BHARATHIDASAN UNIVERSITY

Tiruchirappalli- 620024,
Tamil Nadu, India

Programme

M.Sc., Environmental Science & Sustainable Management

Course Title:

Environmental Pollution & Toxicology(Core Choice)

Course Code: 25PGCC03

Unit-II

Introduction to Particulate Matter

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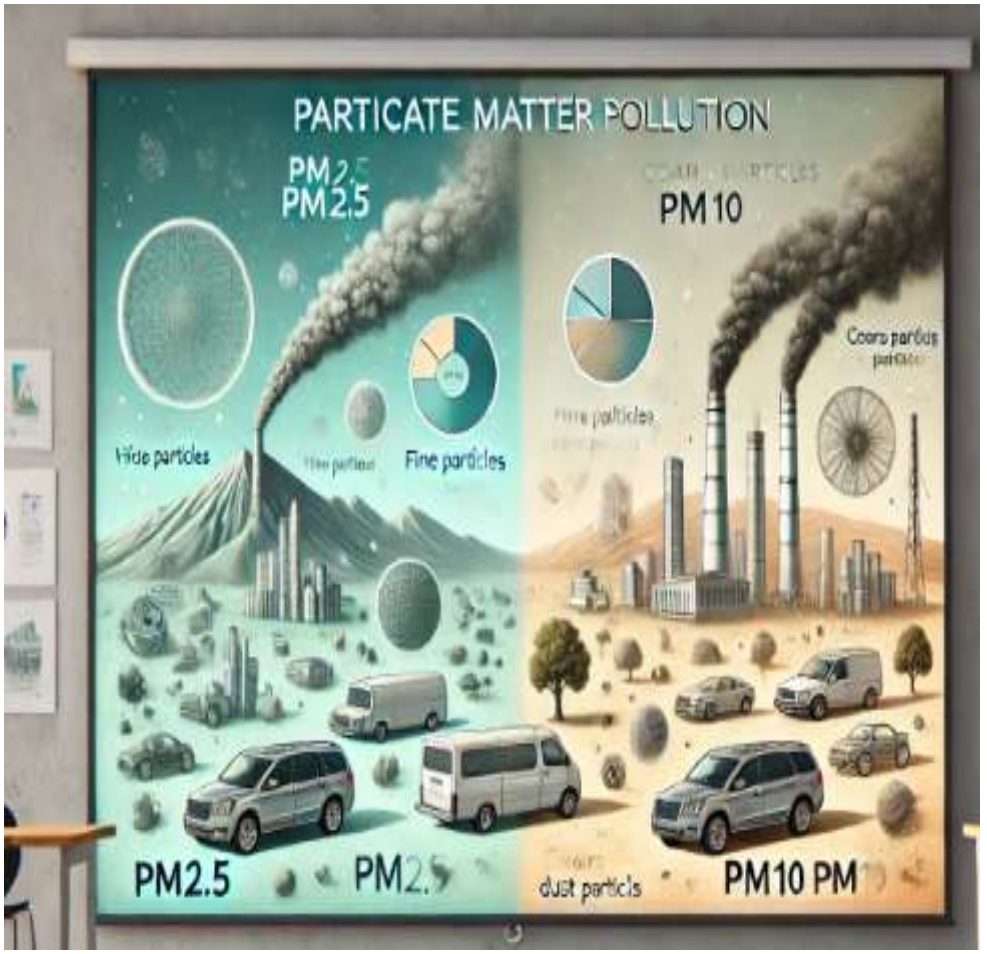
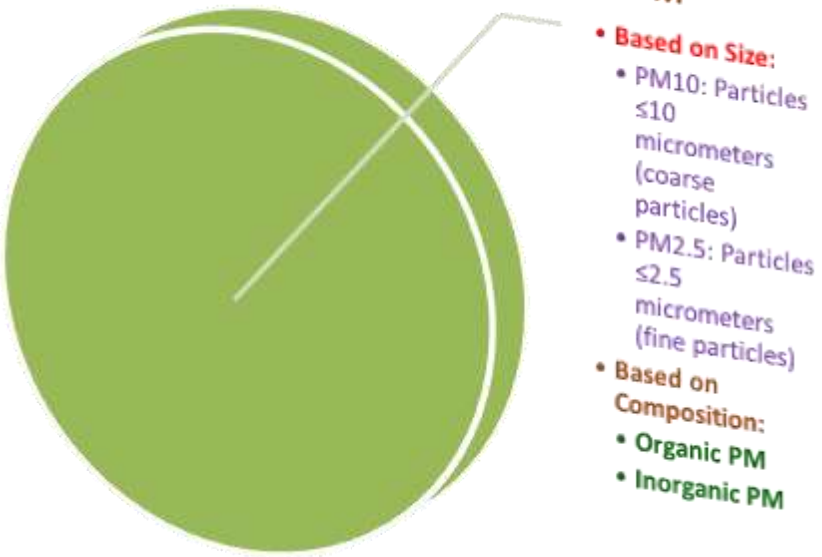
Introduction

