AIR POLLUTION in INDIA Explained

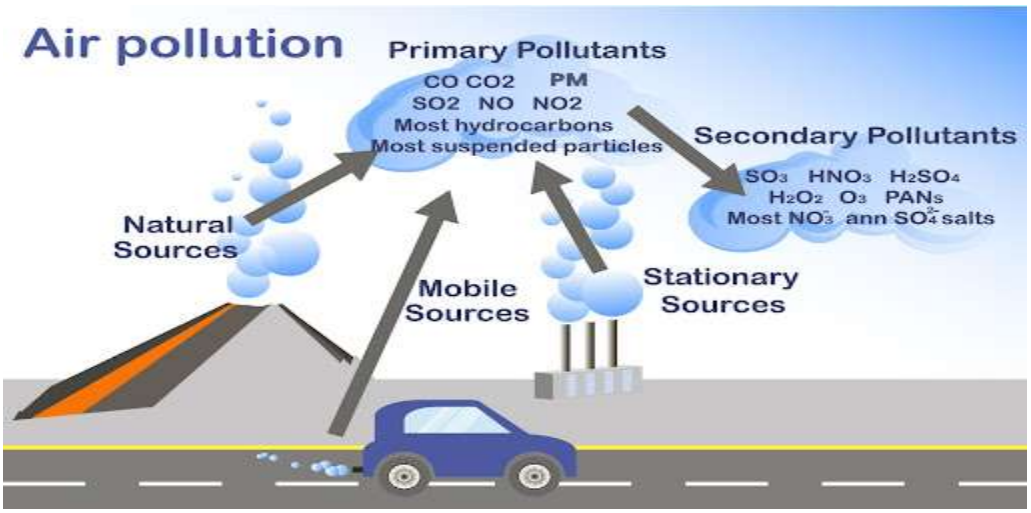
Lessons from the Delhi Experience

Context:

- India's cities face **severe air pollution**, with **Delhi, Mumbai, and Kolkata among the world's worst**, worsened by **Diwali fireworks, traffic**, and industrial emissions across the region.
- The **Air Quality Index (AQI)** in **Delhi and its National Capital Region on October 23rd, 2025** remained under the **"very poor"** category with the **Graded Response Action Plan (GRAP) II norms** already in place.

1. What is Air Pollution?

- As per the definition by **WHO, Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent** that modifies the natural characteristics of the atmosphere.



- **Household combustion devices, motor vehicles, industrial facilities** and forest fires are common **sources of air pollution.**
- **WHO data shows** that almost **all of the global population (99%)** breathe air that **exceeds WHO guideline limits and contains high levels of pollutants**, with **low- and middle-income countries suffering from the highest exposures.**
- **Air quality** is closely linked to the **earth's climate and ecosystems globally.**

2. Mention Key findings from the 2024 World Air Quality Report?

- Only **17% of global cities meet WHO air pollution** guideline.

- **Seven** countries met the **WHO annual average PM2.5 guideline of 5 µg/m3:**
  - **Australia, Bahamas, Barbados, Estonia, Grenada, Iceland, and New Zealand.**
- The **five most polluted countries in 2024** were:
  - **Chad (91.8 µg/m3)**: More than **18 times higher than the WHO PM2.5 annual guideline.**
  - **Bangladesh (78.0 µg/m3)**: More than **15 times higher than the WHO PM2.5 annual guideline.**
  - **Pakistan (73.7 µg/m3)**: More than **14 times higher than the WHO PM2.5 annual guideline.**
  - **Democratic Republic of the Congo (58.2 µg/m3)**: More than **11 times higher than the WHO PM2.5** annual guideline.
  - **India (50.6 µg/m3)**: More than **10 times higher than the WHO PM2.5 annual guideline.**
- A total of **126 (91.3%) out of 138 countries** and regions exceeded the **WHO** annual **PM2.5 guideline value of 5 µg/m3.**
- **Byrnihat, India** was the most **polluted metropolitan area of 2024, with an annual average PM2.5** concentration of **128.2 µg/m3.**
- The region of **Central & South Asia** was home to the t**op seven most polluted cities in the world.**
- **India** was **home to six of the nine most polluted global cities.**
- The **most polluted major U.S. city was Los Angeles, California.**
  - **Ontario, California** was the most polluted city in the **United States.**
  - **Seattle, Washington** was the **cleanest** major city in the **U.S.**
- **Mayaguez, Puerto Rico** was the **cleanest metropolitan area** of **2024**, with an annual **average PM2.5 concentration of 1.1 µg/m3**.
- **PM2.5 concentrations** decreased in every country in Southeast Asia, though transboundary haze and **lingering El Niño conditions remain major factors.**

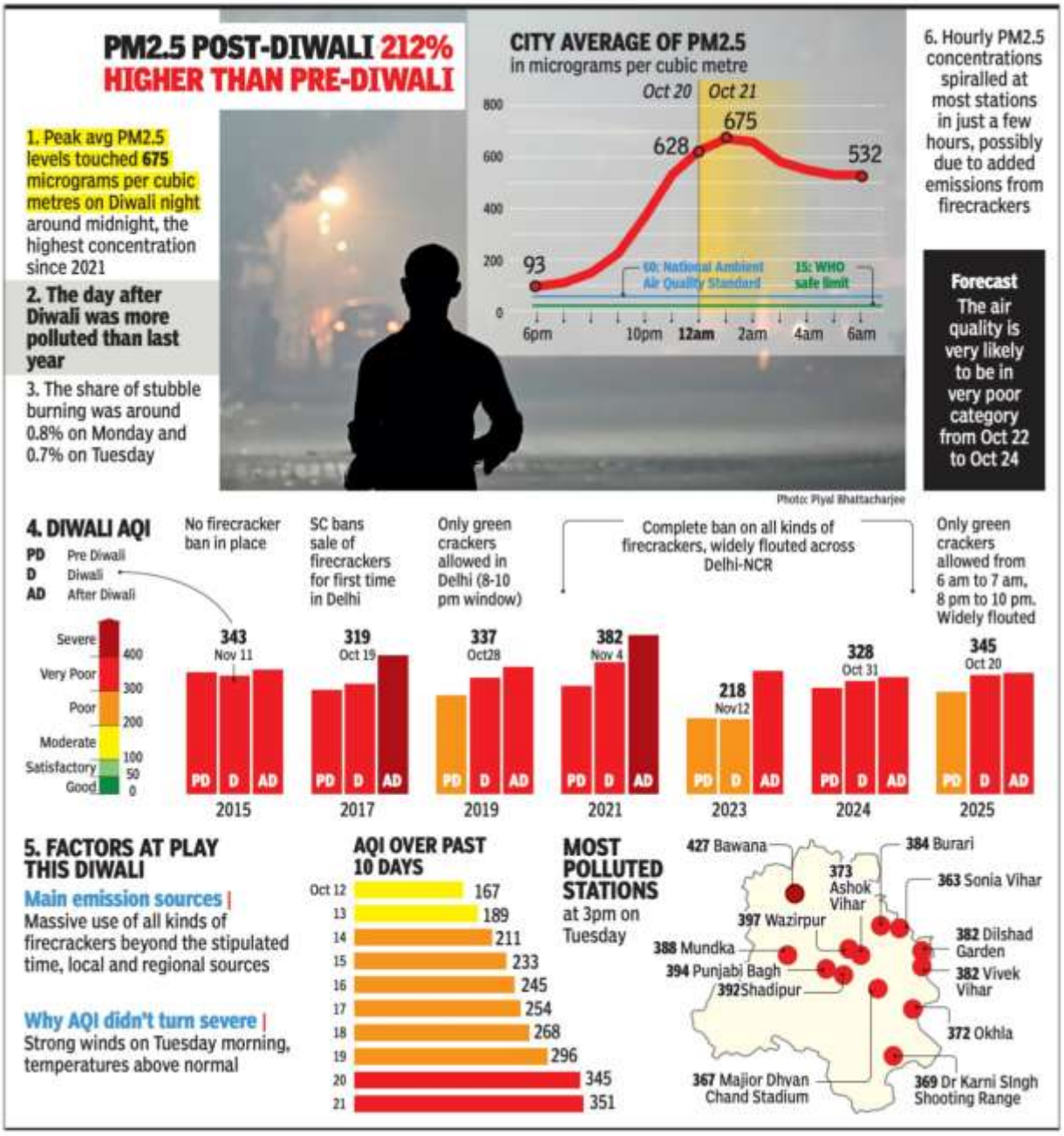
- In **Africa**, the scarcity of real-time, **publicly accessible air** quality monitoring data is so severe that there is **only one monitoring** station for every **3.7 million people.**
- Wildfires in the **Amazon rainforest** impacted vast areas of **Latin America in 2024, with PM2.5 levels** in some cities across B**razil's Rondônia and Acre states quadrupling in September.**
- **Oceania** is the **world's cleanest region, with 57%** of regional cities meeting the **WHO PM2.5** annual guideline value of **5 µg/m3.**

3. Why Diwali is considered as the start of Air Pollution season in New Delhi?

- The **air quality in India's capital ranks** among the worst in the world.
- As **India and the Indian diaspora celebrated Diwali on October 20th, 2025**, residents of **New Delhi** and much of **north India** also gasped through the start of **air pollution season.**
- Despite a **yearslong ban on Diwali firecrackers**, which exacerbate the **seasonal increase in pollution**, a drop in temperatures at this time of year creates a **blanket of smog so thick that many historical sites in New Delhi**, India's capital, become invisible.
- The **city's residents choke on its air,** with the air quality index soaring past **350 on October20th, 2025.**
- This **Diwali, for the first time in five years**, the **firecracker ban was modified to allow Delhi residents to set off "green" firecrackers** that produce fewer pollution particles.
- However, for the **Indian government and bureaucracy**, pollution does not appear to be an **emergency.**
- **Comprehensive action plans and research** into the effects of pollution are poorly executed.
- In a report filed in **India's Parliament in March**, the ministry **responsible for pollution control said it had used less than 1 percent of the $100 million** allocated to it last year.

- While cities like **Beijing have fundamentally fixed** similar problems, **New Delhi remains** such a **persistent chamber of toxic winter air** that some political leaders have questioned its suitability as **India's capital.**

4. Which areas of Delhi are affected in Post Diwali air pollution?



- Several locations, such as **Anand Vihar, Dwarka Sector 8, Patparganj, and Jahangirpuri**, recorded peaks above **1,400 to 1,800 µg/m³, which is 15-20 times higher than the permissible standards.**
- The **capital city's air quality index (AQI) at 11 PM** stood at **347, in the 'very poor' category, as per Central Pollution Control Board (CPCB) data.**
- Data indicates that this year's **Diwali pollution levels** were the **highest** in recent years, despite the promotion of **'green' crackers.**
- Delhi's air quality on **Diwali this year was worse than last year,** which stood at **328 in 2024**, and **higher than the previous two years ie 218 in 2023 and 312 in 2022.**

Worst-affected areas:

- According to **DPCC data, Anand Vihar** recorded the h**ighest PM10 concentration around 2 AM, followed closely by Dwarka Sector 8, Patparganj and Jahangirpuri.**
- Stations such as **Mundka, Ashok Vihar, and Okhla Phase 2** also reported values exceeding the safe limits during **late-night hours.**
- At several locations, including **Patparganj, Nehru Nagar, JLN Stadium, and Okhla Phase 2**, data were missing for multiple hours between **11 pm and 5 am**, which suggests a possible instrument saturation due to extremely **high particulate concentrations**.
- The reading, which was resumed early in the **morning, remained beyond the safe limits.**

5. What causes New Delhi's pollution?

- The **sources of noxious air in New Delhi** are well known: **vehicles, construction, demolition, heavy industry and seasonal events including the burning of crop waste and fireworks set off during the festival season around Diwali**, the Hindu festival of lights.

- The **air quality nose-dives to "severe" levels** only in the winter because **atmospheric conditions** make it harder for these pollutants to be **dispersed.**
- In recent years, **stubble burning** which is a **farming practice of setting fire to crop residue after harvesting** to make way for sowing the next crop, **has received a lot of attention as a source of New Delhi's pollution.**
- **Northwesterly wind carries** smoke from stubble burning in two heavily **agricultural neighboring states, Haryana and Punjab**, to New Delhi, adding to the **city's concentration of particulate matter.**
- **New Delhi sits in a landlocked plain**, with mountains and plateaus on all sides.
- Its bowllike **topography traps pollutants**, unlike in other big cities in India, such as **Kolkata and Mumbai**, which are flanked by the sea, which helps **disperse them.**
- But according to emissions studies **conducted from 2015 to '18** by multiple **research organizations**, stubble **burning contributed less than 21 percent of the overall concentration** of the smallest particulates, which are **harmful to huma**n health.
- **Transport, industry, power plants, construction and demolition** were much more significant sources.

6. What experts recommend to fix Pollution related issues in Delhi?

- The **Commission for Air Quality Management**, which monitors and manages air quality in **New Delhi** and adjoining areas, has suggested a road map for using **clean fuels and electric mobility, as well as for controlling municipal solid-waste burning and crop-residue burning.**
- It has also called for **strengthening air quality monitoring.**
- It also sometimes **recommends emergency measures**, from **school closures to banning construction work, limiting commercial vehicles or mandating that offices work at half of capacity.**
- The obstacle is the **inefficient execution of the agency's recommendations**, partly because of a lack of personnel to enforce them and a **lack of coordination.**
- The **lax enforcement of the firecracker ban** is a case in point.
- In **October 2024**, the **Delhi government tried to crack down on the production, sale, storage and use of firecrackers just ahead of Diwali, a ban that has been in place since 2020.**
- With only **377 enforcement teams** spread across a city of **20 million people, the ban was widely flouted.**
- This month, **India's Supreme Court modified the ban,** allowing the use of **"green crackers,"** which are considered **30 percent less polluting than regular ones.**
- But monitoring this change requires even **more officials to scan the QR codes** that show whether the crackers are green or not.
- The **lack of personnel affects** other pollution control efforts, as well.

7. How does politics get in the way of controlling Delhi's pollution?

- The work also gets caught up in **India's cutthroat politics.**
- While **Prime Minister Narendra Modi and the Bharatiya Janata Party (B.J.P.)** have been in power at the national level for more than a decade, the government of the **capital region has been largely in the hands of one of its rivals, the Aam Aadmi Party.**
- Each party blames the other for **New Delhi's air-quality issues, and neither has taken responsibility.**
- After the **B.J.P. came to power in New Delhi in 2025**, the capital's new government pushed for the **complete ban on firecrackers to be eased.**
- **Rekha Gupta, New Delhi's chief minister**, said she wanted to balance the tradition of **bursting crackers during Diwali with environmental protection**.
- The **two parties**, as well as others, have also held power in neighboring **Haryana and Punjab states.** Both states have laws **banning stubble burning** but have not complied with requests from the country's top court for the bans to be carried out.

