



Centre for Science and Environment

# LET'S CLEAR THE AIR ON AIR

An e-primer on air pollution for schools





A N I L A G A R W A L 1 9 4 7 - 2 0 0 2

'Environmental literature being generated for schoolchildren is, with some exceptions, in the genre of nature education. It is very important to expose young children to the beauties and wonders of nature. But as they grow older, it is important they begin to understand how human beings and human societies interact with their environment for their survival and their growth, how these human–nature interactions become a part of a society's culture, and why it is important to rationalize our relationship with our environment.'

Anil Agarwal  
Founder-director, CSE



Centre for Science and Environment

# **LET'S CLEAR THE AIR ON AIR**

**An e-primer on air pollution for schools**

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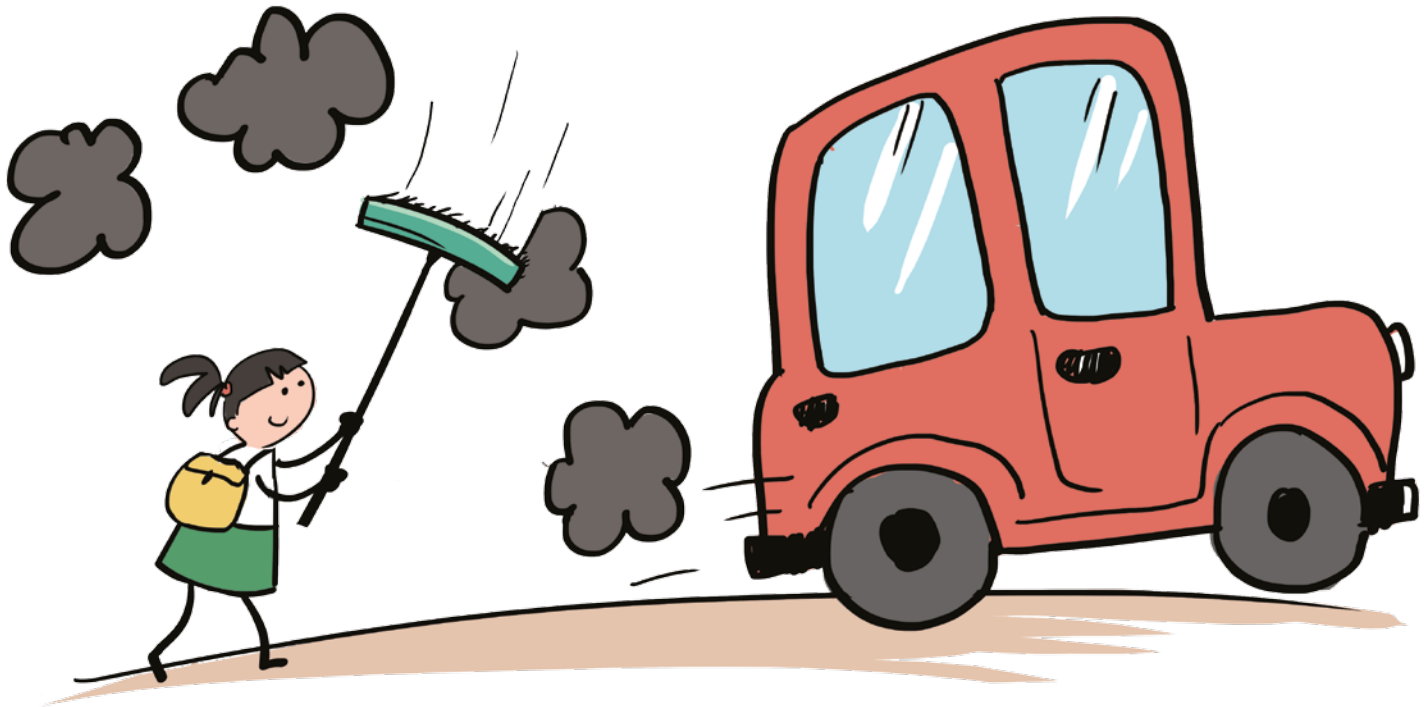
**RESOURCE BANK**



Email: [support@greenschoolsprogramme.org](mailto:support@greenschoolsprogramme.org)

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# WHY ARE WE SCARED ABOUT OUR AIR?