What is Particulate Matter (PM)?

- Definition:
  - Definition: **Solid or liquid particles suspended in the air**
- **Importance of Study:**
  - Impacts on air quality, health, and climate.



PM:Types


Classification of PM
• Based on Size:
• PM10: Particles ≤10 micrometers (coarse particles)
• PM2.5: Particles ≤2.5 micrometers (fine particles)
• Based on Composition:
• Organic PM
• Inorganic PM

PM:Properties

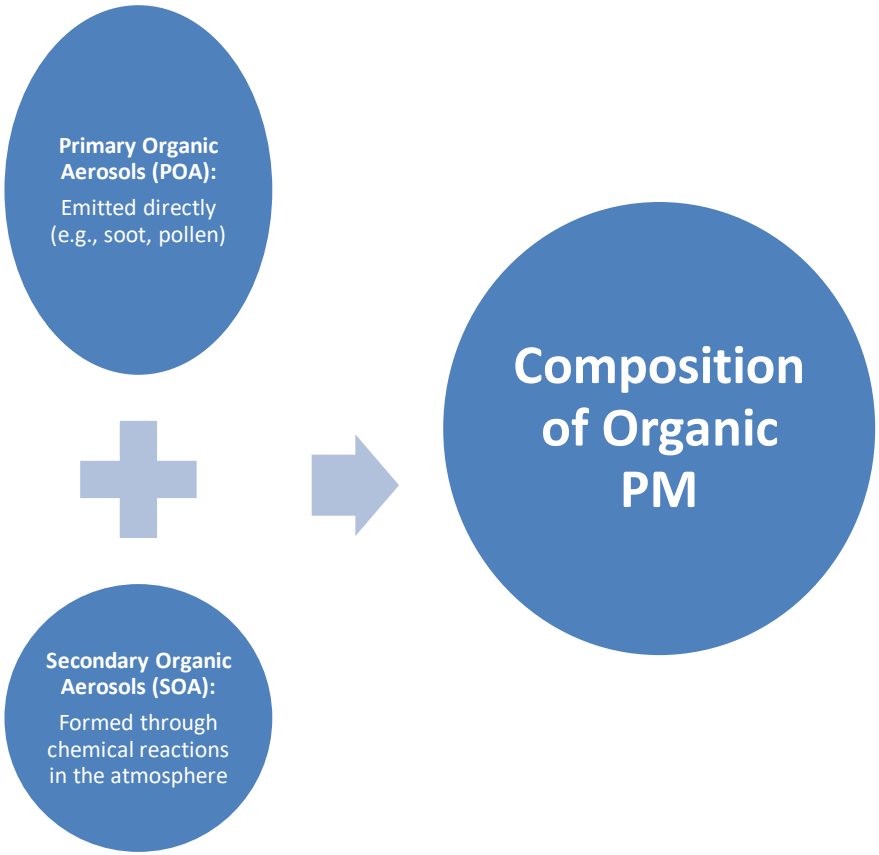
- **Physical Properties:** Size, shape, and density
- **Chemical Properties:** Composition (e.g., sulfates, nitrates, black carbon)
- **Behavior in the Atmosphere:** Lifespan and deposition