- **Persuading farmers** not to practice stubble burning will require subsidies for mechanized alternatives.
- The **Aam Aadmi Party government in Punjab** has blamed the B.J.P. for not allocating enough funds.
- To address vehicular pollution, **successive New Delhi governments** have adopted cleaner compressed natural gas for buses and trucks, phased out **10-year-old diesel and 15-year-old gasoline vehicles, and imposed charges on heavy-duty vehicles that pollute more.**
- Reducing pollution from **cars faces a larger hurdle: public transport.**
- The capital has **45 buses per 100,000 people**, according to the **Center for Science and Environment**, about half those of London.
- There has been some progress.
- The concentration of the **smallest pollutants has been reduced in recent years by about 7 percent.**
- But that is a **small fraction of what's required to achieve a meaningful improvement in air quality.**

8. What are green crackers?

- Eco-friendly fireworks developed by the **Council of Scientific & Industrial Research-National Environmental Engineering Research Institute (CSIR-NEERI),** green crackers release a reduced amount of harmful pollutants.
- These are made with a reduction in the size of the shell and usage of raw materials in composition, **elimination of the ash usage**, and the use of additives as dust suppressants to reduce emissions, according to **CSIR-NEERI.**
- The green crackers were **first developed by the CSIR-NEERI** in 2018.
- The institute introduced three variants – **SWAS (Safe Water Releaser), STAR (Safe Thermite Cracker), and SAFAL (Safe Minimal Aluminium).**
- The above versions **eliminate potassium nitrate and sulphur**, thus reducing particulate matter and **gas emissions by 30 to 40 per cent.**

9. Are green crackers sustainable?

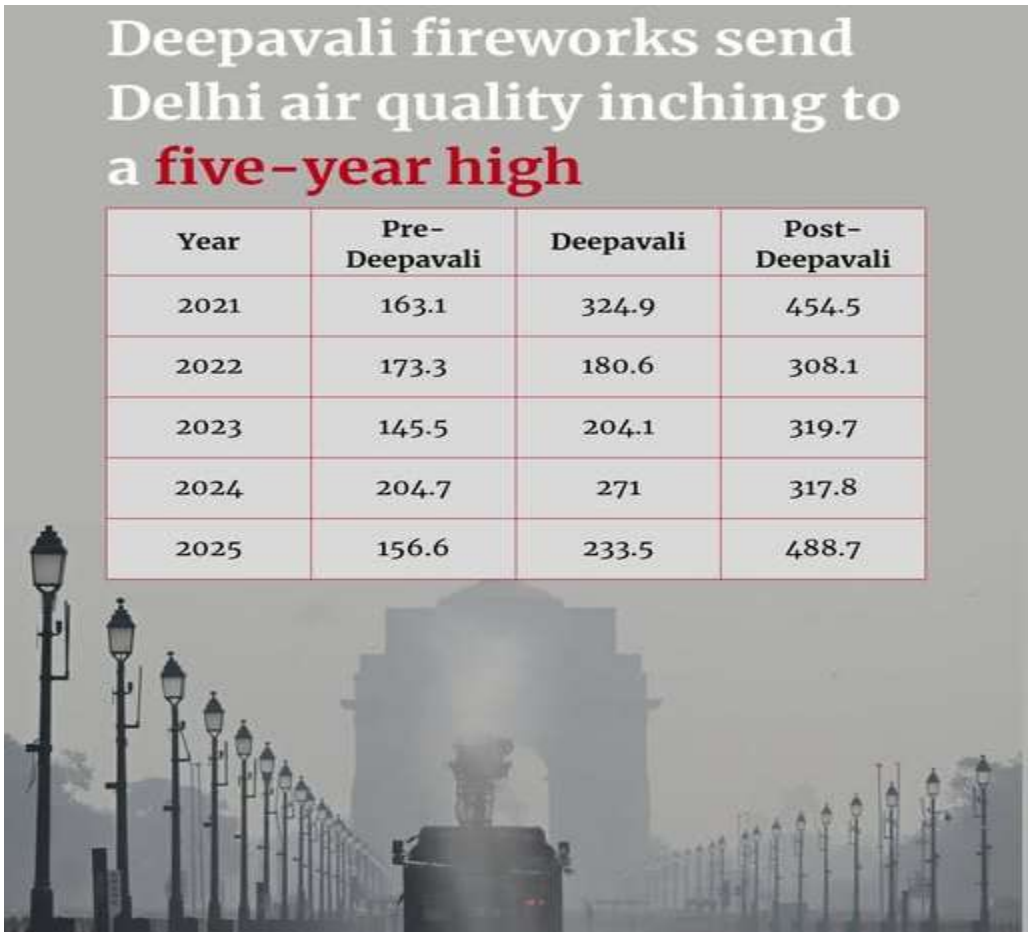
- The severe dip in **Delhi AQI comes** with the **Supreme Court allowing the bursting of 'green' crackers** this year for a span of two hours.
- However, **residents flouted the SC order** and continued to **burst crackers even beyond the dedicated slot.**
- A week before **Diwali, the Supreme Court** permitted the sale and bursting of **green crackers in the Delhi-National Capital Region (NCR)** between **October 18 and 21 for Diwali.**
- **Chief Justice of India (CJI) BR Gavai** directed the **Central Pollution Control Board (CPCB) and the State PCB** to monitor the **Air Quality Index (AQI) from 18 October** and submit the report to the court.

10. How did stubble burning affects Delhi's air quality?

Metric	2024 (Oct 1–12)	2025 (Oct 1–12)	Change (2025 vs 2024)
Total Stubble Burning – Punjab	392	105	↓ 73.2%
Total Stubble Burning – Haryana	387	70	↓ 81.9%
Total Combined Fire Counts	779	175	↓ 77.5%
Average Delhi PM2.5 (µg/m³)	60.79	51.48	↓ 15.5%

- An earlier comparative analysis of satellite fire data, **Central Pollution Control Board (CPCB) readings**, and **Climate Trends found that Punjab and Haryana together** recorded just **175 stubble burning incidents between October 1 and 12 this year, down from 779 in the same period last year.**
- This about **77.5 per cent decline was primarily** driven by **flood-induced waterlogging that delayed paddy harvesting** and prevented farmers from **torching crop residue**, the report said.

11. Mention key findings of CPCB and Climate Trends Report?



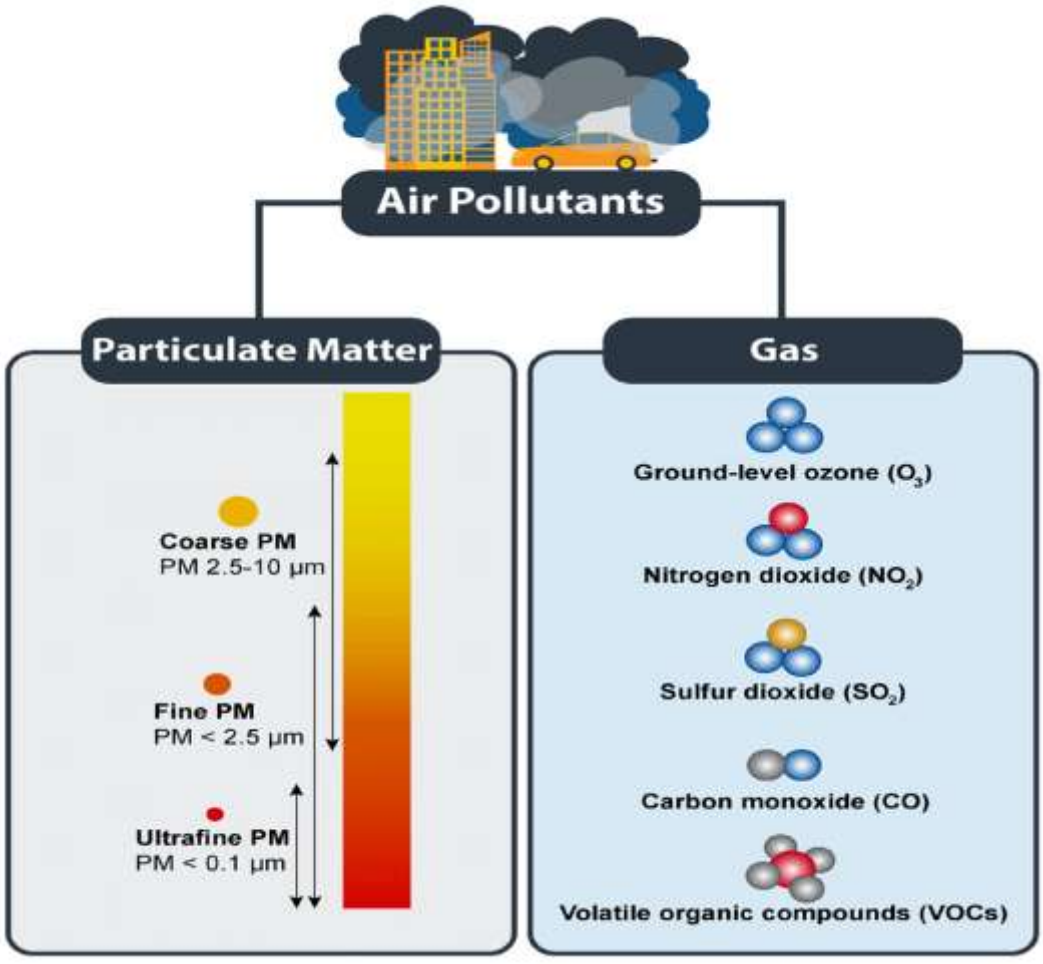
Year	Pre-Deepavali	Deepavali	Post-Deepavali
2021	163.1	324.9	454.5
2022	173.3	180.6	308.1
2023	145.5	204.1	319.7
2024	204.7	271	317.8
2025	156.6	233.5	488.7

- Experts analysing the **Climate Trends report** said that it is most likely that **the high concentration of PM 2.5 is due to local emission of firecrackers** in the different parts of the city on this auspicious **Diwali festival night.**
- **An earlier comparative analysis** of satellite fire data, **Central Pollution Control Board (CPCB) readings, and Climate Trends** found that **Punjab and Haryana** together recorded just **175 stubble burning incidents between October 1 and 12 this year, down from 779 in the same period last year.**
- An earlier comparative analysis of satellite fire data, **Central Pollution Control Board (CPCB) readings, and Climate Trends** found that Punjab and Haryana together recorded just **175 stubble**

burning incidents between October 1 and 12 this year, down from 779 in the same period last year.

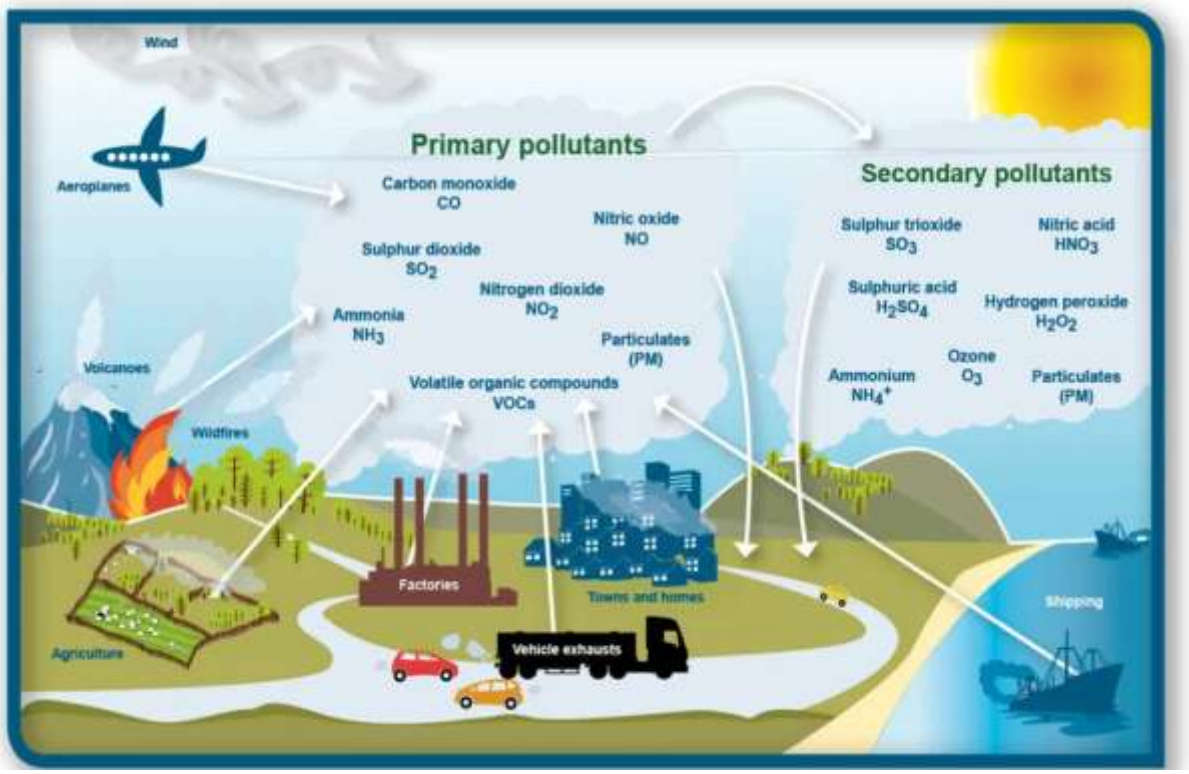
	2021	2022	2023	2024	2025
Pre	163.1	129.3	92.9	204	156.6
Diwali	324.9	180.7	145.5	227.7	233.5
Post	454.5	168	319.7	220	488

12. Enlist various types of air pollutants?



The **air pollutants** can be classified into the following two types:

Air pollutant	Description
Primary air pollutants	• These **pollutants are emitted directly from a source,** such as a vehicle, volcanic eruption, or wildfire. • Examples include **carbon monoxide, nitrogen oxide, and sulfur oxide,particulate matter(PM).**
Secondary air pollutants	• These pollutants are **formed when primary pollutants react with other substances in the atmosphere.** • Examples include **ozone, secondary organic aerosol (haze), and acid rain.** ▪ **Ozone:** Formed when hydrocarbons and nitrogen oxides combine in the presence of sunlight ▪ **Nitrogen dioxide (NO2):** Formed when NO combines with oxygen in the air ▪ **Acid rain:** Formed when sulfur dioxide or nitrogen oxides react with water ▪ **Secondary organic aerosol (haze):** A secondary pollutant. • **Secondary pollutants are harder to control than primary pollutants** because they are **formed through complex chemical reactions that are not well understood.**



Classification of pollutant according to their existence in nature:

- **Quantitative Pollutants:** These occur in nature and become **pollutants when their concentration reaches beyond a threshold** level. E.g. **carbon dioxide, nitrogen oxide.**
- **Qualitative Pollutants:** These **do not occur in nature and are human-made**. E.g. **fungicides, herbicides, DDT** etc.

13. What Is AQI?

- The **Air Quality Index (AQI)** is a public health tool designed to **communicate air pollution levels** or the quality of air in simple terms.
- Eight pollutants namely **particulate matter (PM) 10, PM2.5, Ozone (O3), Sulphur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO), lead (Pb) and ammonia (NH3)** act as major parameters in deriving the **AQI of an area, as per the CPCB.**
- **AQI is a calculated index based** on different parameters.

- It is for common **man's understanding** of the quality of air.
- **AQI has different color-coded ranges** simply to tell the citizens that air is **good or satisfactory or very poor and what they should be doing.**

Breakpoints for AQI Scale 0-500 (units: µg/m^3 unless mentioned otherwise)

AQI Category (Range)	PM_{10} 24-hr	$PM_{2.5}$ 24-hr	NO_2 24-hr	O_3 8-hr	CO 8-hr (mg/m^3)	SO_2 24-hr	NH_3 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.6 –1.0
Moderate (101-200)	101-250	61-90	81-180	101-168	2.1- 10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10.1-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748*	17.1-34	801-1600	1201-1800	3.1-3.5
Severe (401-500)	430 +	250+	400+	748+*	34+	1600+	1800+	3.5+

**One hourly monitoring (for mathematical calculation only)*

14. How Is Air Quality Measured?

- Air quality is a **measure of how clean or polluted the air is**.
- Air quality is measured with the **Air Quality Index, or AQI.**
- The AQI works like a **thermometer** that **runs from 0 to 500 degrees.**
- The **AQI has six categories** that communicate the **level of health concern using specific colors.**
- **Instruments** on the **ground and satellites orbiting Earth** collect **information** about **what is in our air.**
- For example, **satellites in NOAA's GOES-R** (**short for Geostationary Operational Environmental Satellites-R**) Series monitor the particle pollution in our atmosphere.

AQI Category, Pollutants and Health Breakpoints								
AQI Category (Range)	PM_{10} 24-hr	$PM_{2.5}$ 24-hr	NO_2 24-hr	O_3 8-hr	CO 8-hr (mg/m^3)	SO_2 24-hr	NH_3 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.5 – 1.0
Moderately polluted (101-200)	101-250	61-90	81-180	101-168	2.1- 10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748*	17-34	801-1600	1200-1800	3.1-3.5
Severe (401-500)	430 +	250+	400+	748+*	34+	1600+	1800+	3.5+

15. How did the assessments of Delhi's air quality by CPCB and IQAir differ?

- **Delhi's air turned toxic after Diwali**, with confusion over its actual pollution level.
- India's **Central Pollution** Control Board (CPCB) pegged the city's **AQI near 351**, while **Swiss air-quality monitoring firm IQAir's** readings soared **beyond 2,000.**
- The disparity raised a simple but urgent question: **how can Delhi's AQI be both 400 and 2000 at the same time?**
- The mismatch, experts explain, is **rooted not in error but in the fundamental differences in methodology, scale, and equipment** between India's monitoring framework and international systems such as IQAir's.