**B**ecause it is becoming more and more toxic and unbreathable. Fumes from vehicle exhausts, dust all around us, smoke from chimneys of industries, power plants, diesel generator sets, and burning crops and garbage dumps... they all add up to make our air a noxious mixture of extremely harmful substances.

Today, air pollution has become a national crisis. It ranks among the top killers in the country and is responsible for close to 13 per cent of the deaths in India. Over 75 per cent Indians breathe air that is worse than the levels recommended by the National

Ambient Air Quality Standards.

Some of the world's worst affected cities – including several small and medium-sized ones – are in India. In many cities, the levels of PM10 (tiny particulate matter that are less than 10 micron in size and can go deep inside our lungs), have reached the critical mark. According to the environment ministry, 88 per cent of our cities were in this level in 2016. At the same time, newer pollutants like nitrogen dioxides and ozone have begun to raise their ugly heads.

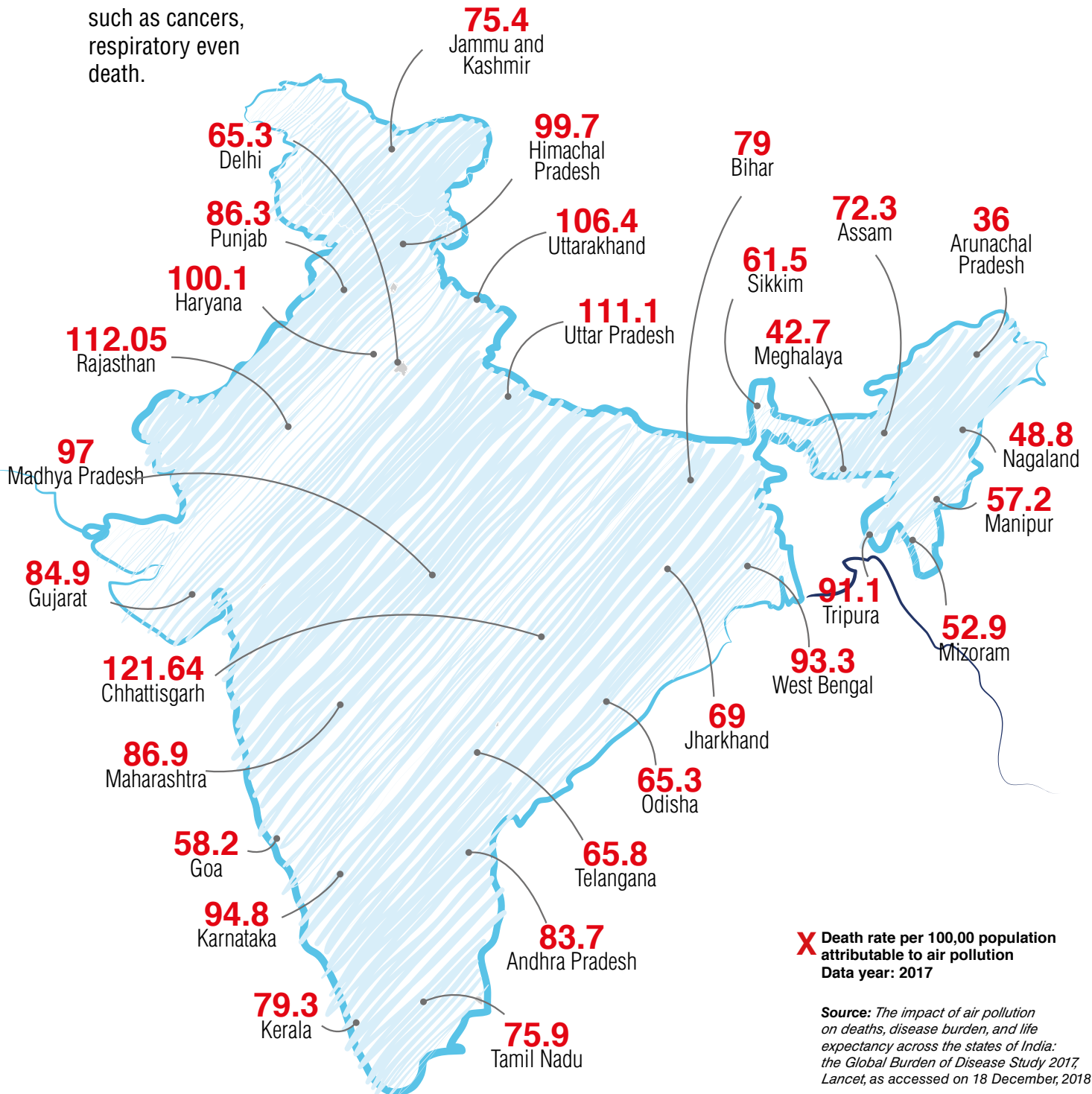
Air pollution has been linked to diseases such as cancers, respiratory ailments and even death. Children, the infirm and