PM: sources

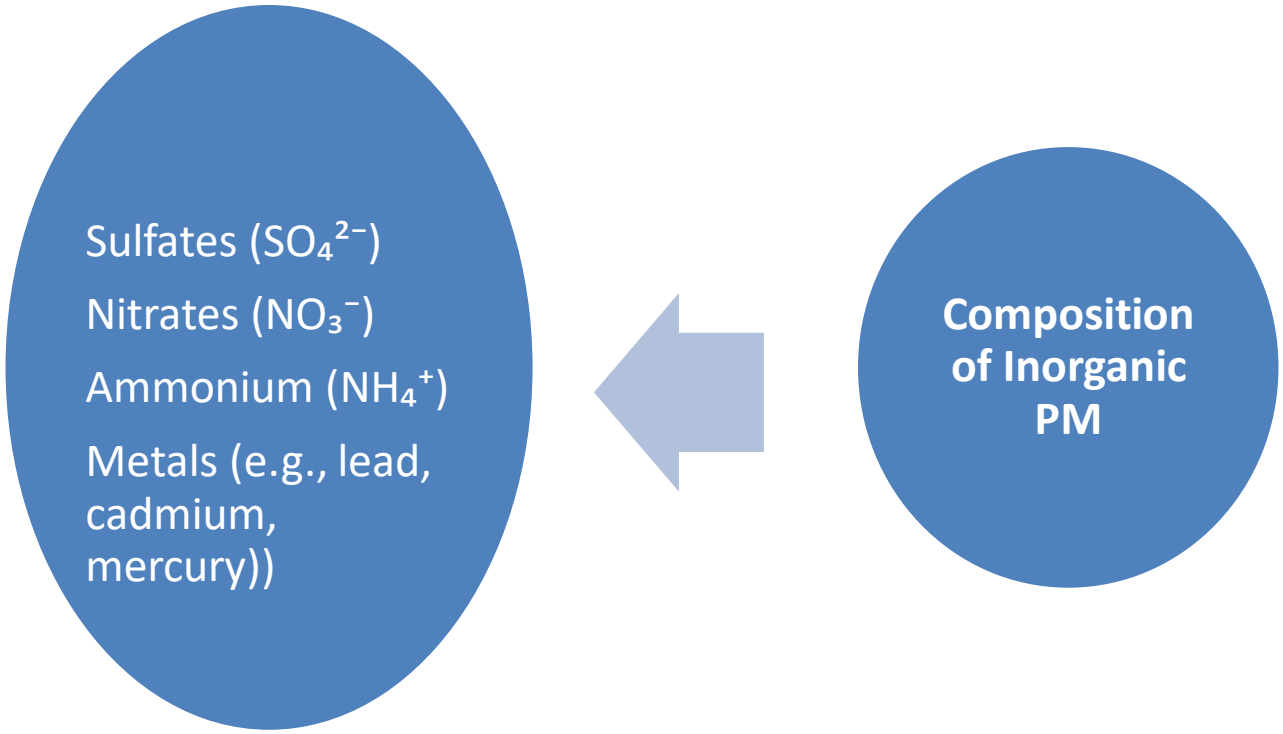
Sources of PM

- **Natural Sources:**
  - Dust storms
  - Volcanic eruptions
  - Sea salt
- **Anthropogenic Sources:**
  - **Industrial emissions**
  - **Vehicle exhaust**
  - **Biomass burning**

PM: Composition



PM: Composition



PM: Case Study(s)

Case Study – Delhi's PM Crisis

- **Problem Statement:**
  - **Severe air pollution episodes in Delhi**
- **Sources:**
  - **Vehicular emissions, construction dust, crop residue burning**
- **Health Impacts:**
  - Increased respiratory illnesses, reduced life expectancy

Interactive Question

I Q 1:

Interactive Question 1

Q: What are the differences between PM2.5 and PM10 in terms of size and health impact?