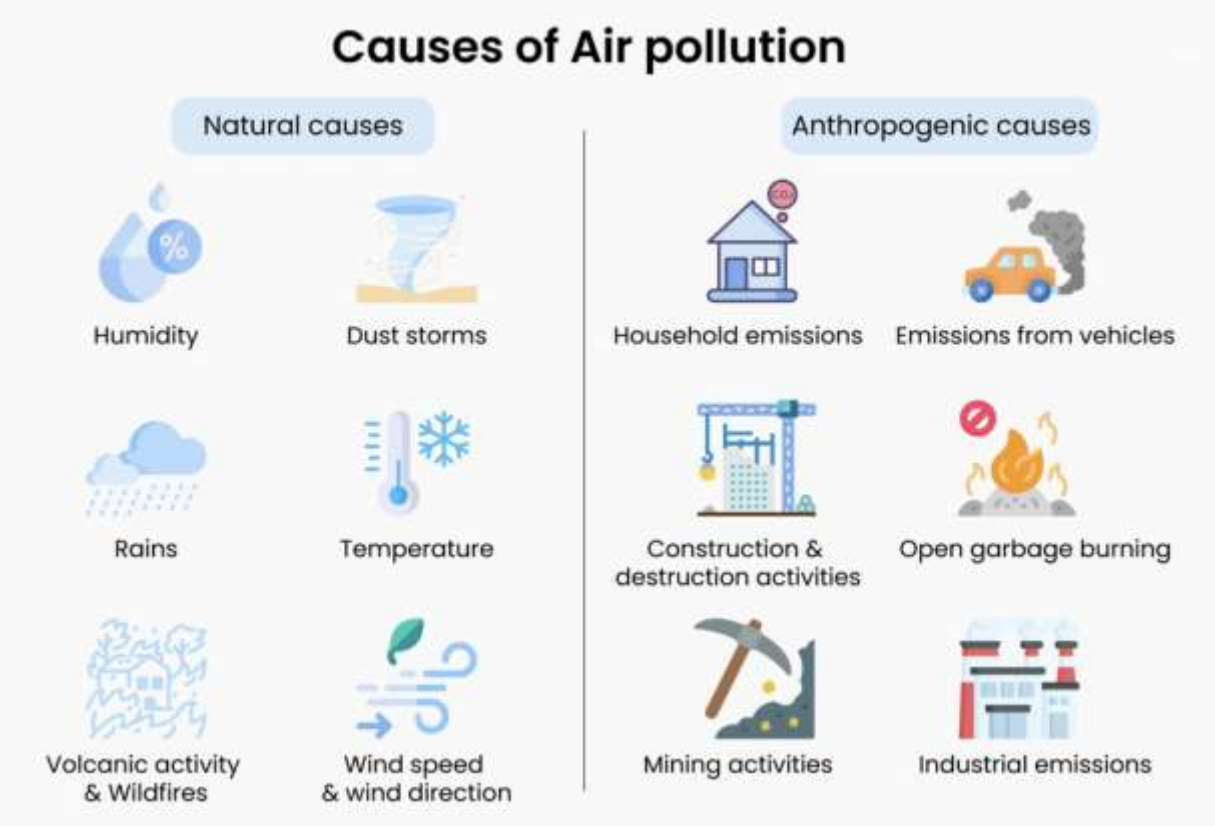
CPCB AQI	IQ AIR
• The CPCB and its associated bodies including the **Delhi Pollution Control Committee (DPCC), the India Meteorological Department (IMD), and the Indian Institute of Tropical Meteorology (IITM)** use reference-grade analyser stations. • These are government-run facilities equipped with **scientifically calibrated instruments** that adhere to **rigorous national standards.** • **India's capped system considers anything above 500** to be a **public health emergency,** where additional	• **IQAir,** however, aggregates data **not just from government networks** but also from **independent sensors,** including those installed by **private companies, community projects, and individuals.** • These devices use **sensor-based measurement rather** than the analyser-based approach. • While sensors allow for wider **geographic coverage and real-time updates**, they are often **low-cost, non-reference devices** that rely on **proprietary algorithms to estimate** pollutant concentrations.

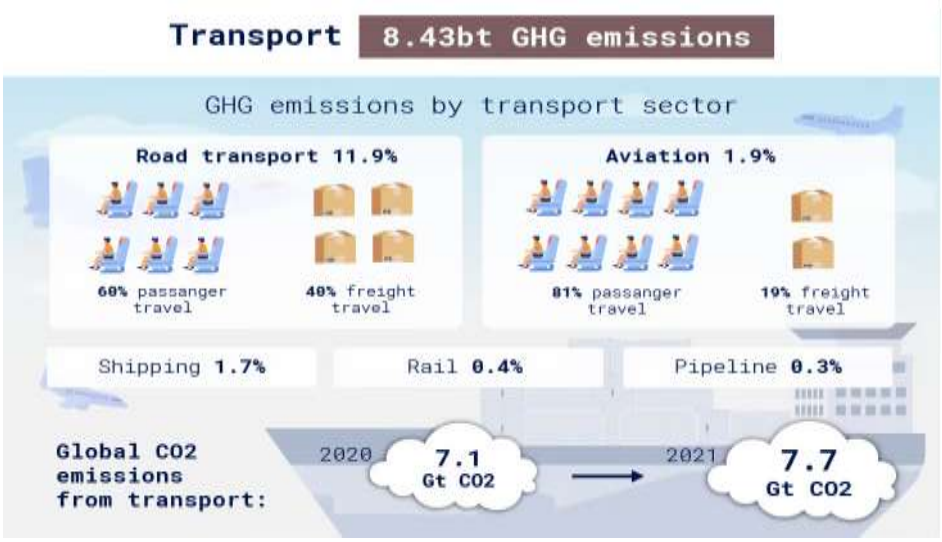
precision offers little practical benefit.	• Because **IQAir does not** disclose the **exact calibration and conversion methods** it applies to **raw data, experts caution against interpreting** its high readings as directly comparable to government data. • The **US-based system used by IQAir** continues **beyond 500 because it aims to display relative differences** even at extremely polluted levels.

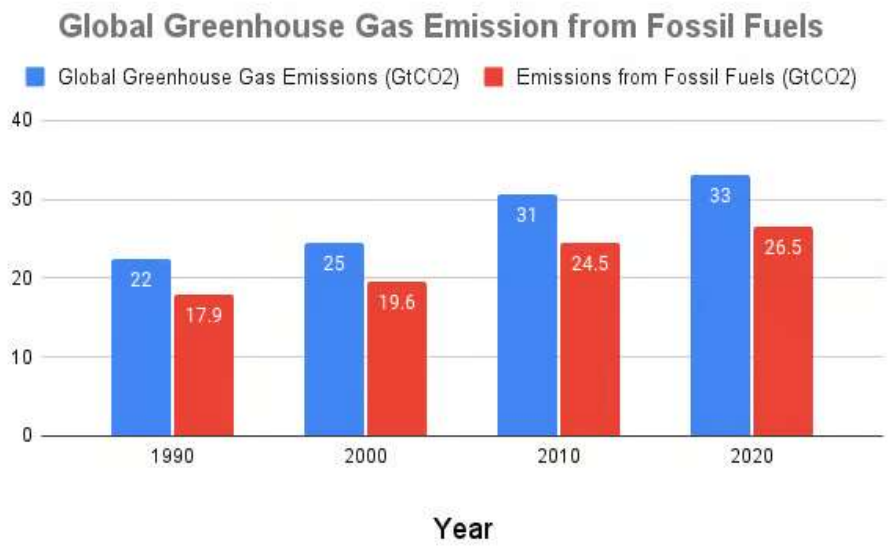
- To understand how these calculations diverge, consider a hypothetical example: if the **concentration of PM2.5**, the fine particulate matter most harmful to human lungs is measured at **1,100 microgrammes per cubic metre, the IQAir calculator could display an AQI of 2,043**, while **CPCB's calculation for the same value would reach around 1,054 before being capped at 500.**
- Both **CPCB and IQAir currently reflect that Delhi's air falls within** the **most dangerous bracket.**
- Ultimately, **both platforms converge on the same warning** that **Delhi's air quality is deteriorating** to levels that **pose serious health risks for all**, including healthy adults.
- Delhi's residents, therefore, **should not be misled by the apparent contradiction between 400 and 2000.**

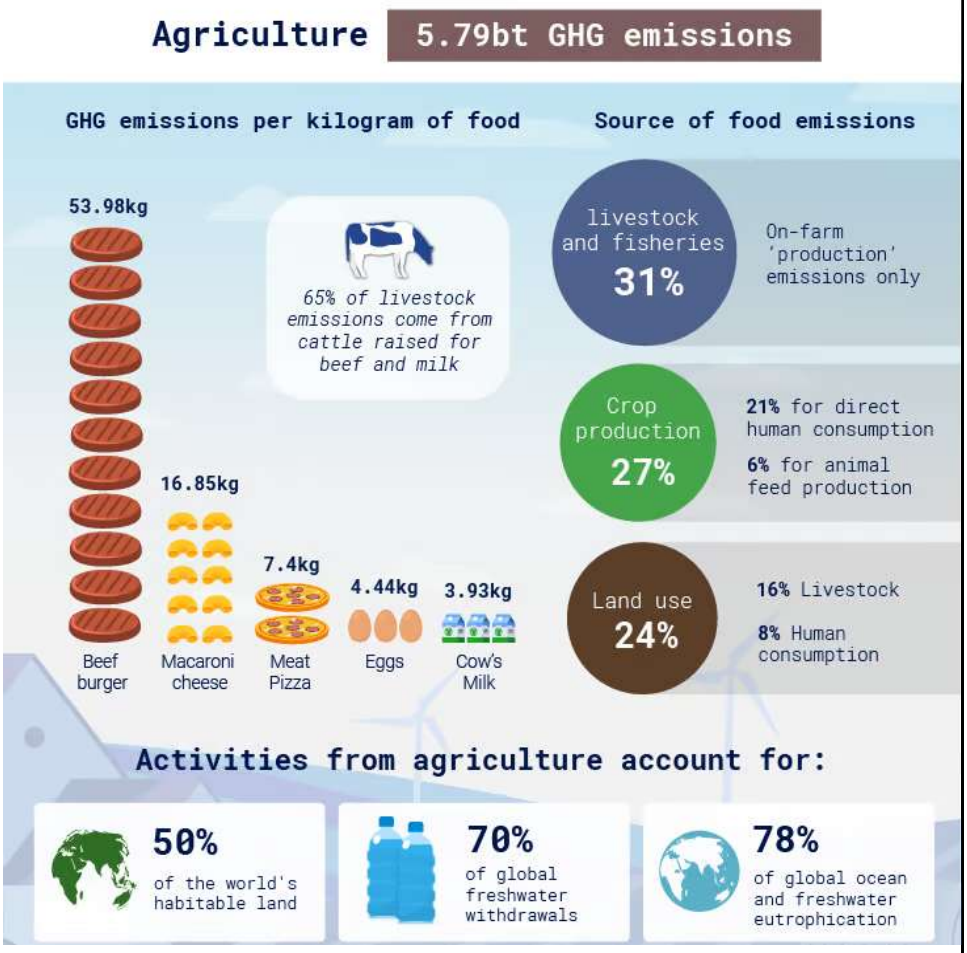
US AQI Level		US PM2.5 (µg/m³)	China PM2.5 (µg/m³)	China AQI Level	
WHO PM2.5 (µg/m³) Recommended Guidelines as of 2024: 0-5.0					
Good	0-50	0-9.0	0-35	Excellent	0-50
Moderate	51-100	9.1-35.4	35.1-75	Good	51-100
Unhealthy for Sensitive Groups	101-150	35.5-55.4	75.1-115	Lightly Polluted	101-150
Unhealthy	151-200	55.5-125.4	115.1-150	Moderately Polluted	151-200
Very Unhealthy	201-300	125.5-225.4	150.1-250	Heavily Polluted	201-300
Hazardous	301+	225.5+	250.1-500	Severely Polluted	301+

16. What are the causes of Air pollution?



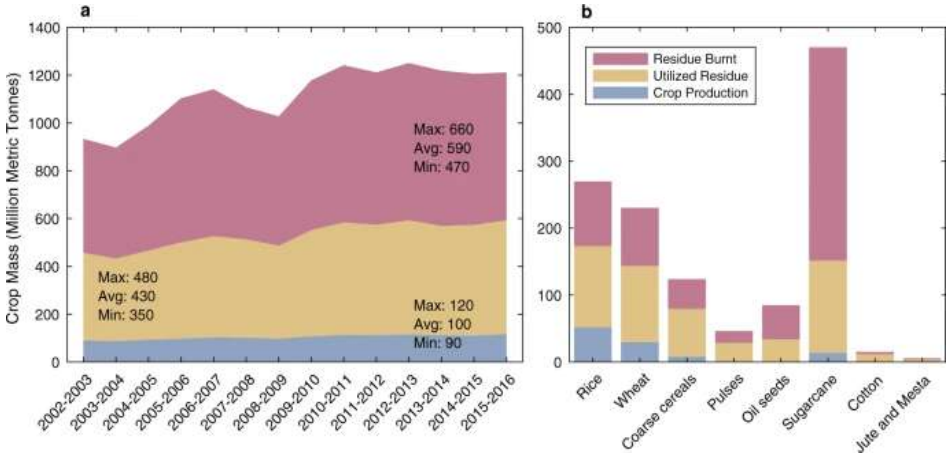
Causes of air pollution	Analysis
Natural Factors	• Certain natural phenomena, such as **volcanoes, forest fires, and dust storms, can contribute to air pollution.**
Fossil fuels	• **Petrol and diesel engines of cars**, ships, trains and other vehicles emit pollutants such as **carbon monoxide (CO), nitrogen oxides (NOx), particulate matter (PM), sulfur dioxide (SO2),** and **volatile organic compounds (VOCs)**. • **Friction from tires and brake wear** also create primary – i.e. direct – **particulate matter emissions**. In addition, the n**itrogen dioxide (NO2) and VOCs** released by road vehicles also undergo **photochemical reactions to form ozone (O3).** • **In Europe**, more than **40% of NOx and almost 40% of primary PM2.5** emissions are linked to road transport. • In the **United States, 35.8% of CO and 32.8% of NOx** stem from **road transport.** 

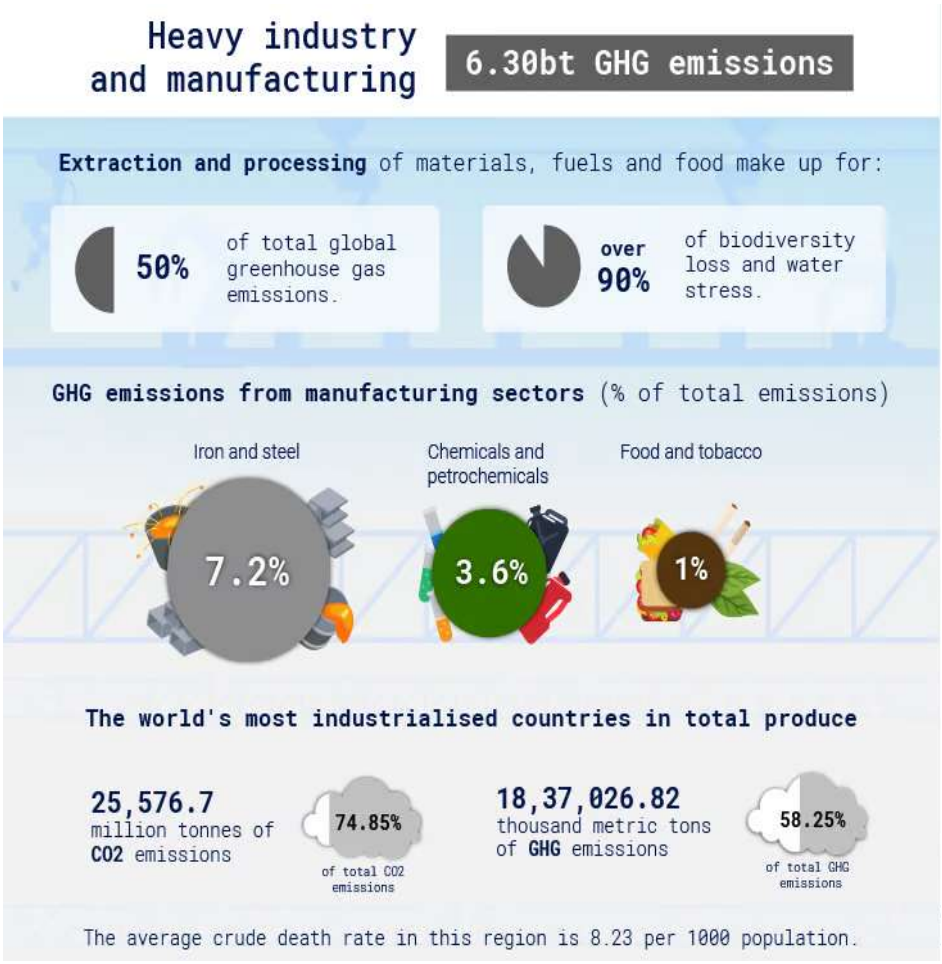
	
Agriculture	• **Agricultural practices** contribute to air pollution through the **release of ammonia, a hazardous chemical byproduct.** • The **use of insecticides, pe**sticides, and fertilizers in farming introduces **harmful chemicals into the air and water.** • A wide range of **nitrogen compounds (NO, NO2, N2), including ammonia (NH3),** can be attributed to **fertilizer production, farm machinery**, and livestock waste management in agriculture. • In **Europe, agricultural activities cause approximately 90% of ammonia emission**s and **80% of methane emissions.**