old, and the poor are the most vulnerable. According to a report in the medical journal *The Lancet*, about 1.24 million people in India lost their lives due to air pollution-related health ailments in 2017 alone.

Added to this is the connection to climate change. Take the transport sector. All the carbon in the fuel burnt in vehicles gets emitted as the heat-trapping global warming gas – carbon dioxide (CO<sub>2</sub>). CO<sub>2</sub> emissions from the transport sector are one of the fastest growing sources of global warming: in India, road transport accounts for 10 per cent of the total CO<sub>2</sub> emissions from all sectors.

## How many did air pollution kill in the states?

Air pollution has been linked to diseases such as cancers, respiratory even death.



**X** Death rate per 100,00 population attributable to air pollution  
Data year: 2017

Source: *The impact of air pollution on deaths, disease burden, and life expectancy across the states of India: the Global Burden of Disease Study 2017, Lancet, as accessed on 18 December, 2018*

## State of Air pollution

Air pollution is responsible for close to 13 per cent of deaths in India and its burden is highest in northern states of Delhi, Punjab, Uttar Pradesh and Haryana. In fact, an average Indian will live 1.7 years longer if the country is able to clean its air

# 12.5%

of total deaths in India in 2017 were caused by air pollution

# 51.4%

of the people who died due to air pollution were younger than 70 years

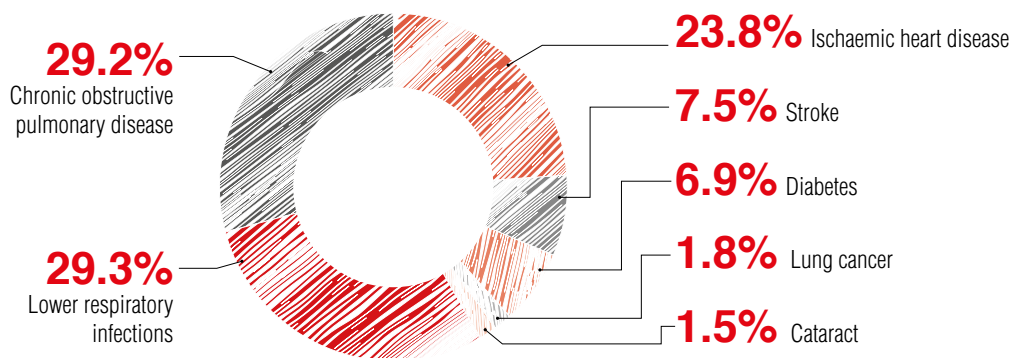
# 76.8%

Indians breath air that is worse than the levels recommended by National Ambient Air Quality Standards

## How poor air affects us

Disability-adjusted life-year (daly) lost is the measurement of the gap between current health status and an ideal situation where the entire population lives to an advanced age, free of disease and disability.

