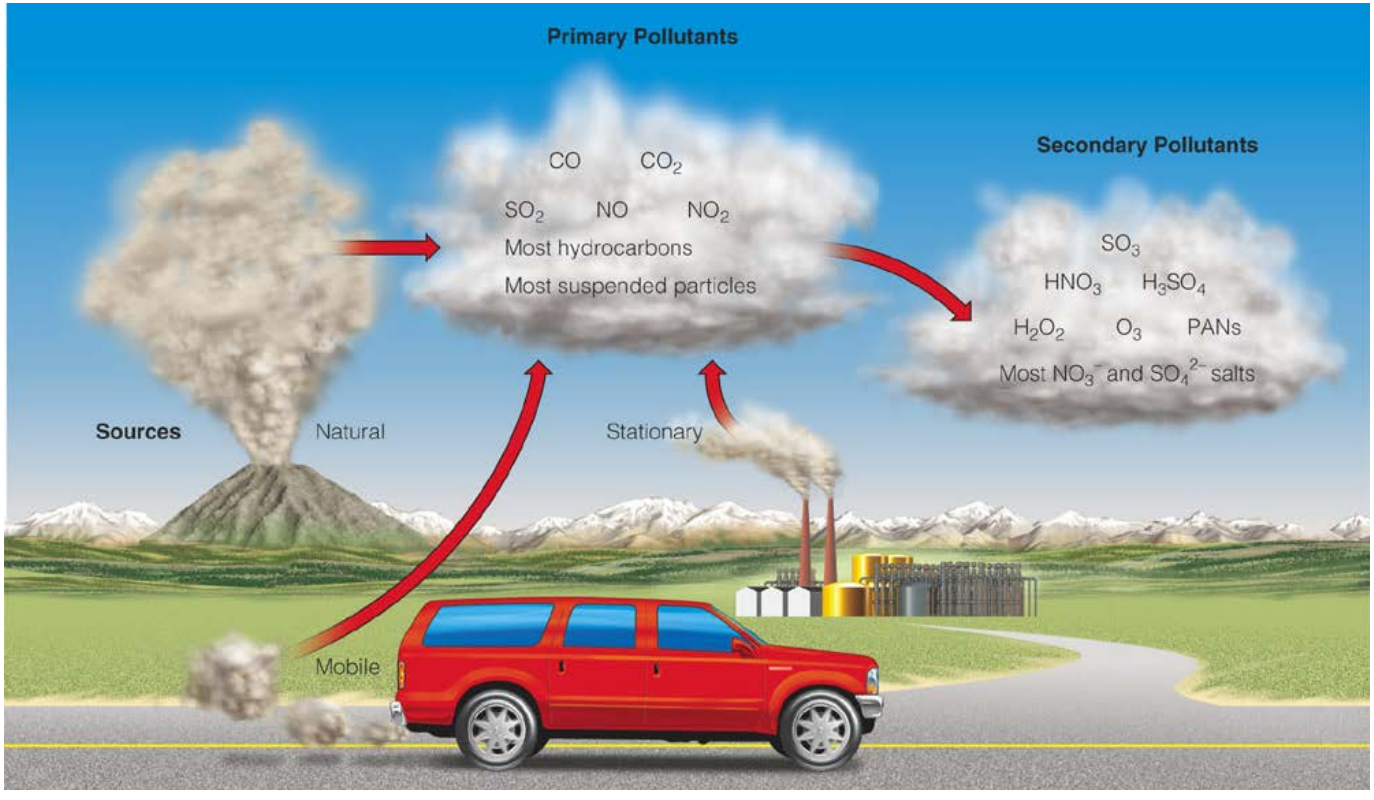
"any solid, liquid or gaseous substances (including noise) present in the atmosphere in such concentrations as may be or tend to be injurious to human beings or other living creatures or plants or property or environment".

Classification: Indoor and outdoor air pollution

Exposure to indoor and outdoor air pollutants may increase an individual's risk for morbidity and mortality from a variety of different conditions in multiple organ systems. These exposures cause and/or exacerbate respiratory diseases and diseases in other organ systems. Air pollution may also cause sensory irritation and decrease well-being through, for example, loss of visibility.