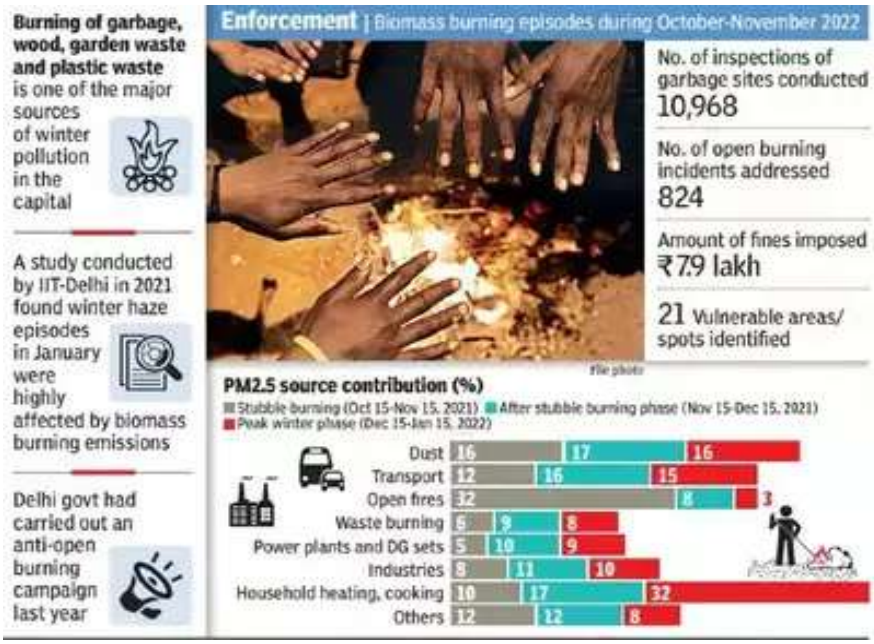
Stubble burning

- **Stubble burning**, a common **agricultural practice to clear fields for new crops,** is another source of air pollution, generating **hazardous pollutants during the burning process.**



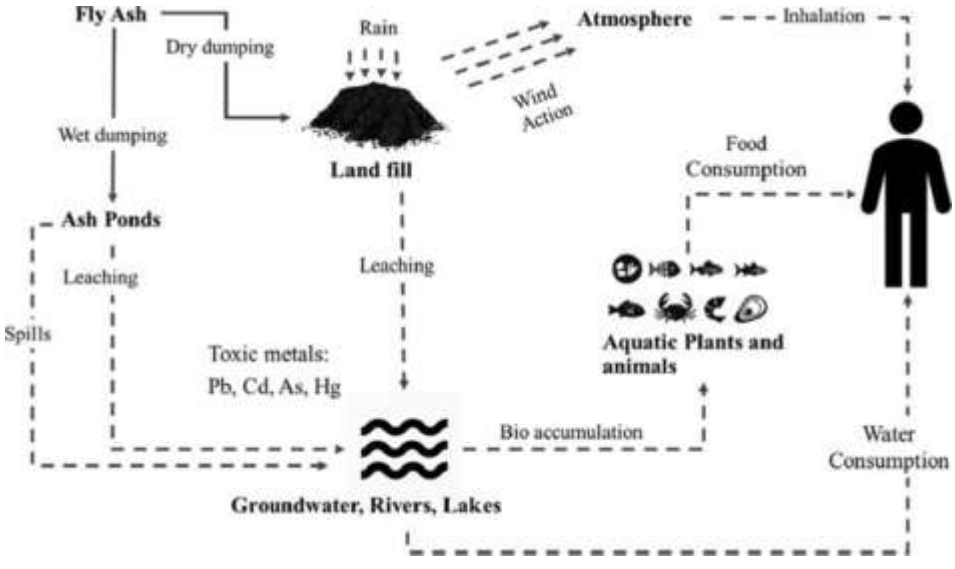
Industrial waste	• The combustion of fossil fuels such as **coal and oil in industrial processes in power plants, refineries, and factories release** a variety of pollutants, the majority of which are identical to those emitted by traffic and mobility. • Industrial activities release pollutants such as **carbon monoxide, hydrocarbons, organic compounds,** and various chemicals into the **air, adversely affecting air quality.** 
Indoor Pollution	• **Household cleaning products and painting supplies** release hazardous chemicals into the air, **contributing to indoor pollution.**

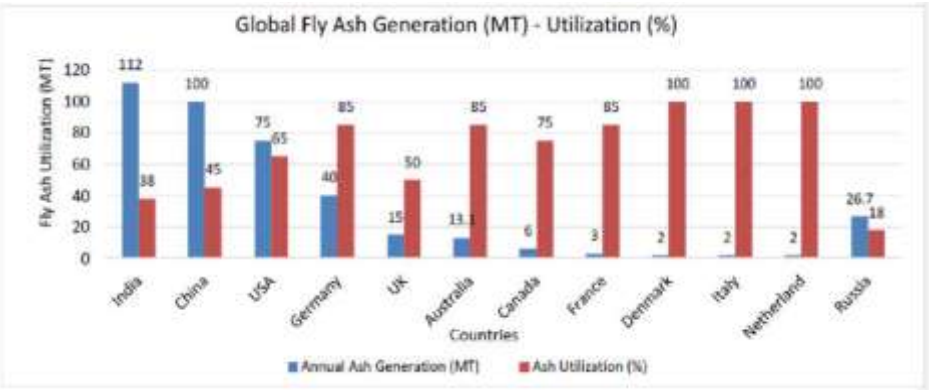
	• Around **2.1 billion people** worldwide (around a third of the global population) **cook using open fires or inefficient stoves fuelled by kerosene, biomass** (wood, animal dung and crop waste) and coal, which generates harmful household air pollution. • **Household air pollution** was responsible for an estimated **3.2 million deaths per year in 2020,** including over **237 000 deaths of children under the age of 5.** • The **combined effects of ambient air pollution** and household air pollution are associated with **6.7 million premature deaths annually.** 
Livestock	• **Half of direct agriculture emissions** come from **livestock**. • **Digestive processes in livestock release methane, a greenhouse gas**, as a by-product into the atmosphere.

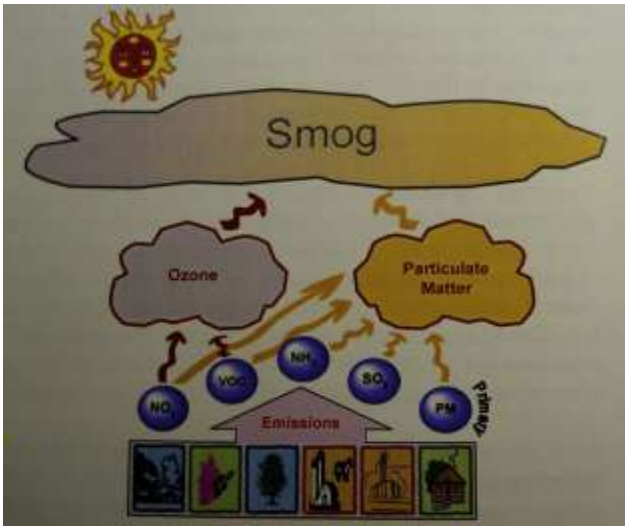
Wildfires	• **Climate change** is not just increasing **wildfire but also spiking air pollution.** • As many as **90% of the wildfires are caused by anthropogenic reasons**, a small spark can turn acres of forest area into ashes. • The **soot and dust particles, smoke** (that contains several toxic chemicals) can **stay suspended in the air for days.**
Open Burning of Garbage Waste	• **Open burning of garbage** is very harmful to the environment. • Open air garbage burning releases **toxins such as black carbon, soot, and carcinogens.**  • Open garbage burning **causes skin irritation, aggravates asthma and other respiratory diseases and illnesses,** increases the **risk of heart diseases**, and difficulties in **breathing, nausea and headaches.**

Fly ash

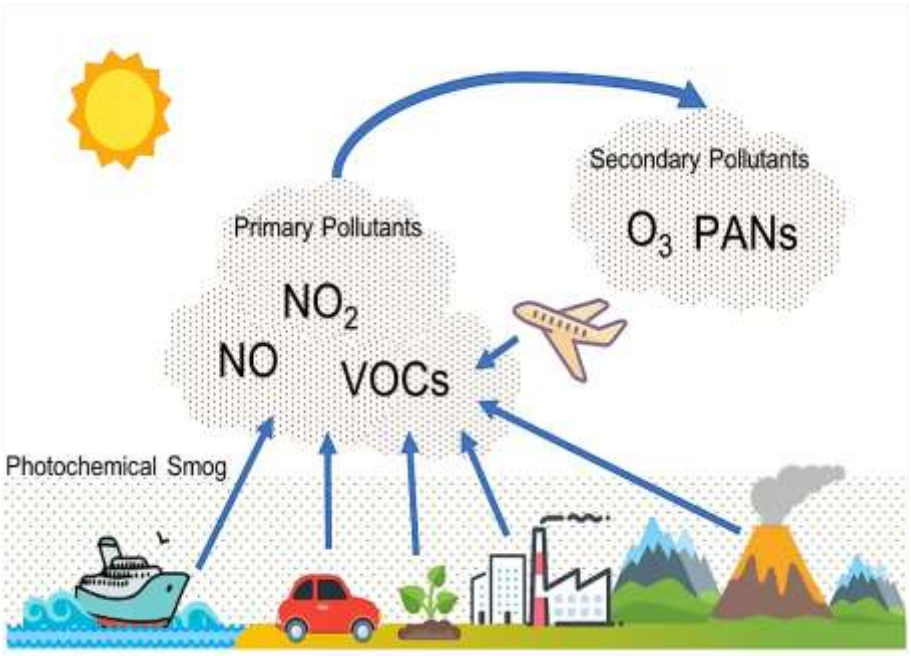
- The **ash produced mostly by thermal power** plants as **by-products of coal burning** operations is t**ermed Fly ash.**
- It consists primarily of **oxides of silicon, aluminum, iron and calcium.**
- Fly ash **pollutes the air as well as water.**

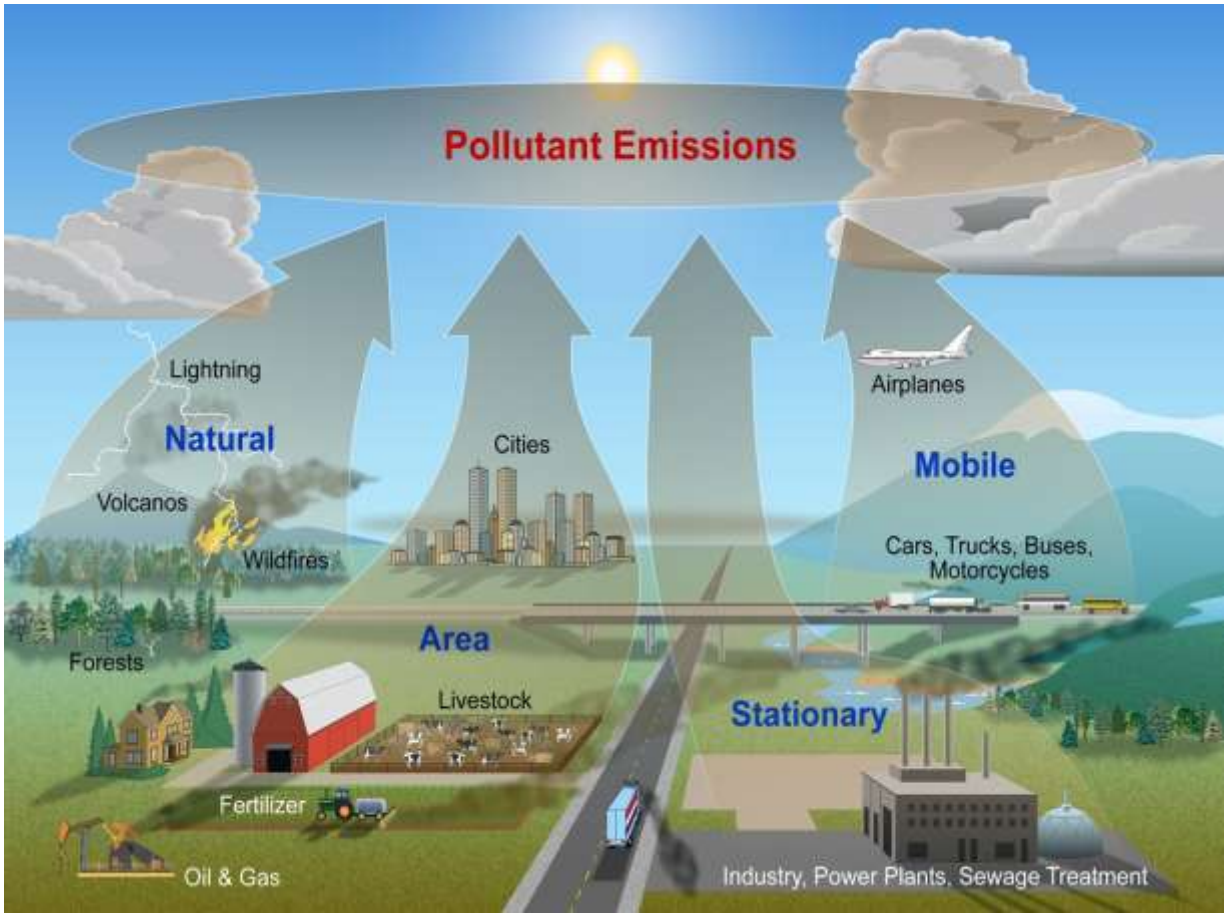


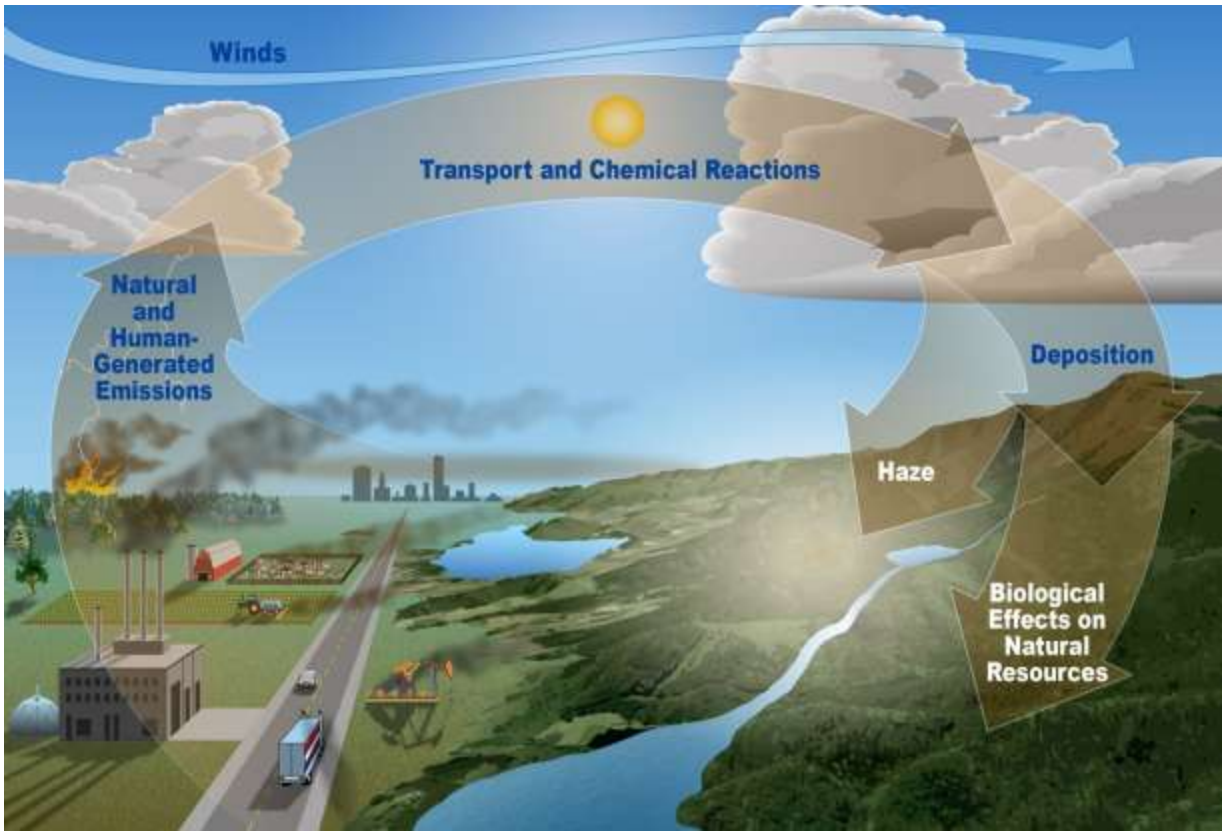
	
Construction and Demolition	• **Construction and demolition sites** are a **rich source of PM and other air pollutants including VOCs**, etc. • People living near these sites experience various health concerns like **difficulty in breathing, irritation in the eyes, nose, and throat,** etc. • **Several construction sites** and **raw materials such as bricks and concrete cause haze** and **foul air** which is hazardous for people especially, **children** and **elderly citizens.** 
Smog	• **Smog is a type of air pollution** derived from vehicular emissions and industrial fumes that **react in the atmosphere with sunlight to form secondary pollutants.**



- There are mainly two types of smog namely **sulfurous smog and photochemical smog.**
- **Sulfurous smog:**
  - **Sulfurous smog,** also known as **"London smog,"** is caused by a **high concentration of sulfur oxides in the air,** which is caused by the use of sulfur-containing f**ossil fuels, particularly coal. Dampness and a high concentration of suspended particulate matter** in the air aggravate this type of smog.
- **Photochemical smog:**
  - **Photochemical smog, also known as "Los Angeles smog**," is most prevalent in **urban areas with a high concentration of automobiles.**
  - It is a **mixture of pollutants** that are formed when **nitrogen oxides and volatile organic compounds (VOCs)** react to **sunlight, creating a brown haze above cities**.
  - It **tends to occur more often in summer,** because that is when there is **enough sunlight.**