The share of diseases triggered by air pollution that caused the loss of dalys in 2017 were:



## Breathing bad



Number of deaths attributable to air pollution



daly rate per 100,000 population attributable to air pollution



Increase in life expectancy if air pollution concentrations were less than the minimum level causing health loss

### INDIA



1.24 million



2,802

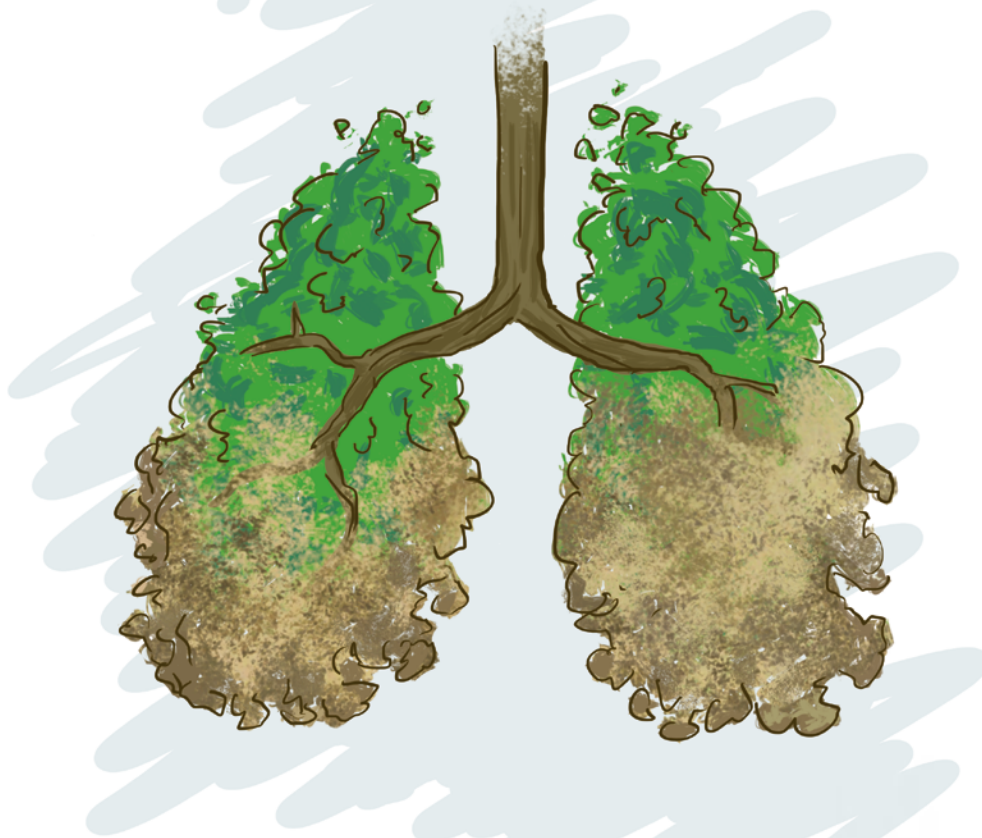


1.7 years

Source: *The impact of air pollution on deaths, disease burden, and life expectancy across the states of India: the Global Burden of Disease Study 2017* released on December 6, 2018, by Ministry of Health and Family Welfare



# WHAT ARE THE MAIN CAUSES OF AIR POLLUTION?



**S**o the question that naturally arises is, why aren't we doing anything to tackle this menace? To be able to do that, we need to identify the causes. A 2016 IIT Kanpur study on the key sources that foul up our air identified the following five: vehicles, power plants and industries, garbage burning, dust, and burning of crop residues.

Vehicles – the transportation sector – is one of the biggest sources. Road dust and industrial

emissions are the other big sources. According to the IIT study, vehicles accounted for 20 per cent of all PM<sub>2.5</sub> emissions and 36 per cent of all NO<sub>x</sub> emissions. In terms of contribution to climate change, the transportation sector accounts for around 20 per cent of global energy consumption – in fact, it is the biggest consumer of oil in the world.