PM: Impacts on Health

Health Impacts of PM

Short-Term Impacts:

Eye irritation, coughing, asthma attacks

Long-Term Impacts:

Cardiovascular diseases

Premature mortality

Climate Impacts of PM

Direct Effects:

Scattering and absorption of sunlight

Indirect Effects:

Modification of cloud properties

Regional climate variations

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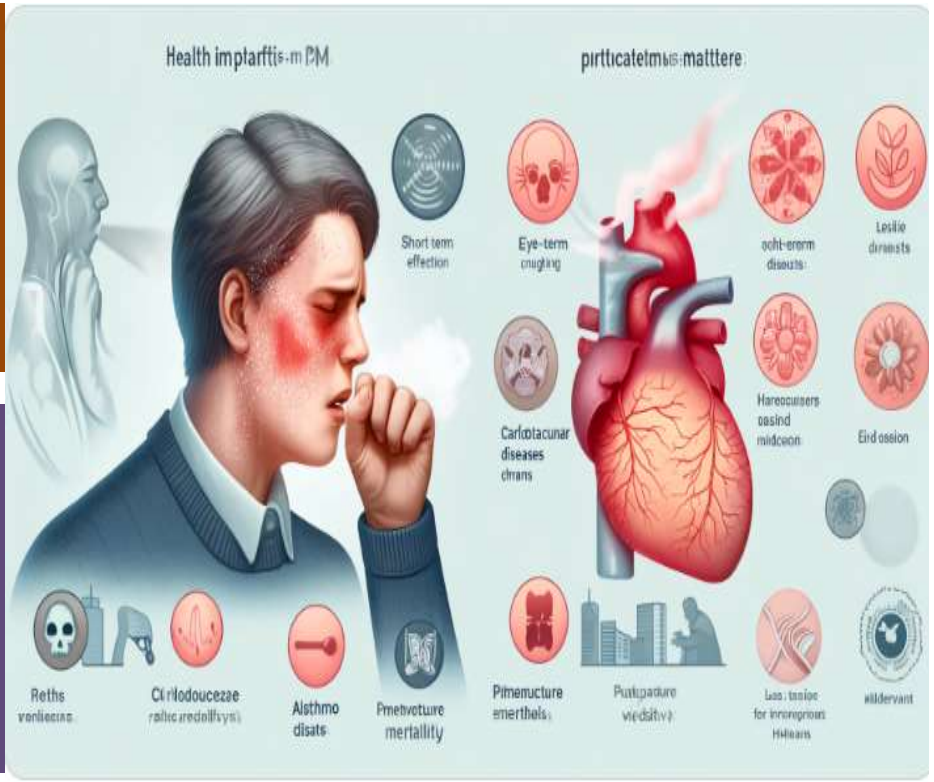


PM :Case study-Agriculture

Case Study – Stubble Burning in Punjab and Haryana

- **Problem Statement:**
  - Post-harvest residue burning contributes to PM pollution
- **Seasonal Trend:**
  - **Peaks during October-November**
- **Impact:**
  - Deteriorates air quality in northern India

PM: Monitoring the levels in India

- **National Air Quality Monitoring Program (NAMP):**
  - Operated by CPCB
- **Air Quality Index (AQI):**
  - How PM2.5 and PM10 are included in AQI calculations?

PM2.5 and PM10 are crucial components in Air Quality Index (AQI) calculations, serving as key indicators of air pollution levels. Multiple studies have demonstrated their significance in assessing air quality and potential health risks. In various AQI calculation methods, PM2.5 and PM10 concentrations are directly incorporated as primary pollutants.