Secondary Pollutants
O_3 PANs
Primary Pollutants
NO_2
NO
VOCs
Photochemical Smog


Pollutant Emissions
Lightning
Natural
Volcanos
Wildfires
Forests
Cities
Airplanes
Mobile
Cars, Trucks, Buses, Motorcycles
Area
Livestock
Fertilizer
Oil & Gas
Stationary
Industry, Power Plants, Sewage Treatment

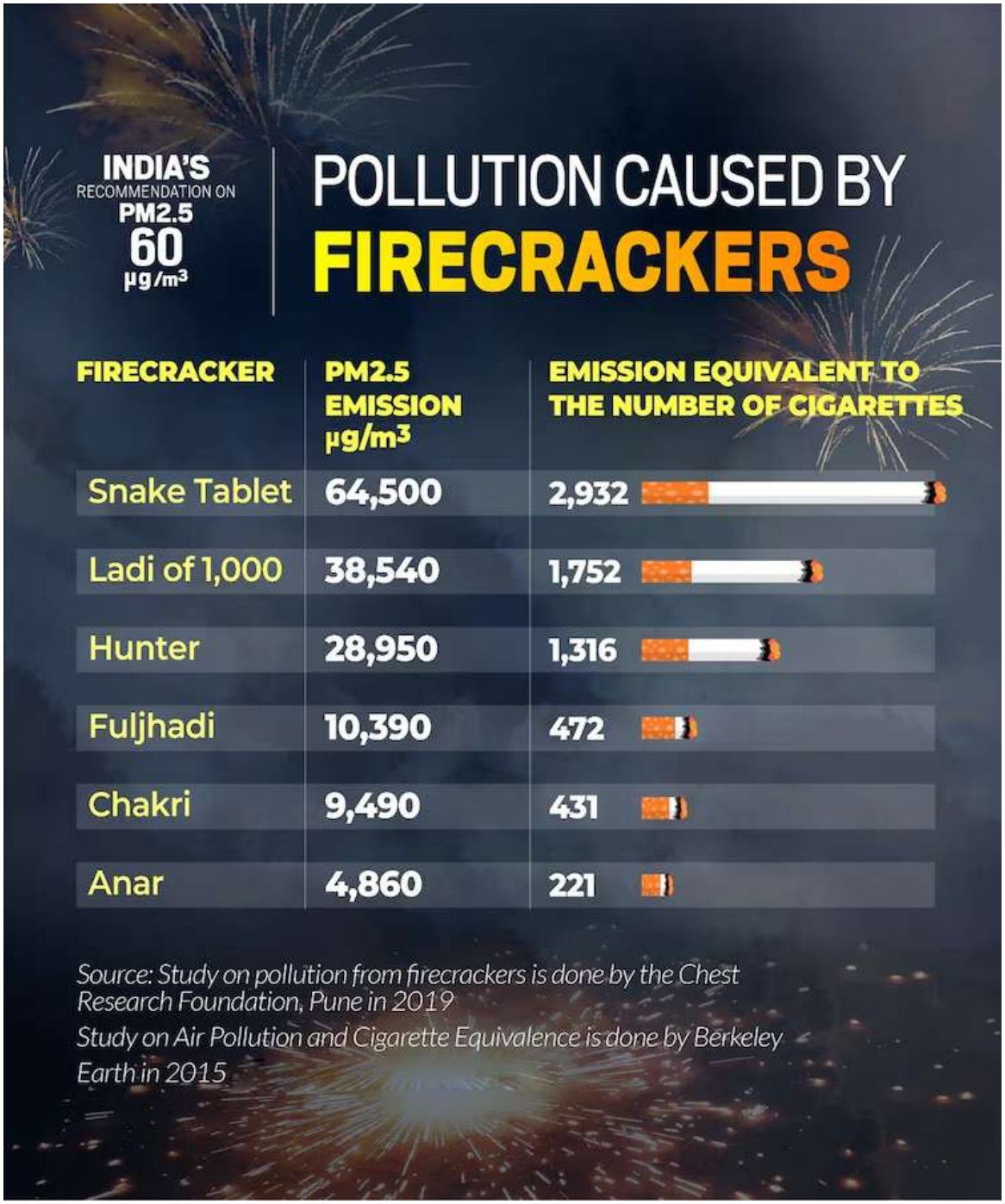


17. What are the major causes of Air Pollution in Delhi?

Major Causes	About
Crop burning in surrounding states	• **Farmers in states like Punjab, Haryana, and Uttar Pradesh** burn crop stubble to clear fields as an **immediate and simple solution after harvest**. • This practice releases **massive amounts of smoke and significantly harmful particles** into the **air**, which are then carried into **Delhi by winds**, significantly worsening the **levels of pollution.**
Frozen, unmoving winter air	• During the **winter months, Delhi's cold weather causes air to be severely frozen and still.**

	 • This means that **pollutants such as smoke, dust**, and **factory pollutants are caught near the ground, stuck in one place.** • As a result, it **accumulates smog, reducing air quality** and increasing health risks for people.
Overpopulation	• With a population of over **20 million, Delhi's fast**-paced urban growth puts immense pressure on its **infrastructure.** • More **people means more cars**, more waste, and s**ignificantly increased energy** consumption, all of which contribute to **higher pollution levels.**
Traffic jams and crowded roads:	• **Delhi's roads are crowded with vehicles**, many of which are **old and release high levels of harmful gasses.** 

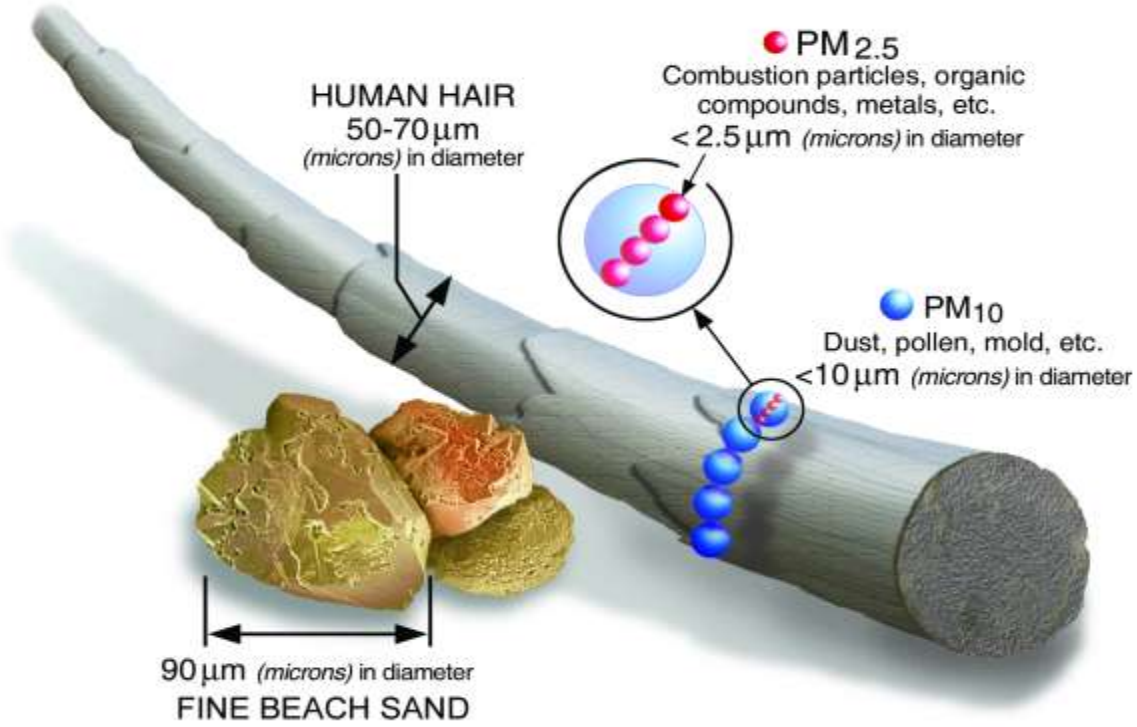
	• The **lack of sufficient public transport options forces** many people to depend on **private cars, causing constant traffic jams** and increasing the already high levels of **air pollution even higher.**
Fireworks during festivals	• Despite the **firecrackers being banned**, they continue to burst **during festivals like Diwali.** • These fireworks release **severely harmful chemicals, including sulfur dioxide and airborne particles, adding to the already high levels of pollution during the festive season.**
Construction and dust	• **Construction in Delhi is creating a lot of dust and pollution because the city is growing quickly.** • **Big building sites and roads** that are being built produce a lot of dust, especially during dry weather. • This **dust canmake the air polluted and unhealthy to breathe**, affecting the well-being of **people living in the city.** 



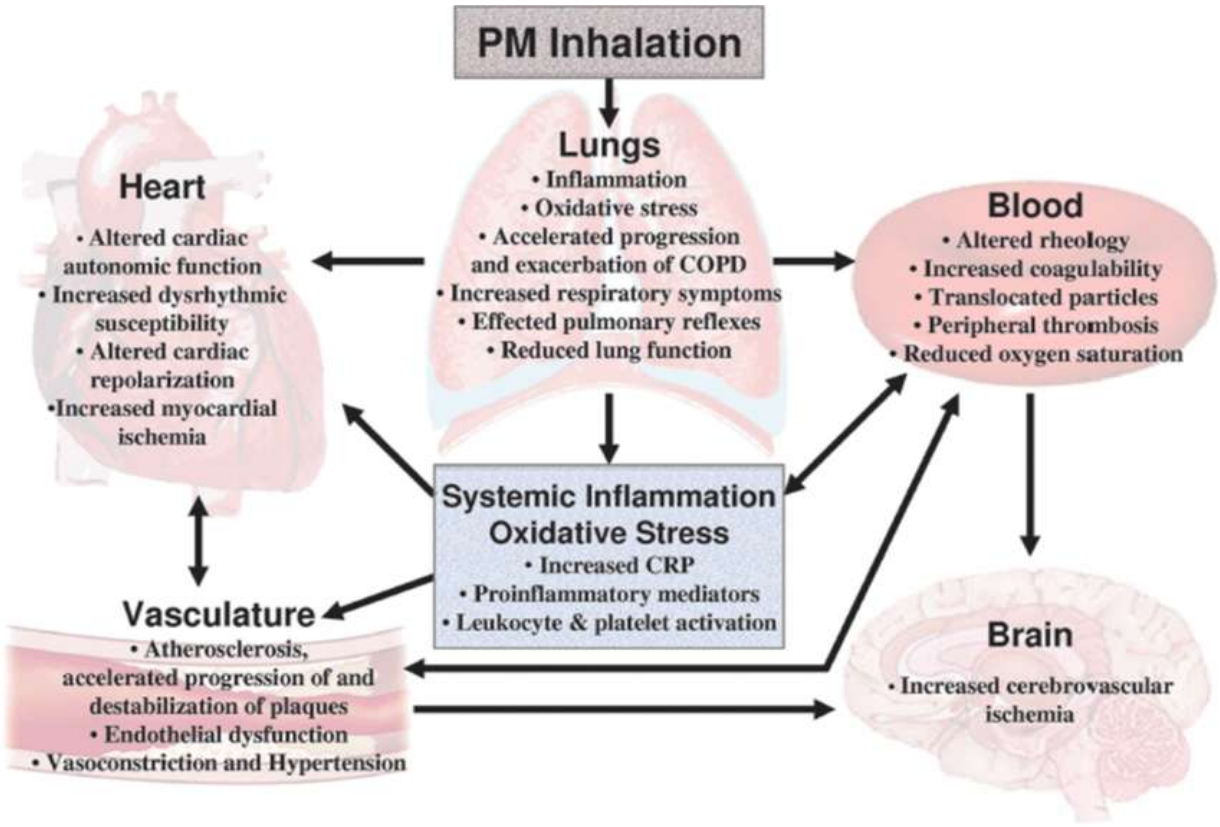
18. What is PM, and how does it get into the air?

- **PM stands for particulate matter** (also called particle pollution)and it is a **mixture of solid particles and liquid droplets** found in the air.
- Some particles, such as **dust, dirt, soot, or smoke, are large or dark** enough to be seen with the **naked eye.**

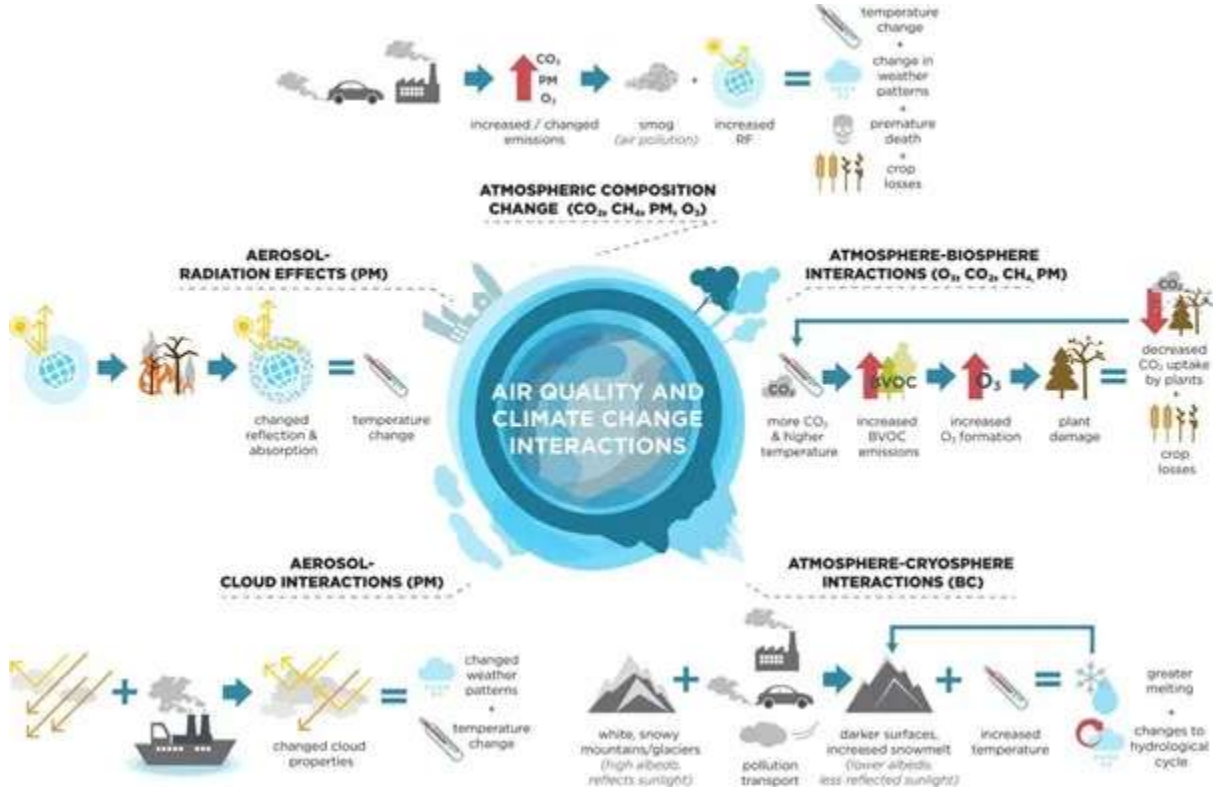
- Others are so small they can **only be detected using an electron microscope.**
- Particle pollution includes:
  - **PM10:** inhalable particles, with diameters that are generally **10 micrometers and smaller**; and
  - **PM2.5:** fine inhalable particles, with diameters that are generally **2.5 micrometers and smaller.**



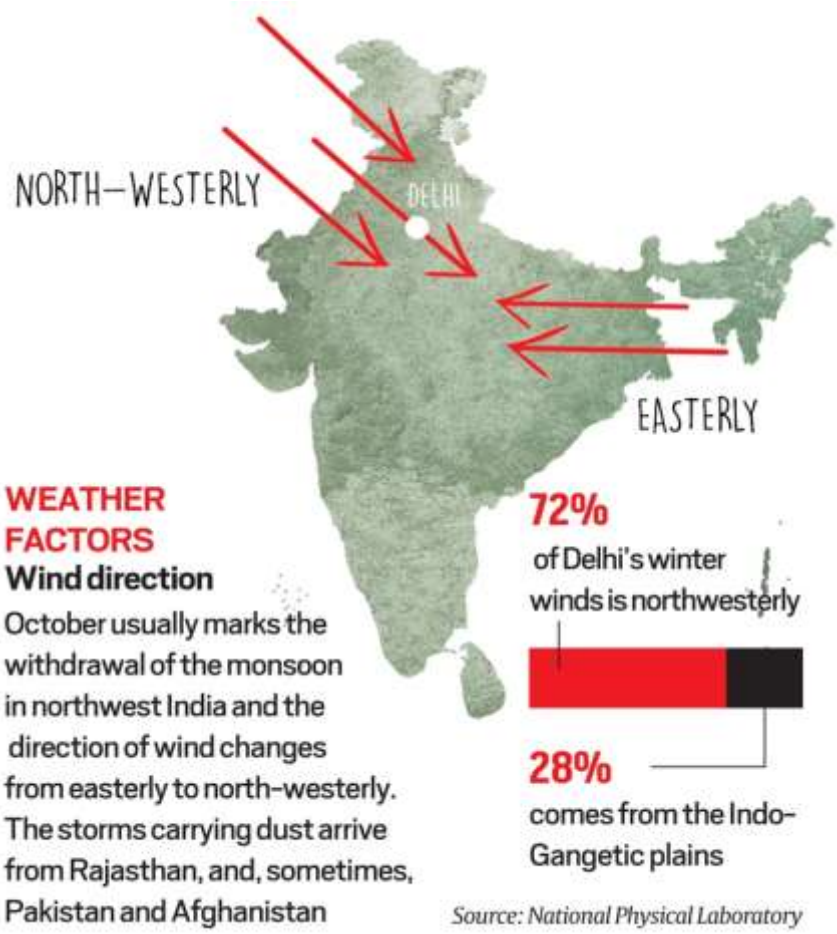
- Most particles form in the atmosphere as a **result of complex reactions of chemicals such as sulfur dioxide and nitrogen oxides**, which are pollutants emitted from power plants, industries and automobiles.
- Some are emitted **directly from a source, such as construction sites, unpaved roads, fields, smokestacks or fires.**
- Particulate matter contains microscopic solids or liquid droplets that are so small that they **can be inhaled and cause serious health problems**.