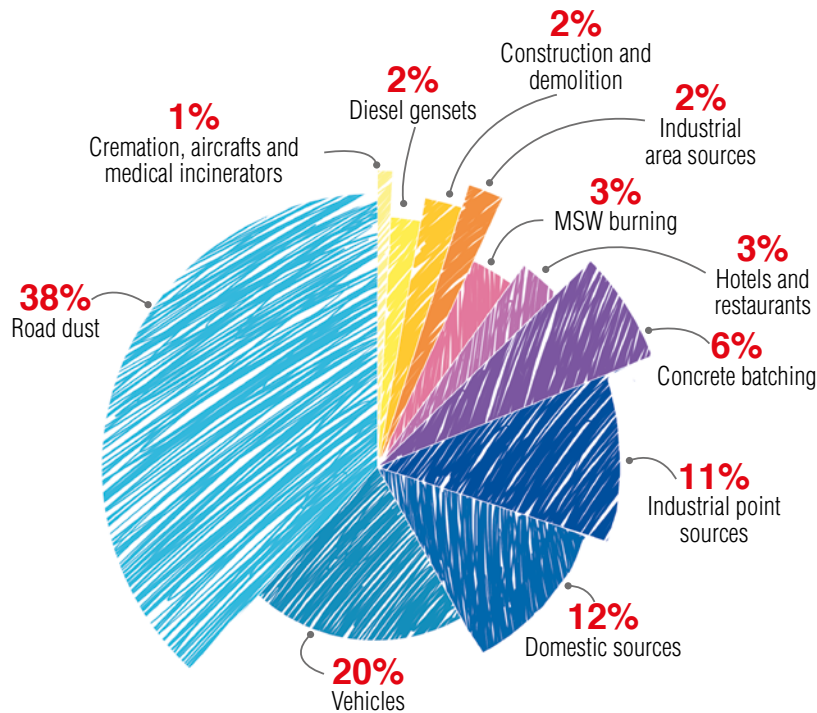
Today, the way a person travels – using vehicles and various transportation modes

-- has become one of the most energy- and pollution-intensive activities. To combat this, new vehicles must emit as little as possible and therefore, technological improvements should take place as fast as possible. But technology alone is not enough. Vehicle usage is growing at an enormous pace; our roads are clogged with massive numbers of four- and two-wheelers. This sheer volume of vehicles threatens to destroy the gains of pollution control.

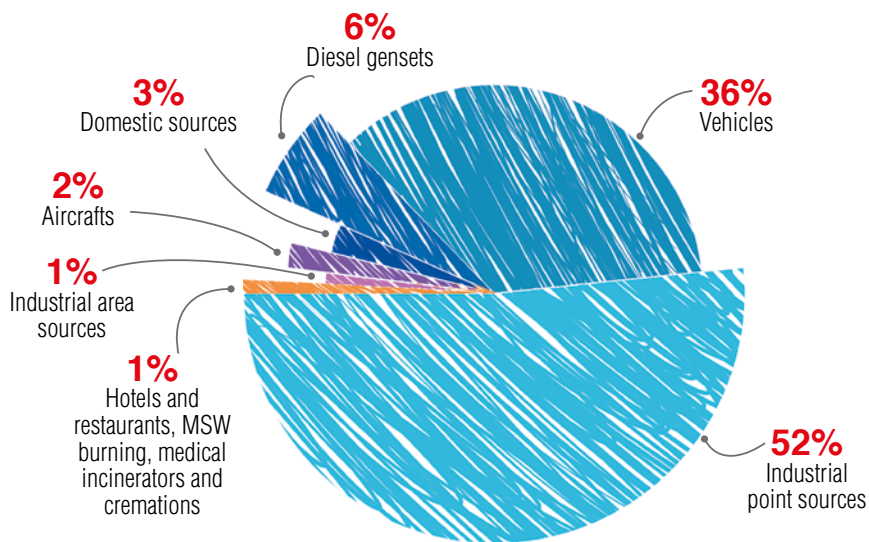
## Who are the biggest polluters?

Air pollution has been linked to diseases such as cancers, respiratory even death.