Interactive Question

I Q 2:

Q: List two natural and two anthropogenic sources of particulate matter.

PM:Prevention of Health problems and Mitigation Strategies

Mitigation Strategies for PM

1. **Policy-Level Actions:**
   - Implementation of BS-VI standards for vehicles
   - Phasing out coal-based power plants
2. **Community Actions:**
   - Promoting renewable energy
   - Adoption of cleaner cooking fuels

PM control through technology

- **Technology for PM Reduction**
- **Emission Control Technologies:**
  - Electrostatic precipitators (ESPs)
  - Scrubbers
- **Air Purification Systems:**
  - Filters, ionizers

The implementation of Bharat Stage VI (BS-VI) emission standards in India marks a significant advancement in the country's efforts to mitigate vehicular emissions. **Officially enforced from April 2020, BS-VI standards aim to drastically reduce pollutants such as nitrogen oxides (NOx) and particulate matter (PM) by 89% and 50%, respectively, compared to the previous BS-IV norms**(Bharj et al., 2019). The transition has involved substantial technological upgrades in vehicles and fuels, with a focus on sustainable mobility solutions.

Current Status of BS-VI Implementation

Nationwide Adoption: BS-VI norms are now in effect across India, with initial implementation in major cities like Delhi(Gajbhiye et al., 2023).

Emission Reductions: Studies indicate a reduction in carbon monoxide (CO), non-methane volatile organic compounds (NMVOC), and other pollutants by varying percentages since the introduction of BS-VI(Gajbhiye et al., 2023).

Challenges with NOx: Despite stringent regulations, NOx emissions have paradoxically increased by 4.9% due to the growing vehicular population(Gajbhiye et al., 2023).