Outdoor Air Pollution

- **Primary** - Released directly from planet's surface.
  - Dust, smoke particles, Nitrogen, Carbon etc.
- **Secondary** - Formed when primary pollutants react or combine with one another, or basic elements.



Monitoring of ambient air quality

National Air Quality Monitoring Programme (NAMP)

Central Pollution Control Board is executing a nation-wide programme of ambient air quality monitoring known as NAMP.

- The objectives of the NAMP are
  - to determine status and trends of ambient air quality;
  - to ascertain whether the prescribed ambient air quality standards are violated; and to Identify Non-attainment Cities;
  - to obtain the knowledge and understanding necessary for developing preventive and corrective measures and to understand the natural cleansing process undergoing in the environment through pollution dilution, dispersion, wind based movement, dry deposition, precipitation and chemical transformation of pollutants generated.

✓ Parameters monitored:

- ✓ Under NAMP, four air pollutants SO2, Oxides of Nitrogen as NO2, Respirable Suspended Particulate Matter (RSPM / PM10) and Fine Particulate Matter (PM2.5) have been identified for regular monitoring at all the locations. The monitoring of meteorological parameters such as wind speed and wind direction, relative humidity (RH) and temperature were also integrated with the monitoring of air quality
- ✓ Trace Metals, PAHs, NH_3 in few cities;
- ✓ BTX, Ozone monitoring conducted in Delhi and some major cities

NAAQS
National Ambient Air Quality Standards
for regulated pollutants

- The current National Ambient Air Quality Standards were notified on 18 November 2009 by CPCB for pollutants considered harmful to public health and the environment.
- Agencies whose standards are followed internationally: WHO, US EPA

Ambient air quality refers to the condition or quality of air surrounding us in the outdoors.

Primary and Secondary Standards

The Clean Air Act (USA) identifies two types of national ambient air quality standards.

Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly

Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

Ambient air quality refers to the condition or quality of air surrounding us in the outdoors.

NAAQS – INDIA : Standard Values

Pollutant	Averaging Period	Primary/Secondary	Historic NAAQS (µg/m^3)	Revised NAAQS (µg/m^3)
CO	1-Hour	Primary	40,000	40,000
	8-Hour	Primary	10,000	10,000
Ozone	8-Hour	Primary/Secondary	75 ppb	**Withdrawn**
Pb	3-Month Rolling	Primary/Secondary	1.5	**0.15**
PM_{10}	24-Hour	Primary/Secondary	150	150
$PM_{2.5}$	24-Hour	Primary/Secondary	65	**35**
	Annual	Primary/Secondary	15	15
NO_2	1-Hour	Primary	N/A	**188**
	Annual	Primary/Secondary	100	100
SO_2	1-Hour	Primary	N/A	**196**
	3-Hour	Secondary	1,300	1,300
	24-hour	Primary	365	**Revoked**
	Annual	Primary/Secondary	80	**Revoked**

Communication of status of air quality

NAQI

COLOUR CODING	AQI Range Index	O_3 (8h avg) (ppb)	CO (8h avg) (ppm)	NO_2 (24h avg) (ppb)	PM_{10} (24h avg.) (µg/m3)	$PM_{2.5}$ (24h avg) (µg/m3)
Good	0 - 100	0 - 50*	0 - 1.7*	0 - 42*	0 - 100*	0 - 60*
Moderate	101 - 200	51 - 98	1.8 - 10.3	43 - 94	101 - 150	61- 90
Poor (Unhealthy for sensitive group)	201 - 300	99 -118	10.4 - 14.7	95 - 295	151 - 350	91-210
Very Poor	301 - 400	119 - 392	14.8 - 30.2	296 - 667	351 - 420	211 - 252
V. Unhealthy	401- Above	393*- Above	30.3- Above	668- Above	421- above	253- above

Note: NAAQS must be adopted from MoEF (2009) Gazette Report which is cut off limit of Good

An **air quality index** (AQI) is a number used by government agencies to communicate to the public how polluted the air currently is or how polluted it is forecast to become.