19. Mention how weather affects the air quality?

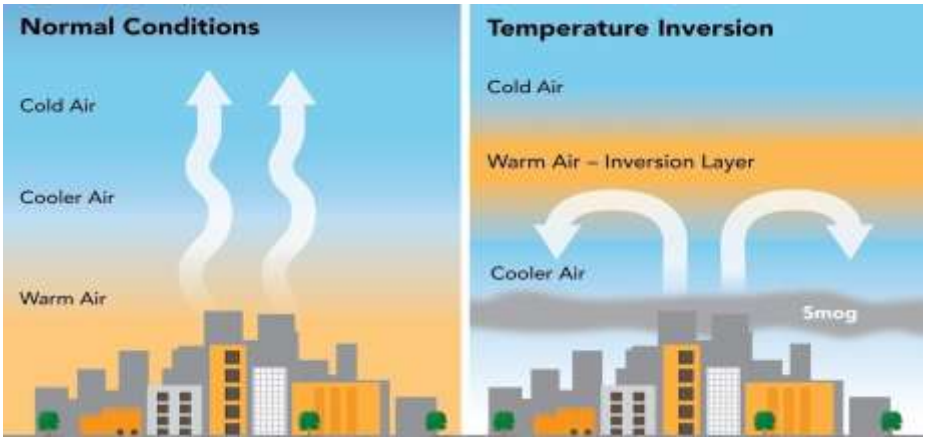


Determinants	Analysis
Wind and temperature	• **Wind carries air contaminants** away from their source, **causing them to disperse**. • In general, the **higher the wind speed, the more contaminants are dispersed** and the lower their concentration. • However, **high wind can also generate dust** which is a **problem in dry windy rural areas**. • As the **ground heats during daytime** the air becomes more turbulent, **especially in the middle of the day**. • **Air turbulence causes polluted air to disperse** as it moves away from its source. • In contrast, **stable conditions often occur at night when the air is cooler.** 



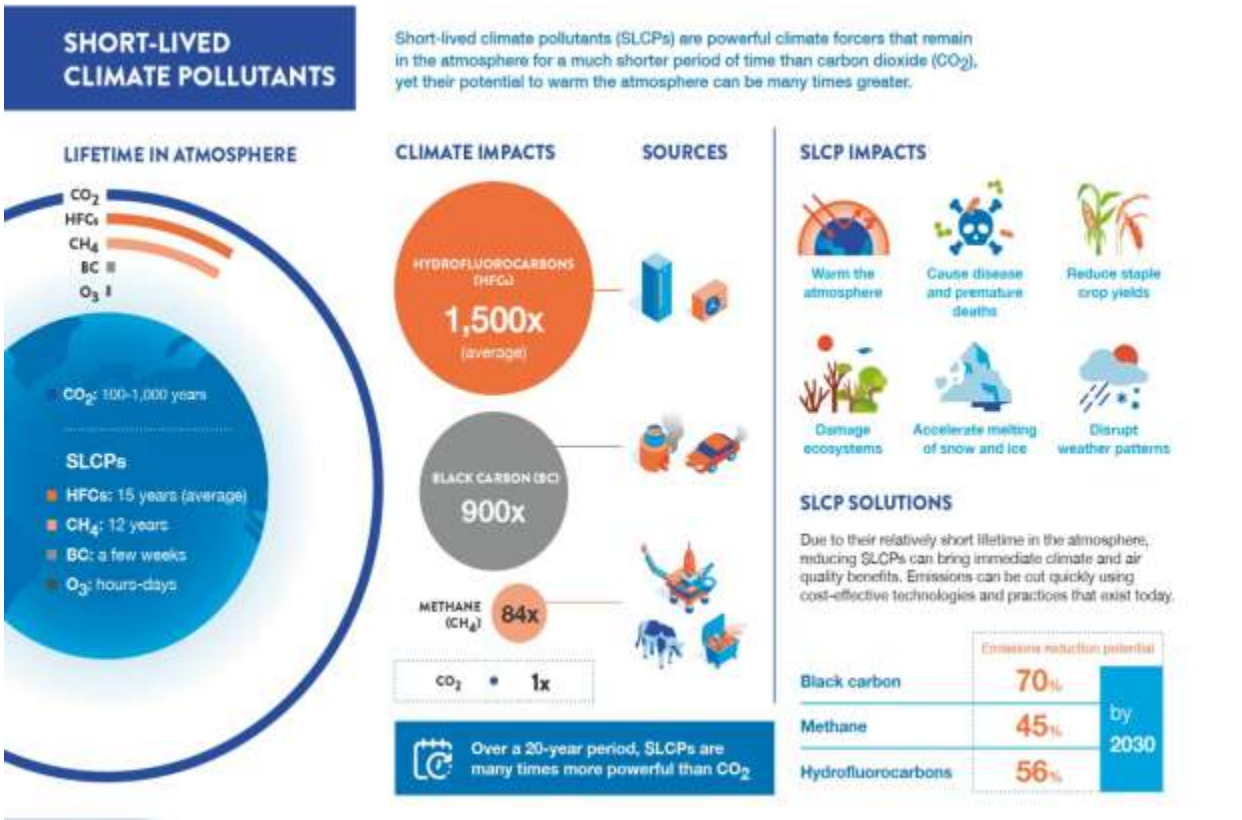
Inversion layers

- **Air usually cool**s with **increasing height** in the **atmosphere**.
- However, sometimes **an upper air layer is warmer than a lower one**.
- This is called an i**nversion.**



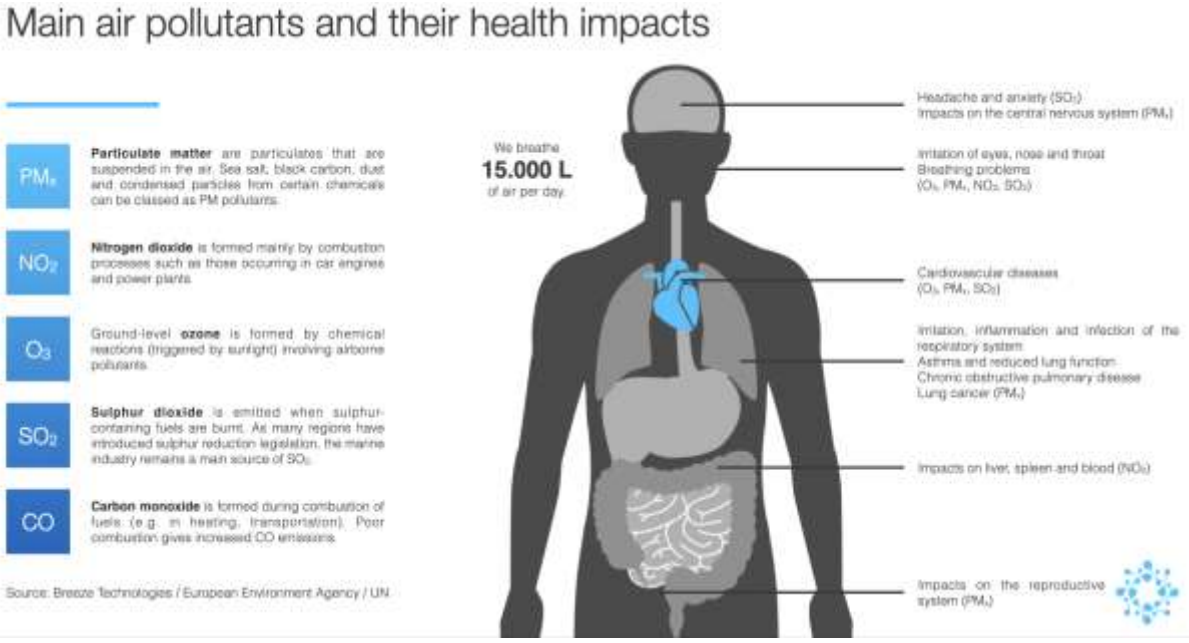
20. What are short-lived climate pollutants and how do they impact climate and health?

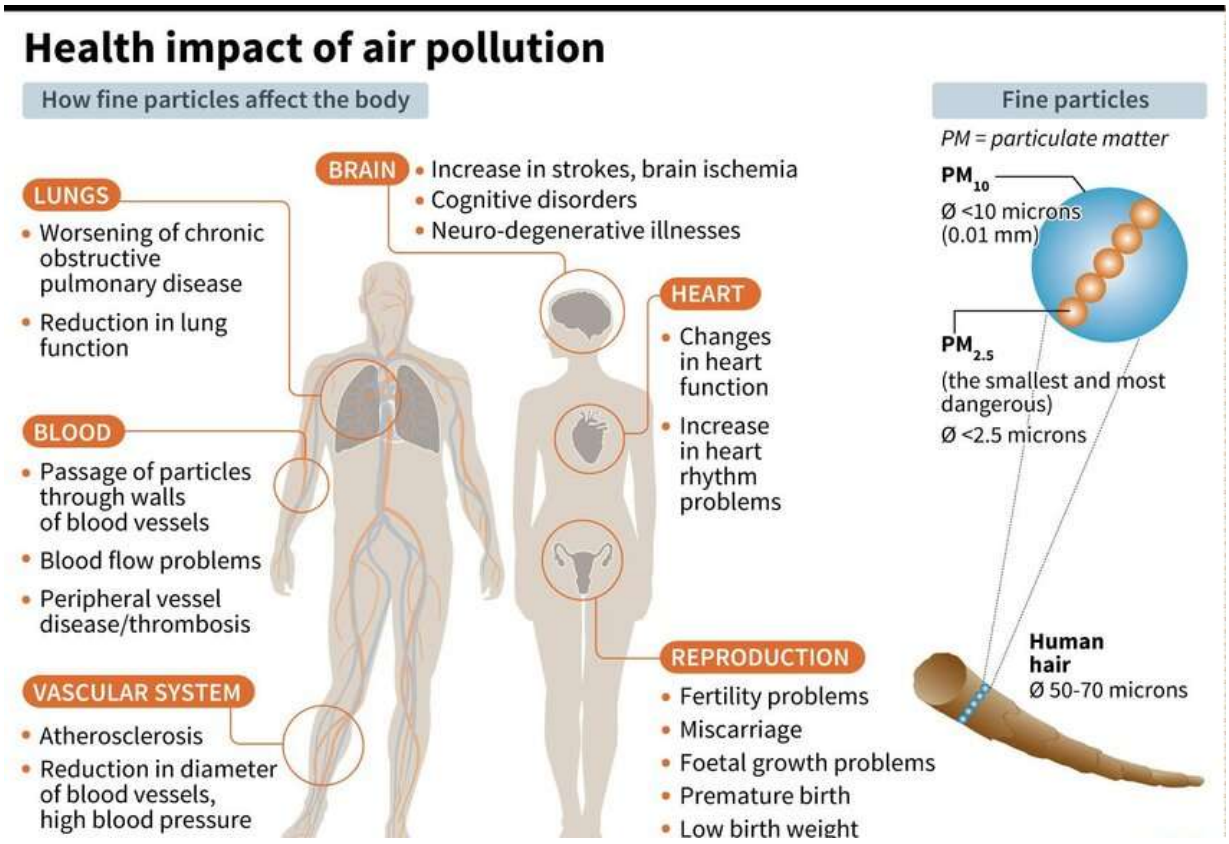
- **Air pollutants**, such as **methane and black carbon,** are powerful **short-lived climate pollutants (SLCPs)** that contribute to **climate change and ill health** .
- Although **SLCPs persist** in the **atmosphere for short lifetimes**, their **global warming potential** is often much **greater than carbon dioxide (CO2).**
- **Black carbon**, a component of fine particulate matter, **is one of the largest contributors to global warming after CO2.**
- **Black carbon warms the earth's atmosphere by absorbing sunlight**, thereby accelerating the melting of snow and ice.
- **Ozone and black carbon** affect weather **processes and decrease agricultural yields,** thus threatening food security.



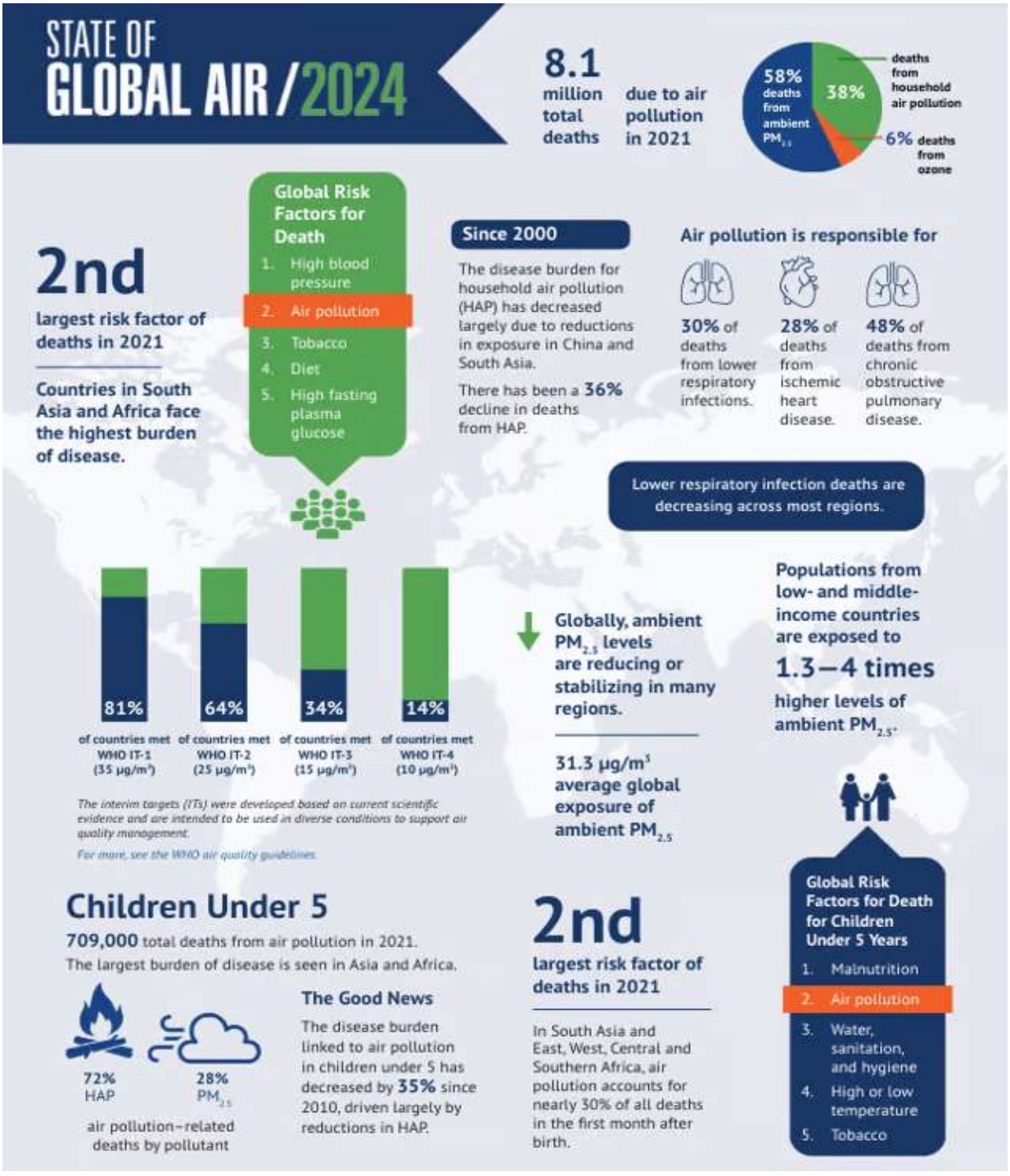
21. What is the impact of air pollution on health?

