Urban Aerosol Pollution

Mains: *GS III - Environmental Pollution and Degradation*

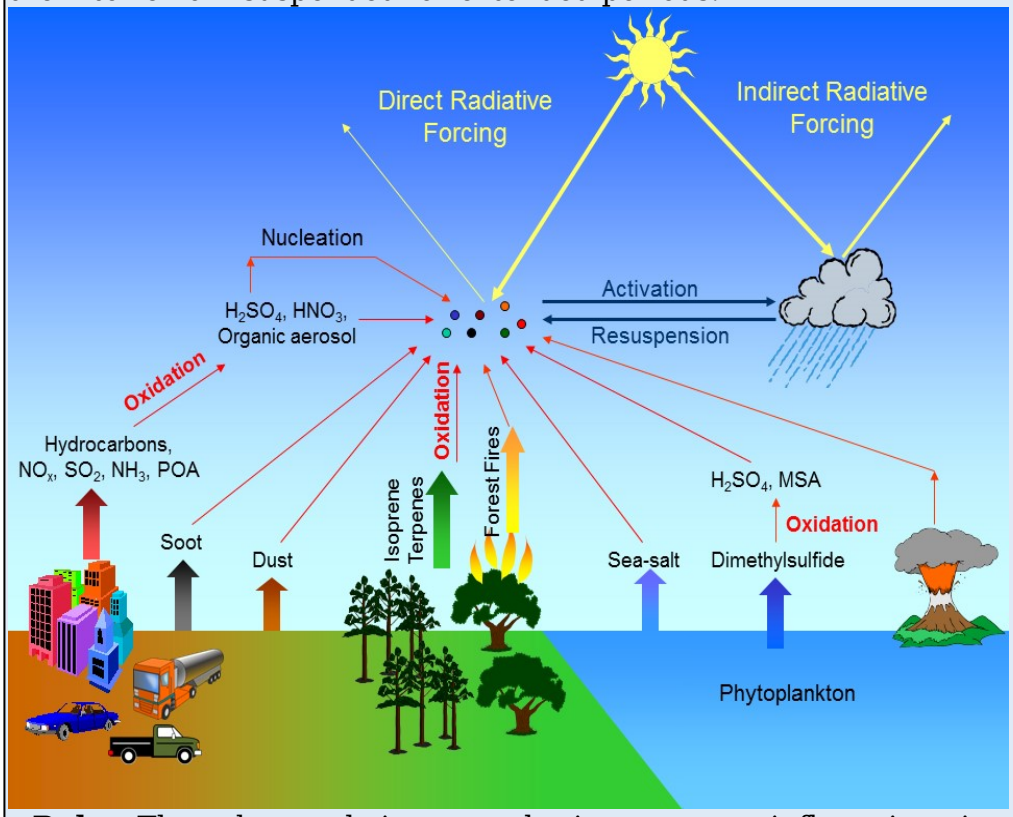
Why in the news?

A recent study on aerosols levels of 141 cities in India from 2003 to 2020 by IIT at Bhubaneswar, has shed new light on urban aerosol pollution patterns across India, revealing a north-south divide in how pollution domes form over cities.

What is urban aerosol pollution?

Aerosols

• It is a suspension of fine solid particles or liquid droplets in a gas, most commonly in air.
• **Sources**
  - Natural cause – Volcanoes
  - Anthropogenic cause - Burning fossil fuels.
• **Size –** They are typically small, with diameters *often less than 1 micrometre,* allowing them to remain suspended for extended periods.



• **Role** – They play a role in atmospheric processes, influencing air quality, weather, and climate.

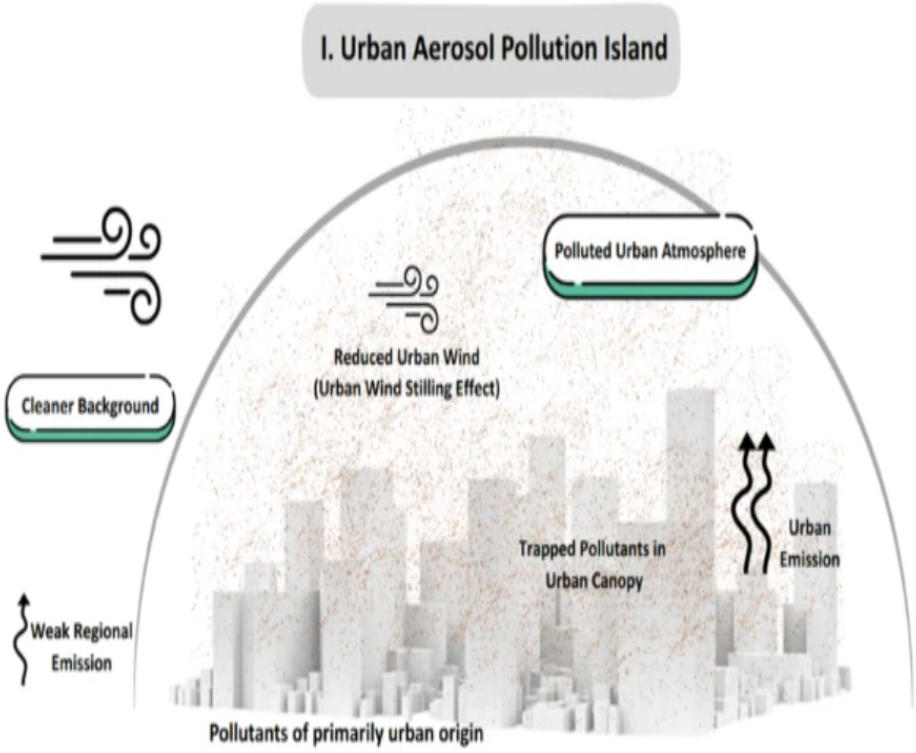
- **Urban aerosol pollution** – It refers to the presence of *small, solid, or liquid particles*

suspended in the atmosphere within cities.