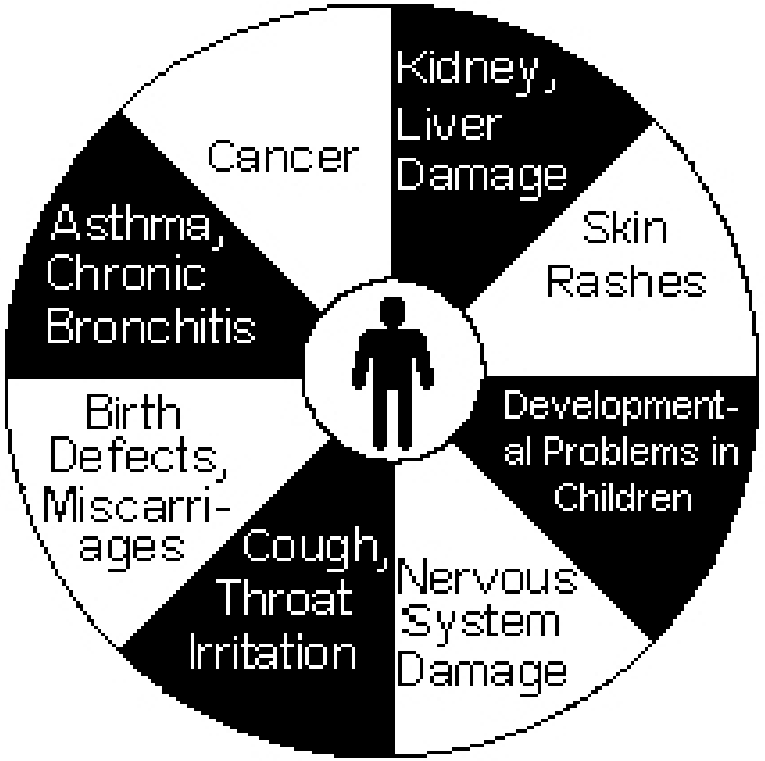
Effects of air pollution

Environment

- Acid Rain
- Smog

Human Health

- Inhalation and dermal contact is the main pathway of exposure
- Lung deposition