- **Air pollution poses serious health risks,** including respiratory diseases such as **asthma and chronic bronchitis, cardiovascular conditions, and premature mortality.**

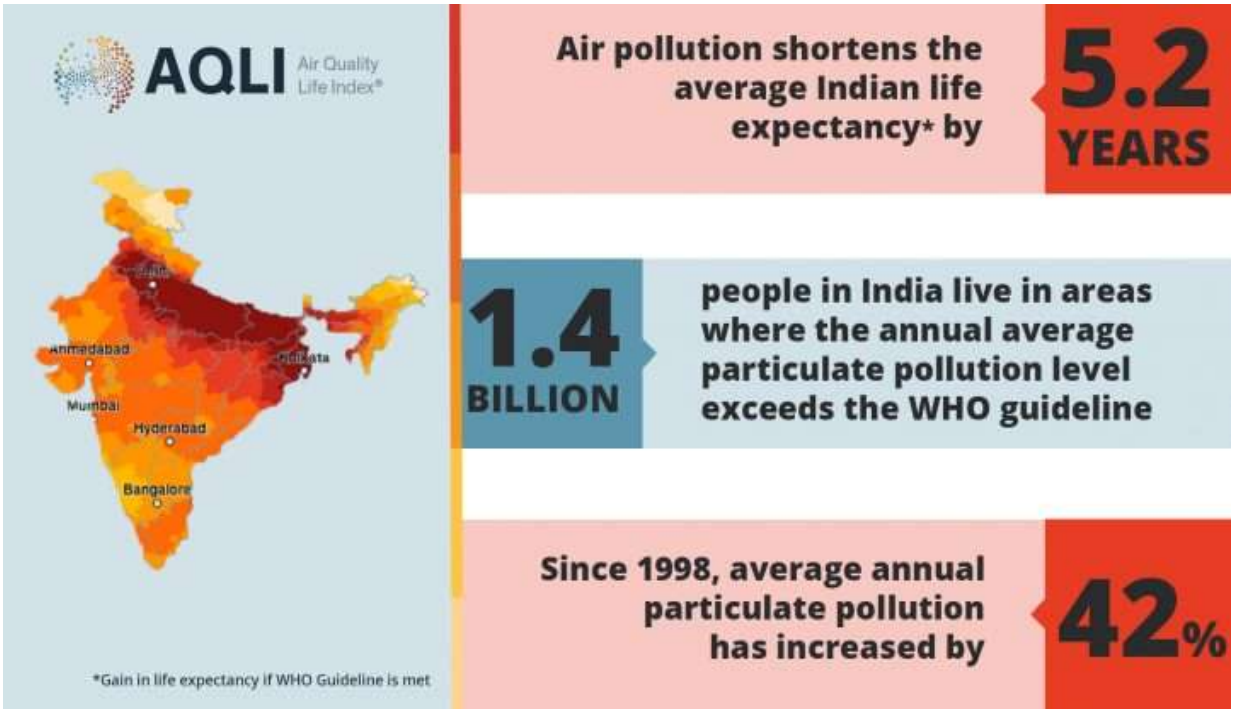




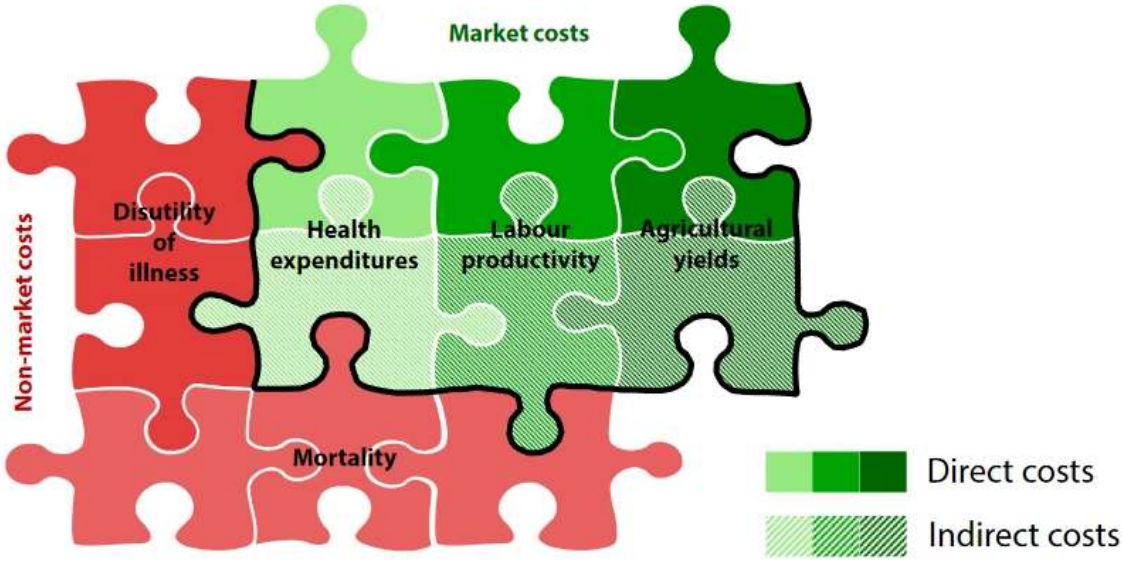
- In **2021, air pollution was a major global killer**, contributing to **8.1 million deaths worldwide.**
- The report, published by the **US-based Health Effects Institute (HEI) in partnership with UNICEF**, also highlighted the **devastating impact on young children.**

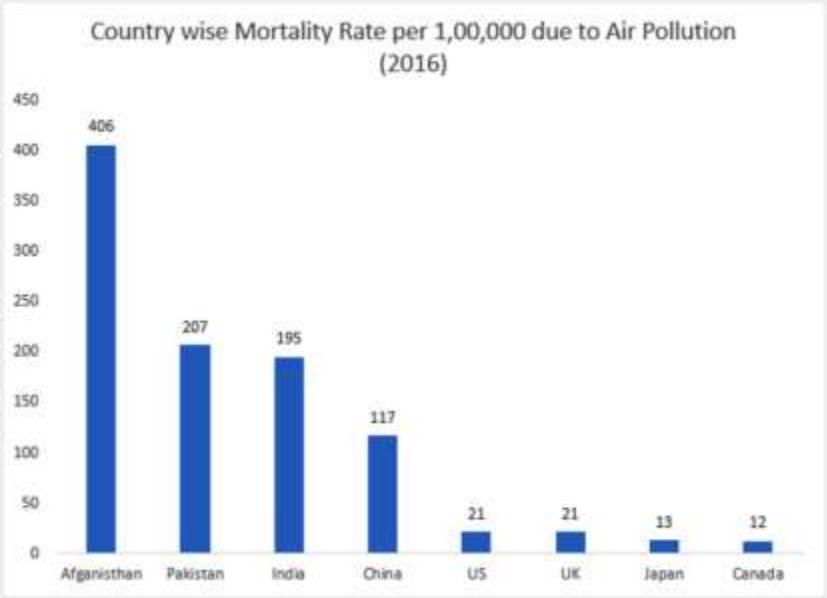


- **According to a study published in The Lancet Planetary Health journal, 1.7 million deaths** were attributable **to air pollution in 2019**, which is around **18% of all deaths in India.**



22. What are the Economic impacts of air pollution?



Impact	Analysis
Healthcare costs	• The **World Bank estimates** that the health damage **caused by air pollution costs $8.1 trillion a year, equivalent to 6.1% of global GDP.** 
Affects productivity	• **Air pollution hampers** workforce productivity and economic activity and around **1.2 billion work days** are **lost globally every year**, which could reach **3.8 billion days by 2060.** • In India, **reduced productivity, work absences and premature deaths** caused by **air pollution** cost the economy an **estimated $95 billion** or **3% of the country's GDP** in 2019. • Despite the **EU's** recent progress, **air pollution still causes €600 billion in losses each year**, or **4% of its annual GDP.**

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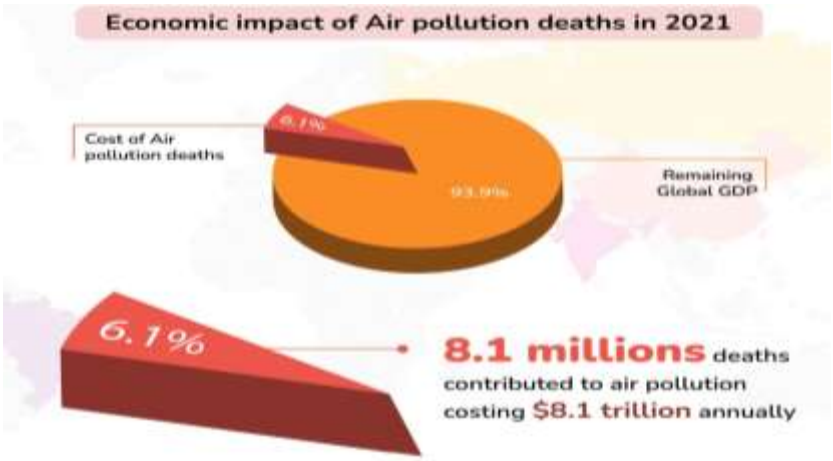
<td> 
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<td>Agriculture</td>
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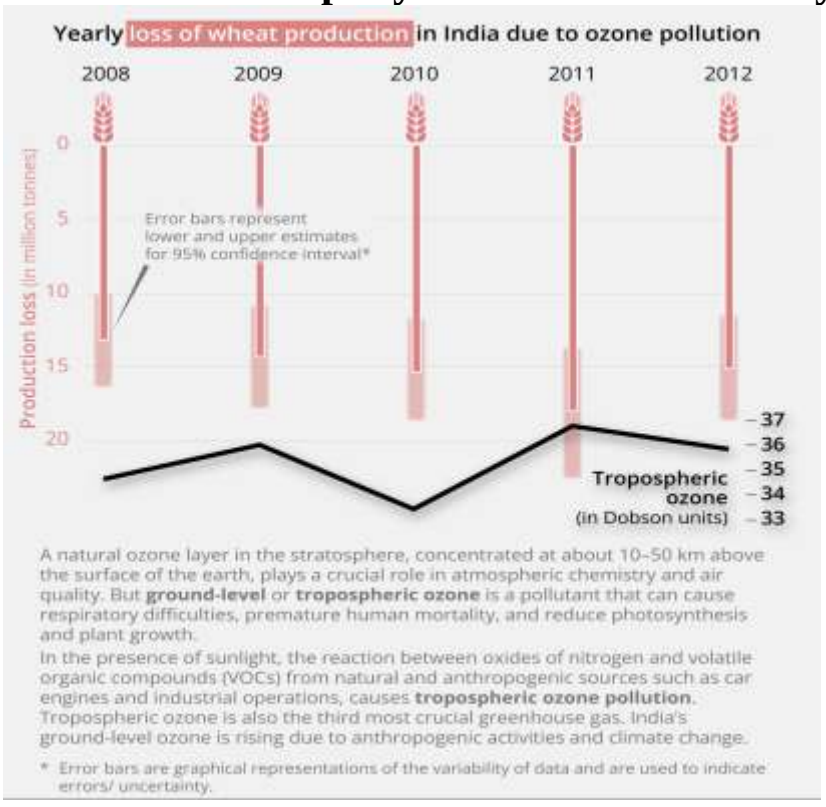
High air pollution affects the global crop yields. As many greenhouse gasses emission contributes to acid rains and smog it affects crop production.
Ground-level ozone and Nitrogen dioxide significantly affect crop yields.
A study indicates that 5% to 12% yield losses globally due to these pollutants and it resulted in around $20 billion per year loss in the economy



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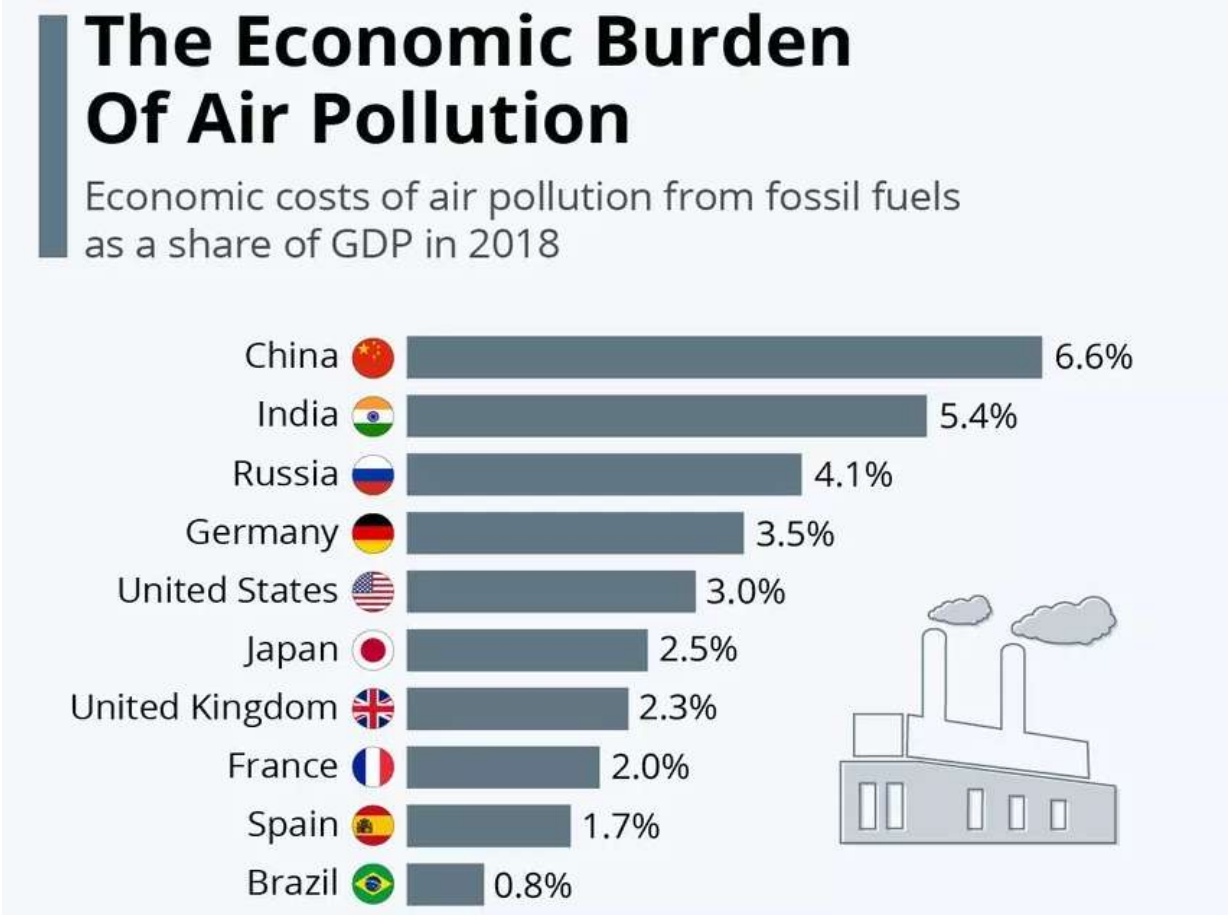
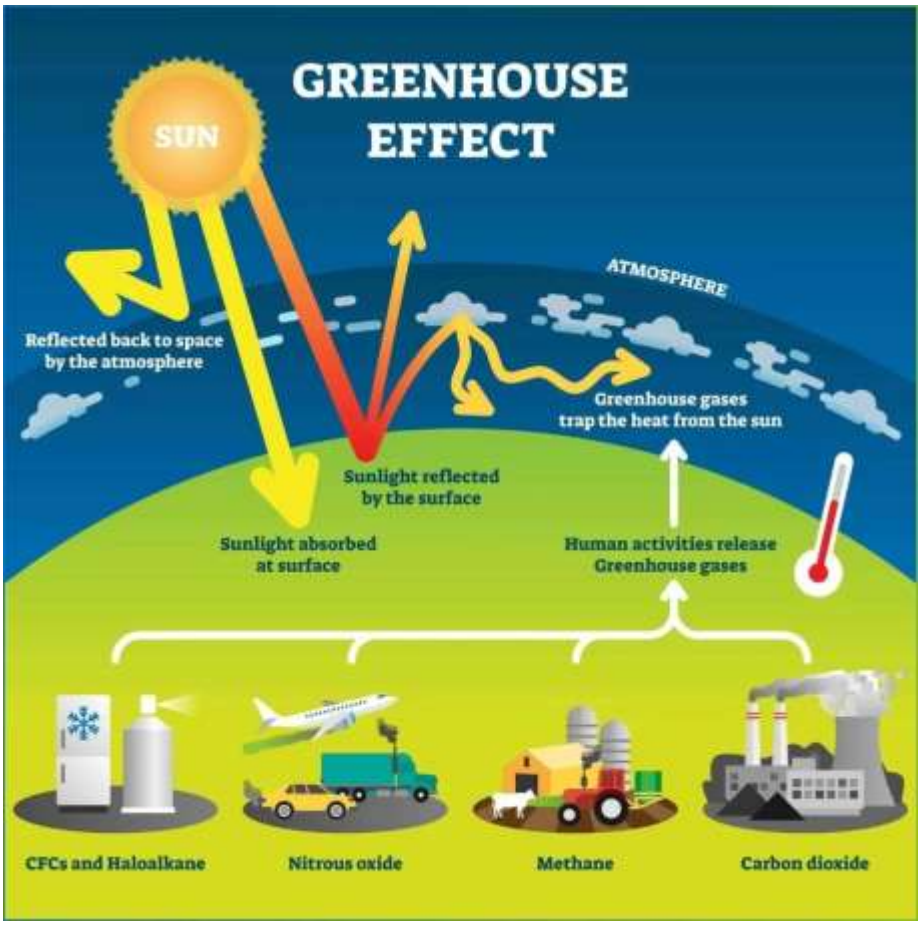
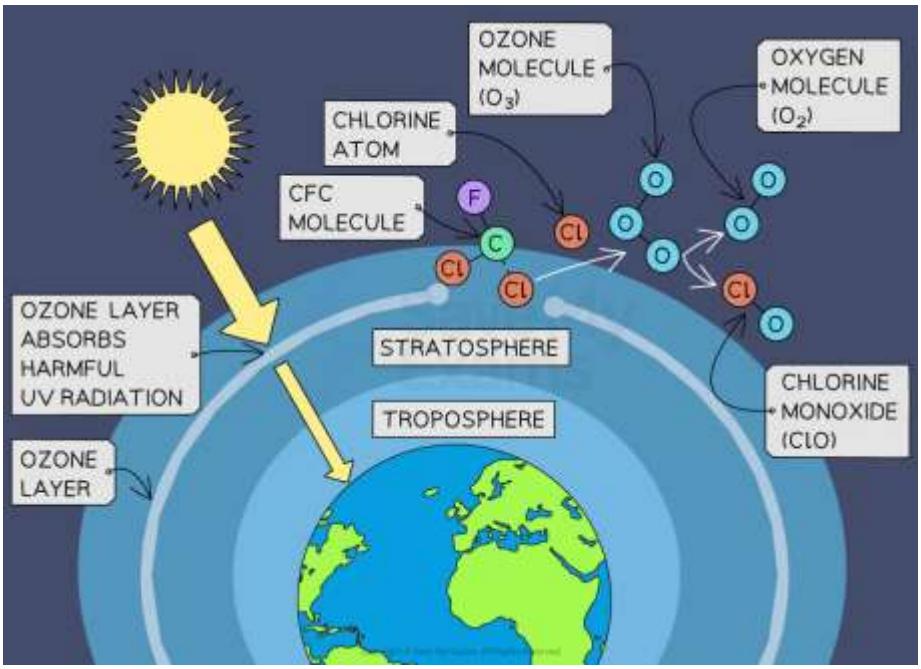