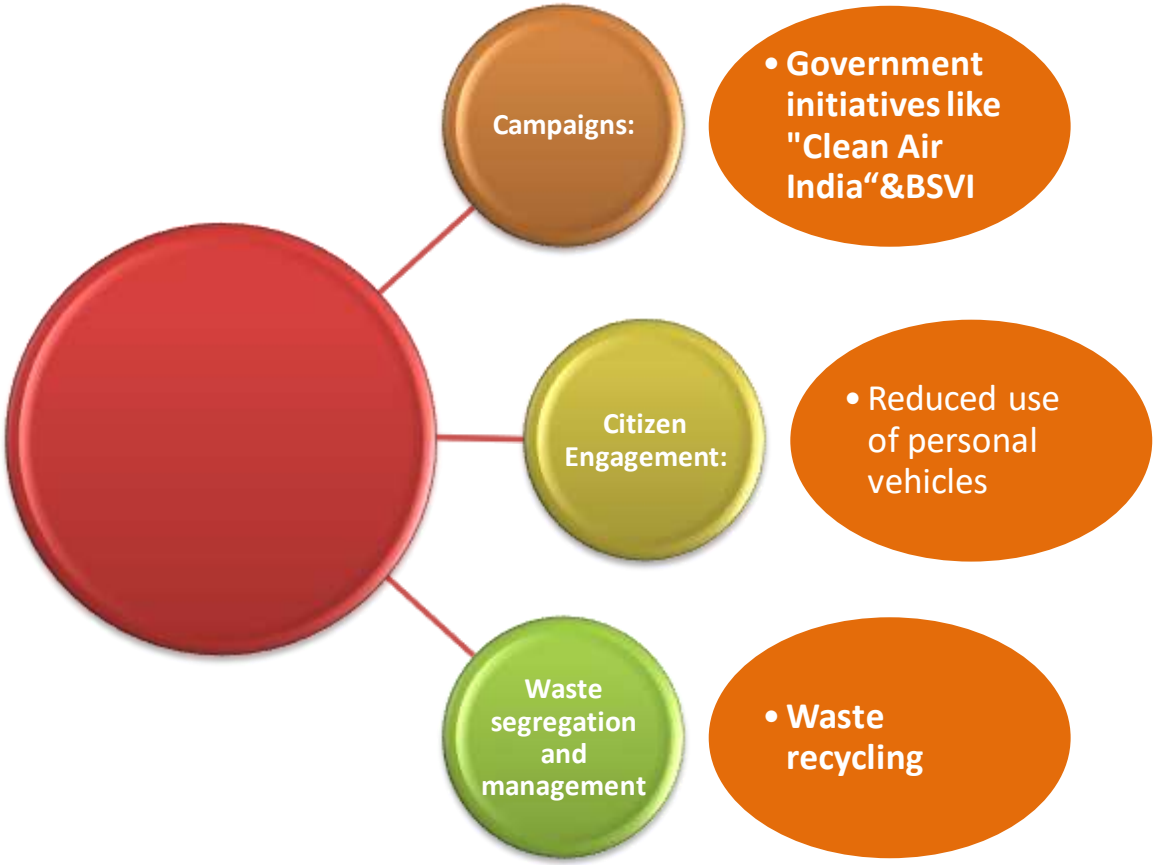
Technological Advancements

Exhaust Control Technologies: Advanced after-treatment technologies are crucial for meeting BS-VI standards, addressing the discrepancies between laboratory and real-world emissions(Bharj et al., 2019)(Mirgal, 2017).

Fuel Innovations: The introduction of oxygenated fuels and differentiated diesel formulations has been pivotal in achieving compliance with real driving emissions (RDE) norms(Kant et al., 2024).

While the BS-VI standards represent a significant step forward in reducing vehicular emissions, the ongoing increase in NOx levels highlights the complexities of real-world emissions management and the need for continuous technological and regulatory advancements.

Role of Public Awareness(RPA)



GWP: Impact on Agriculture

- **Impact on Agriculture**

  Particulate matter adversely affects agricultural productivity by harming plant health and reducing crop yields. PM originates from natural sources, such as dust and pollen, and anthropogenic activities, such as **industrial processes and agricultural operations**, **exacerbating food crises and global hunger**.

A research investigation, undertaken in the year 2021, has demonstrated that particulate matter has a detrimental impact on agricultural productivity by compromising plant health and diminishing crop yields.

Sujit, Das., Debanjana, Pal., Abhijit, Sarkar. (2021). 1. Particulate Matter Pollution and Global Agricultural Productivity. doi: 10.1007/978-3-030-63249-6_4

Interactive Question

I Q 3:

Suggest a novel solution to reduce particulate matter pollution in urban areas.

EMERGING CHALLENGES

Emerging Challenges

- **Urbanization:**
  - Increasing construction(metro rail) and Demolishion vehicular movement and emissions.
- **Industrial Expansion:**
  - Rise in emissions without adequate control measures
- **Agricultural and plantation activities**
- **Dust storm**

PM_Management

- **Public Awareness and Community Involvement**
  - **Education Campaigns:**
    - **Raising awareness about impacts of waste burning.**
  - **Community Actions:**
    - **Composting of organic wastes, mass transit system.**

Summary & Key Takeaways

- Importance of PM mgmt. in India
- Major types and sources
- Case studies highlighting challenges and solutions
- Management: Role of policy, technology, and public participation.

Final Interactive Question

I Q 4:

Suggest one innovative solution to mitigate PM present in your region(local context).

References

- **Books and Articles:**
  - "Air Pollution: Measurement, Modelling, and Mitigation" by Abhishek Tiwary and Ian Williams
  - "Environmental Pollution and Control" by C. S. Rao
- **Reports and Standards:**
  - Central Pollution Control Board (CPCB) Reports
  - World Health Organization (WHO) Guidelines for Air Quality
- **Websites:**
  - Ministry of Environment, Forest and Climate Change
  - Air Quality India App

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