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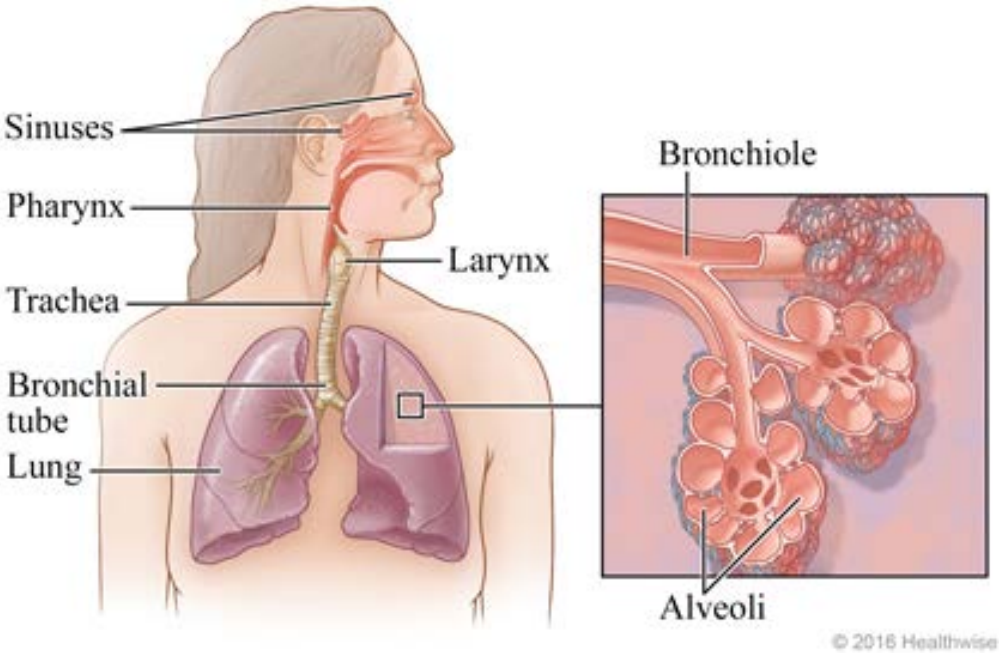
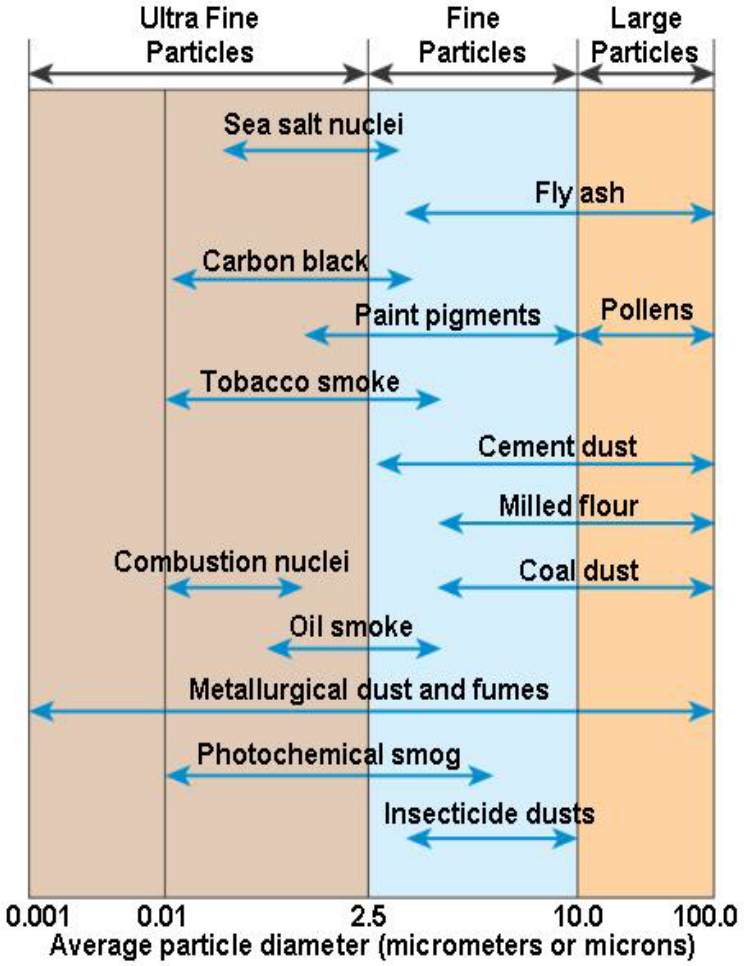

Sinuses
Pharynx
Larynx
Trachea
Bronchial tube
Lung
Bronchiole
Alveoli
© 2016 Healthwise


Ultra Fine Particles
Fine Particles
Large Particles
Sea salt nuclei
Fly ash
Carbon black
Paint pigments
Pollens
Tobacco smoke
Cement dust
Milled flour
Combustion nuclei
Coal dust
Oil smoke
Metallurgical dust and fumes
Photochemical smog
Insecticide dusts
0.001
0.01
2.5
10.0
100.0
Average particle diameter (micrometers or microns)