23. Mention how air pollution contributes to climate change?

- **Air pollutants** not only severely **impact public health**, but also the **earth's climate and ecosystems globally.**
- **Air pollution contributes** to climate change in several ways, including:

Impact	Analysis
Greenhouse gasses	• Air pollutants like **methane and black carbon are short-lived climate pollutants (SLCPs)** that t**rap heat in the atmosphere**, causing global warming. • **Methane is 84 times more potent than carbon** dioxide, another greenhouse gas.

	
Ozone depletion	• **Ozone depletion** is the **thinning of the ozone layer** in Earth's atmosphere, which allows **more harmful ultraviolet (UV) radiation** to reach the planet. • The main reasons for the ozone hole are **chlorofluorocarbons, carbon tetrachloride, methyl bromide and hydrochlorofluorocarbons.**

24. Enlist global initiatives to combat air pollution?

Initiatives	Analysis
Global Methane Pledge	• The **Global Methane Pledge (GMP)** is a **voluntary framework** supporting nations to take action to **collectively reduce methane emissions by 30% from 2020 levels by 2030.** • This could **eliminate over 0.2˚C of warming by 2050.** • The **GMP** was announced at **COP 26** in **November 2021** by the **European Union and the United States.** • As of **September 2024, over 155 countries** have **joined the GMP.** • **India has opted not to sign the Global Methane Pledge.**

International Clean Air Day

- **Since 2020**, each **7th of September** has been recognised as **International Day of Clean Air for Blue Skies (Clean Air Day)**.
- This event recognises the **importance of reducing air pollution** – the single greatest environmental health risk globally, and one of the main avoidable causes of death and disease globally.

BreatheLife campaign	• **BreatheLife** is a **joint campaign of the Clean Air and Climate Coalition, World Health Organisation, United Nations Environment Programme,** and **World Bank** to mobilize cities and individuals **to protect our health and our planet** from the effects of **air pollution.** 

25. Enlist initiatives taken by India to combat air pollution?

Initiatives	Analysis
The Winter Action Plan 2024	• **Delhi government launched a 21-point winter action plan** to **combat air pollution,** featuring real-time drone surveys and a special task force.

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<td>National Clean Air Programme (NCAP)</td>
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The National Clean Air Programme (NCAP) was launched in 2019 as a long-term, time-bound, national-level strategy to tackle the country's air pollution problem comprehensively.
NCAP aims to achieve a 20-30% reduction in Particulate Matter concentrations by 2024, keeping 2017 as the base year for comparing concentrations.

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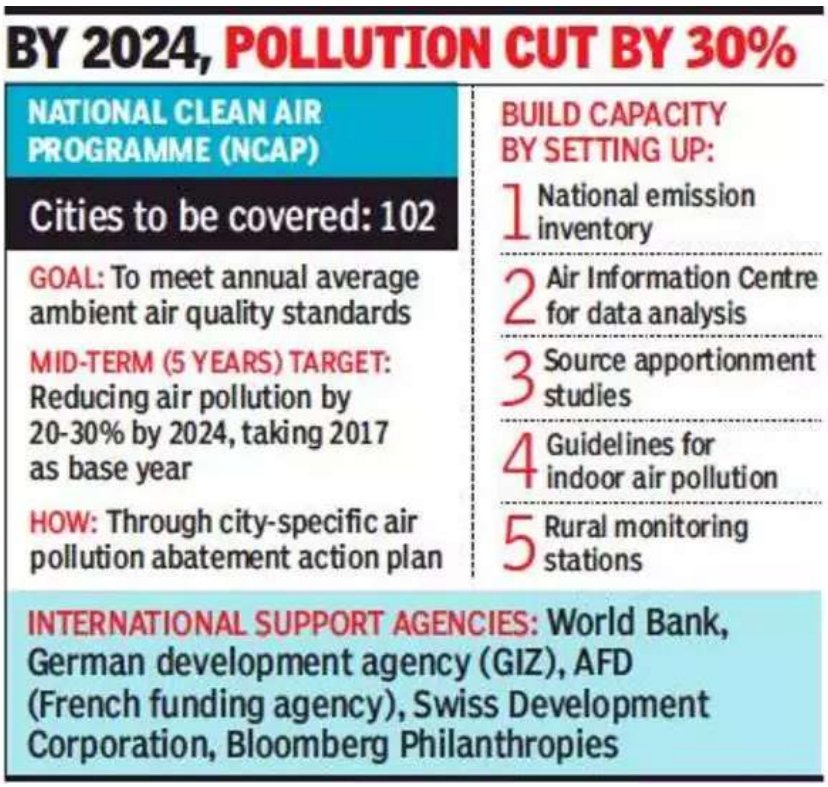
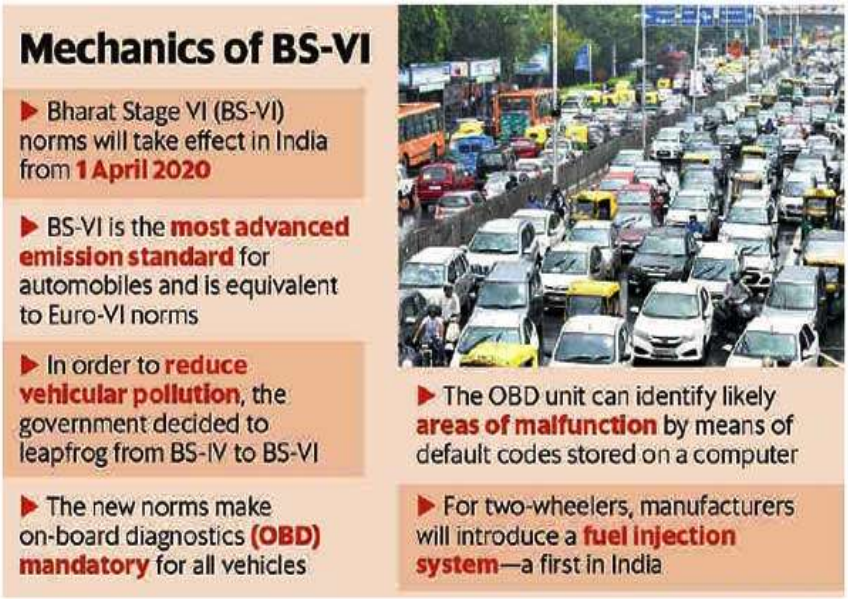


New Commission for Air Quality Management

- **The Commission for Air Quality Management (CAQM)** was established as a **statutory body** by the **government in August 2021** as an overarching body to **carry out air quality management in Delhi NCR.**

BS-VI Norms	• **BSVI, or Bharat Stage Emission Standard 6**, is a set of regulations that c**ontrol the amount of pollutants** emitted by vehicles in India. • The government of India **introduced BSVI in April 2020 to replace BS4** and reduce pollution levels. • **BS6**-compliant engines use modern technology like **Lean NOx traps (LNTs), selective catalytic reduction (SCR)** units, and **diesel particulate filters (DPFs**) to meet the emission targets. 
Graded Response Action Plan	• The **Graded Response Action Plan (GRAP)** is a set of measures that are **implemented to reduce air pollution** in the **National Capital Region (NCR) of India.** • The plan is based on the **National Air Quality Index (AQI)** and is activated when the **air quality reaches a certain level.**

	
National Electric Mobility Mission Plan (NEMMP)	• Under **NEMMP 2020**, the Government has launched **Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India)** scheme to promote manufacturing of **electric and hybrid vehicle technology.** 

(R&D) initiatives	• **Wind Augmentation and Air Purifying Unit (WAYU):** ▪ A device developed by the **Department of Science and Technology (DST) and CSIR-NEERI** that can reduce air pollution **in industrial complexes, residential areas, and schools**. ▪ This device uses wind generators to **dilute pollutants and filters to remove them.**  • **Air Pollution Control Division (APCD)** ▪ A division of **CSIR-NEERI that conducts research on air quality management,** including monitoring, prediction, and simulation. ▪ The **APCD also uses emission inventories** and dispersion modeling to identify impacts.

26. What could be the possible way ahead?

Way ahead	Analysis
Psychological Nudging	• **New research by the University of Kent** has found that using **low-cost psychological interventions** can **reduce vehicle engine idling** and in turn improve air quality, especially when there is **increased traffic volume at railway level crossings.** • **Convincing individuals to shift** from **personal vehicles to public transport** or carpooling necessitates a major shift in behaviour
Enforcement of Regulations	• **Implementing and enforcing regulations against forest fires, smoking in public spaces**, and the **use of firecrackers during festivals** require a robust legal framework and effective law enforcement.
Community Engagement	• **Engaging local champions** and **communities** in clean air initiatives requires sustained efforts in awareness building and community participation. Building a sense of **responsibility and ownership among residents** can be a game changer in **combating air pollution.** 

Integrated Urban Planning	• **Develop and implement comprehensive urban planning** that integrates **sustainable transportation, waste management** and green spaces. • **Prioritize mixed-use developments** to reduce commuting distances and promote walkability.
Government Policies and Incentives	• **Formulate and enforce** policies that promote **clean transportation, energy efficiency, and waste reduction.** • **Provide financial incentives for businesses and individuals** adopting eco-friendly practices and technologies.

27. What is the relevance of the topic for UPSC CSE?

- **For Prelims:** Air pollution, Solid Waste Management, National Green Tribunal, National Clean Air Programme, System of Air Quality and Weather Forecasting and Research (SAFAR) Portal, New Commission for Air Quality Management, Graded Response Action Plan
- **For Mains:** Major Driving Factors of Air Pollution, Reasons for Persistent Air Pollution in India Despite Significant Initiatives

Some previous years prelims questions.

Q1. According to the Environmental Protection Agency (EPA), which one of the following is the largest source of sulfur dioxide emissions? **(2024)**

(a) Locomotives using fossil fuels
(b) Ships using fossil fuels
(c) Extraction of metals from ores
(d) Power plants using fossil fuels

Ans: (d)

Q2. In the context of WHO Air Quality Guidelines, consider the following statements: **(2022)**

1. The 24-hour mean of PM2.5 should not exceed 15 µg/m3 and annual mean of PM2.5 should not exceed 5 µg/m3.
2. In a year, the highest levels of ozone pollution occur during the periods of inclement weather.
3. PM10 can penetrate the lung barrier and enter the bloodstream.
4. Excessive ozone in the air can trigger asthma.

Which of the statements given above are correct?

(a) 1, 3 and 4
(b) 1 and 4 only
(c) 2, 3 and 4
(a) 1 and 2 only

Ans: (b)

Q3. Which of the following are the reasons/factors for exposure to benzene pollution? (2020)

1. Automobile exhaust
2. Tobacco smoke
3. Wood burning
4. Using varnished wooden furniture
5. Using products made of polyurethane

Select the correct answer using the code given below:

(a) 1, 2 and 3 only
(b) 2 and 4 only
(c) 1, 3 and 4 only
(d) 1, 2, 3, 4 and 5

Ans: (a)

Q4. In the cities of our country, which among the following atmospheric gasses are normally considered in calculating the value of the Air Quality Index? **(2016)**

1. Carbon dioxide
2. Carbon monoxide
3. Nitrogen dioxide
4. Sulfur dioxide
5. Methane

Select the correct answer using the code given below:

(a) 1, 2 and 3 only
(b) 2, 3 and 4 only
(c) 1, 4 and 5 only
(d) 1, 2, 3, 4 and 5

Ans: (b)

Some previous years mains questions.

Q1. Describe the key points of the revised Global Air Quality Guidelines (AQGs) recently released by the World Health Organisation (WHO). How are these different from its last update in 2005? What changes in India's National Clean Air Programme are required to achieve revised standards? **(15 Marks-2021)**

Q2. Write a review on India's climate commitments under the Paris Agreement (2015) and mention how these have been further strengthened in COP26 (2021). In this direction, how has the first Nationally Determined Contribution intended by India been updated in 2022? **(15 Marks-2025)**

Some questions from this year and previous years interview transcripts.

Board Lieutenant General Raj Shukla sir:

- Why is there air pollution in delhi?

Board Sheel Vardhan Sir:

- What is NGT? its role, why and when it was set up?
- So do you think NGT has really made an impact?
- Why do we take actions when air is polluted and not put limitations on when it is clean to maintain the good AQI?

Board Suman Sharma mam:

- How Delhi air is polluted by parali from Punjab?
- If you are DM in Punjab, how will you solve it?

Board Suman Sharma mam:

- What are we doing for air and water pollution?

Board BB Swain sir:

- How to tackle stubble burning?
- Tell an issue of stubble burning apart from pollution.

Board Sheel Vardhan Singh sir:

- Tell me why groundwater is getting polluted? and solutions.
- As we know there is stubble burning in states surrounding NCR, what are its solutions?
- How will you pursue farmers in this case at an individual level?

Some questions for QUIZ.

Q1. Consider the following pollutants:

1. Nitrogen dioxide
2. Sulphur dioxide
3. Ammonia
4. PM 10
5. Ground-level ozone
6. Lead

How many of the above pollutants are considered in the calculation of AQI?

(a) Only three
(b) Only four
(c) Only five
(d) All six

Ans: (d)

Some questions for POLL.

Q1. Are you satisfied with the steps taken to combat Air pollution in the Delhi region?

(a) YES
(b) NO
(c) Can't say.

Q2. Are developed countries spending enough to combat pollution?

(a) YES
(b) NO
(c) Can't say.

Q3. Do you believe the ban on firecrackers during Diwali is effective in reducing pollution?
(a) YES
(b) NO
(c) Can't say.

Q5. Should the government impose stricter penalties for violating pollution control rules during festivals?
(a) YES
(b) NO
(c) Can't say.

Q6. Would you personally support celebrating Diwali without firecrackers to protect air quality?
(a) YES
(b) NO
(c) Can't say.

Q7. Do you think air quality emergencies should be treated as a national disaster issue?
(a) YES
(b) NO
(c) Can't say.

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