- **Two types**
  - Urban aerosol pollution island
  - Urban aerosol clean island
- **Urban aerosol Pollution Island –** It refers to the *cities that show higher aerosol levels* than the surrounding areas.
- It occurs, whenever less transport of aerosol or pollution is happening irrespective of the season.
- The aerosol levels were not uniformly higher in the surrounding areas compared with the city.
- **Urban aerosol clean island –** It refers to the cities that show relatively *lower aerosol levels compared with the surrounding areas*.

What is the level of urban aerosol pollution Island in India?

- **Regional variation** – *57% Cities in south and southeast India show higher aerosol levels* inside the city compared to neighbouring parts.
- **Causes** – This occurs due to *local pollution sources* which dominates aerosol presence and lack any large external source of pollutants coming from elsewhere.
- It became distinct in many cities during *no dust scenario.*



- **Consequences** – This results in a typical "pollution dome" where *urban areas are more polluted* than their rural surroundings.

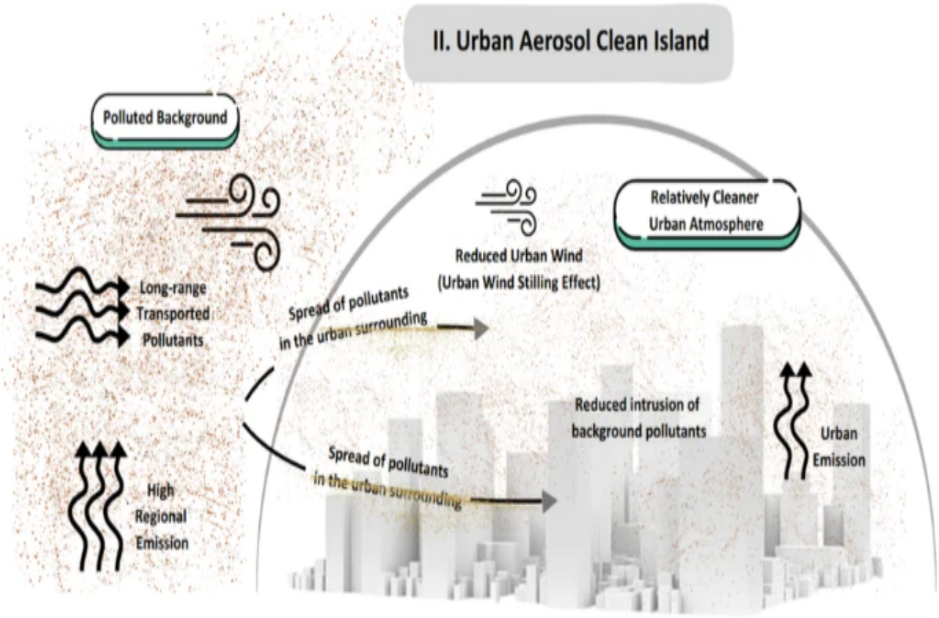
> ***A pollution dome*** *is a phenomenon where pollutants, such as smog and particulate*

matter, become concentrated and trapped in the atmosphere usually above a city or industrial area, forming a dome-like layer of polluted air.

- **Higher level** – It is in the *areas southwest of the city*, which are located upstream of the dust flow.
- **Lower level** – It is in the *northeast side of the city situated downstream of the dust flow* that exhibited less aerosol levels which almost matched the levels seen in the city.
- It is a trail that continues downwind for some distance.

What is the level of urban aerosol clean Island in India?

- **Regional variation** – *43% of cities in northwest and northern Indo-Gangetic Plain* display lower aerosol levels within city limits than in surrounding areas.
- North Indian cities, despite being blamed for poor air quality, are found to *have no consistent pollution domes.*
- **External aerosol source** - Aerosols from external sources such as *dust from the Thar Desert and biomass burning* contribute heavily to background pollution.
- It became pronounced in many cities in *high dust case.*



- Clean island effect is whenever the pollution transport from outside is enhanced.
- **Cities as barriers** – The infrastructures of the cities block aerosol entry and creating cleaner urban zones compared to their surroundings.
- This unexpected pattern is linked to a phenomenon known as *urban wind stilling effect.*

Wind Stilling Effect

• It refers to a *weakening of surface winds across highly urbanised cities* where the buildings and infrastructure reshape local climates, *creating zones of atmospheric stagnation.*
• These zones collectively lead to invisible barriers around the city in the upwind regions.
• They *partially block the entry of long-range aerosol* pollution, especially mineral dust from the nearby arid regions.
• This results in cities having relatively less aerosol loading than the surrounding areas.
• Global megacities such as *Shanghai, Atlanta and a few European c*ities have urban aerosol clean islands.

- **Seasonal variation in India**
  - **During monsoon** – Not studied due to non-availability of data due to clouds and rain.
  - **Pre-monsoon** – Clearly observable.
  - **Post-monsoon** – Normally disappears but seen again in winter due to dry conditions.

What lies ahead?

- Deeper scientific understanding could help to evolve an idea on how urban growth and emerging micro-climates influence air pollution and its spatial patterns.
- Creation of truly sustainable, climate-resilient cities will depend on our capability to understand and anticipate these multifaceted interactions as cities continue to grow.

Reference

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