Research at IIT Kapur

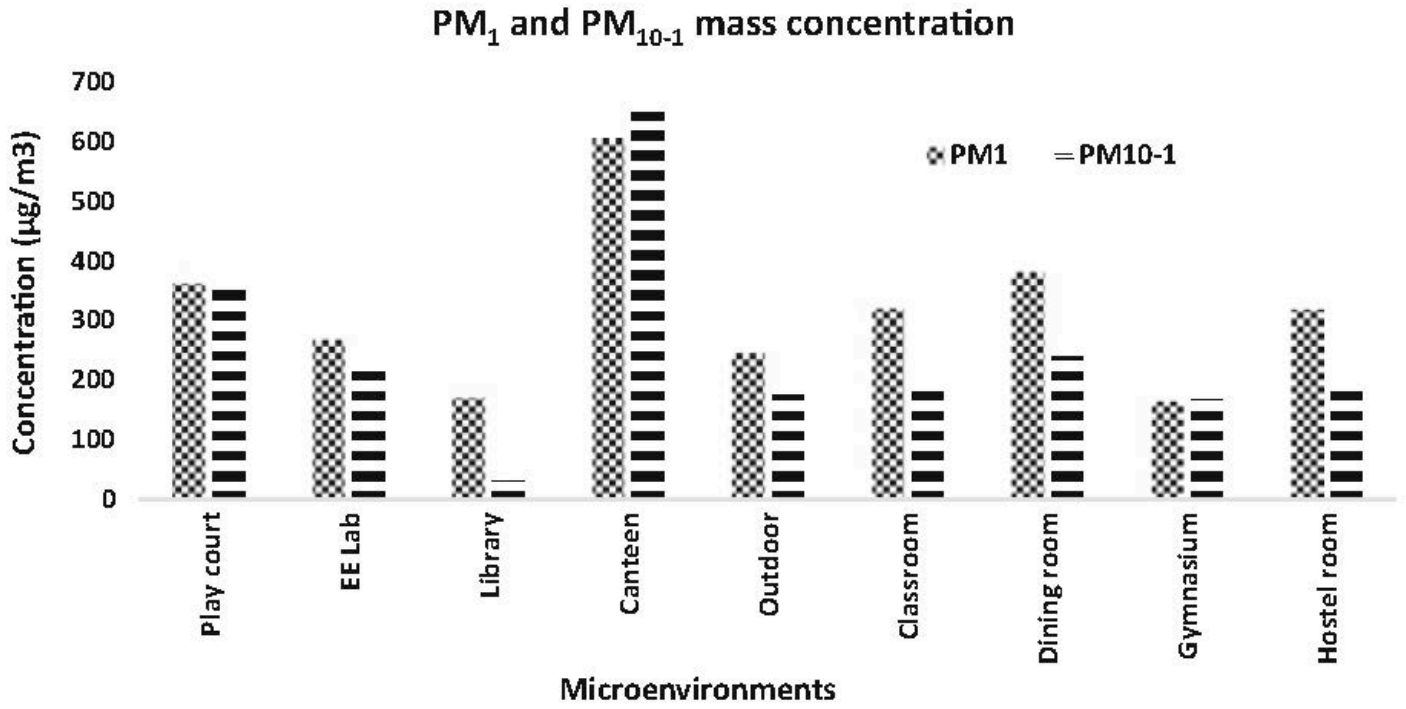


Fig. 4.2 Mean MC of PM_1 and PM_{10-1} in different microenvironments

Goel, A. Izhar, S. Gupta, T. (2017) .**Study of Environmental particle levels, its effect on lung deposition and relationship with human behavior.**
Gupta, T. et al. (*Eds.) Environmental Contaminants: Measurement, Modeling and Control* (pp 77-92). Springer Series: *Energy, Environment and Sustainability.* Singapore: Springer Nature Pte. Ltd.

Research at IIT Kapur

Characteristics of exposure to particles due to incense burning inside temples in Kanpur, India.
Goel et al. 2017

Goel et al., Aerosol and Air Quality Research, 17: 608–615, 2017

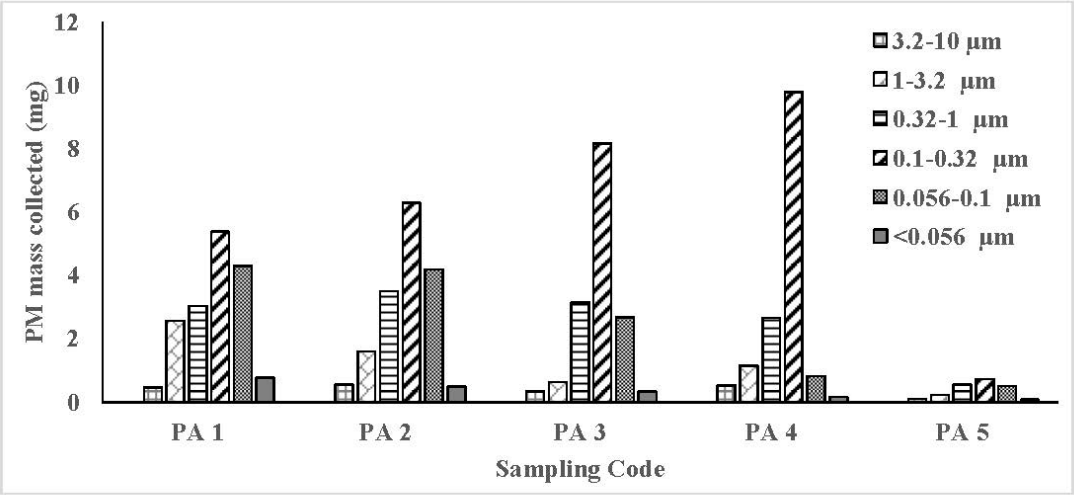


Fig. 1. Mass of particle collected in PA for all stages of MOUDI.

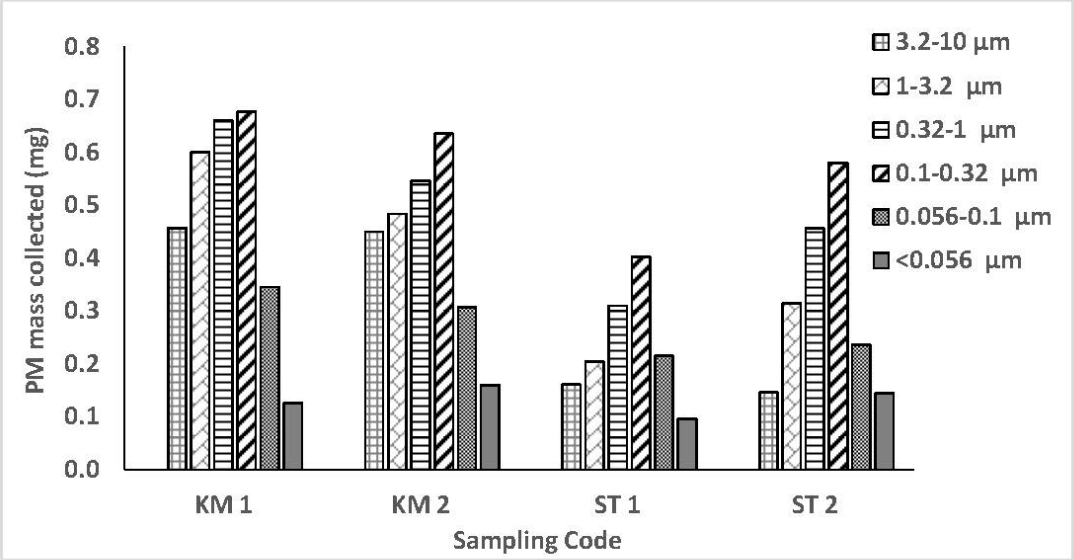
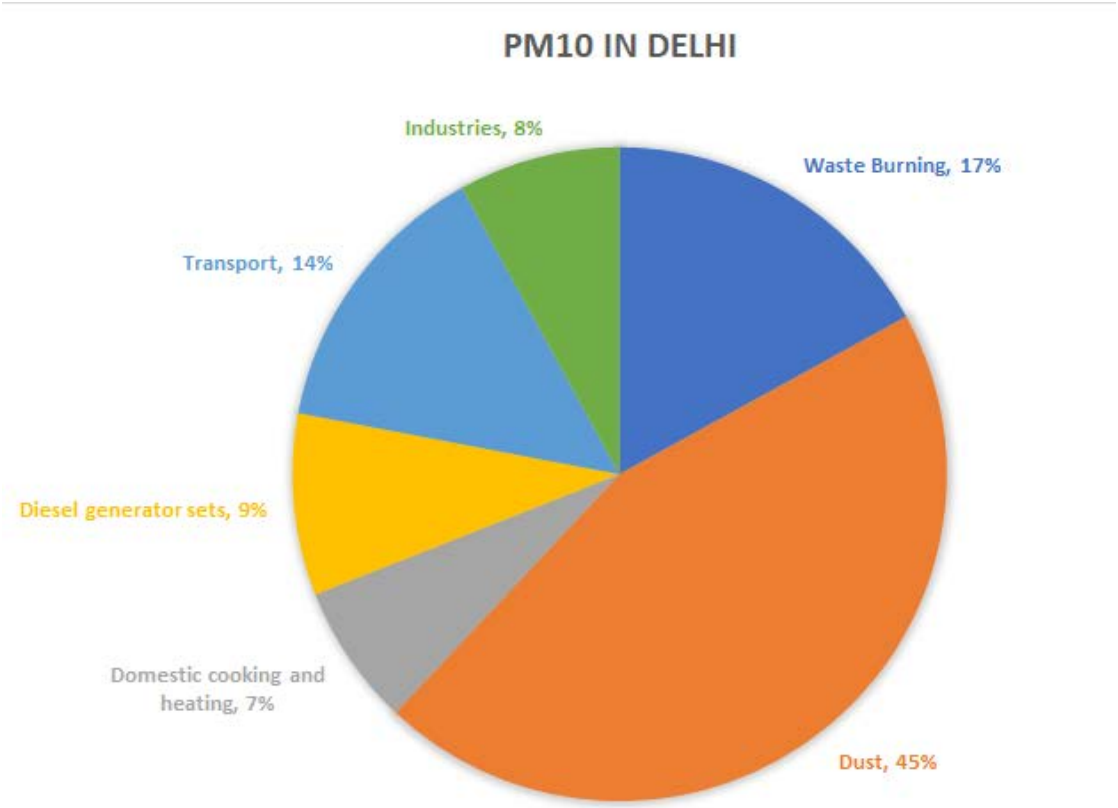
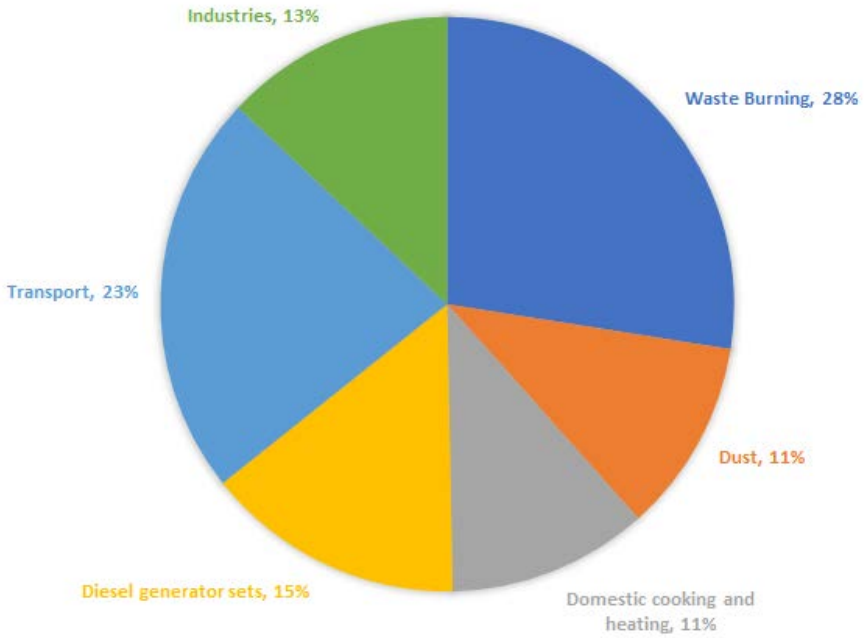


Fig. 2. Mass of particles collected at KM and ST for all stages of MOUDI.

Major Sources of Ambient Air pollution



PM2.5 IN DELHI



PM2.5 IN KANPUR