### PM2.5



### NOx



Source: 2016, Comprehensive study on air pollution and green house gases(GHGs) in Delhi, IIT Kanpur

# THE DESOLATION OF SMOG

The story of CNG in Delhi



In the mid-1990s, when motorization in Delhi was just taking off (after the liberalization of India's economy), the city was devastatingly polluted. Smog, spewed forth from its growing vehicle fleet, hung on the city like a death trap. The government responded by launching pollution control drives, but these were restricted to checking the

tailpipes of vehicles to see if they met antiquated and very basic emissions limits. It was one such drive that hurtled Centre for Science and Environment (CSE) into an aggressive campaign on the right to clean air.

Anil Agarwal, founder of CSE, wrote at that time, "It began during the high summer of 1995, when I saw a large number of cars lined up in the heat to get

their emissions levels checked. Even as an environmentalist, I was not aware of the contours of this technical problem of vehicular pollution."

During the next few years, CSE would research and analyse to get to the bottom of the issue. It pieced together the jigsaw puzzle in a report titled *Slow Murder: The deadly story of vehicular pollution in India*. The

publication identified the main dimensions of the problem: One, health risks associated with air pollution were not well understood and the data available was not adequate. Two, the hegemonic automobile industry was obstructing any move towards more stringent emissions norms. Three, the government's own refineries (that produced the fuel used in India) were offering stubborn resistance to any move towards cleaner fuel. Four, public transport, and non-polluting and non-motorized means of transport, were neglected by planners. Five, apathy of vehicle users towards maintenance meant old (and polluting) vehicles ruled the roads.

On 1 November 1996, Slow Murder was released by the then vice-president of India, K.R. Narayanan. On 18 November 1996, the Supreme Court (SC) issued a suo moto notice to the Delhi government to submit an action plan to control air pollution in the city. In December 1996, the Delhi government submitted the action plan to the court—but implementation was not possible without public pressure.

CSE launched the 'Right to Clean Air' campaign in 1996–97 to help people see through the smokescreen of polluted air and the factors responsible for it. The campaign began without any premeditated design. It evolved over time, responding to new needs and challenges. But it constantly pushed for solutions.

By the end of 1997, little tangible progress had been made on the action plan. In November 1997, CSE held a public meeting called 'Slow Murder and Since...' at which shocking data on air pollution, including the fact that

there had been almost 30 per cent increase in the number of premature deaths in cities in just three years (from 1991 to 1995), was presented.

The public campaign was bolstered by the participation of media, eminent personalities and the general public. In 1998, the then Ministry of Environment and Forest constituted the Environment Pollution (Prevention and Control) Authority for the national capital region and gave it sweeping powers to deal with the issue of air pollution. In June 1998, after taking stock of the key actions needed to reduce air pollution, EPCA submitted a Report on monitoring and priority measures proposed by the authority for air pollution control. A key proposal was converting all public transport and taxis to run on compressed natural gas (CNG).

CNG was not totally pollution-free, but it was a much better option than petrol and

certainly light years ahead of diesel, the devil's fuel. These traditional fuels produced more oxides of sulphur and nitrogen and more PM2.5 and 10, all deadly pollutants (some of them carcinogenic) linked with death in humans, animals and plants.

The SC set a deadline for the implementation of this proposal. This started a deadly game of cat and mouse as the automobile industry (aided by the action—and inaction—of reluctant government agencies and authorities) missed deadline after deadline set by the SC to achieve conversion to CNG.

Finally, the court decided that enough was enough and put its foot down. With a final warning and deadline, the remaining pieces fell into place and Delhi achieved conversion of public transport to CNG. A great victory had been achieved, but that only made CSE more determined to work harder to save our environment.

pointed to the terrible price Delhi was p...

**Roll down the window of your bullet-proof car, Mr Prime Minister The security threat is not the gun. It's the air of Delhi**

**PEOPLES' CHARTER ON CLEAN AIR FOR IMMEDIATE IMPACT**

**PROVIDE CLEAN DIESEL, OR IMPROVE IT**  
Diesel emissions contain deadly particulate matter with traces of the strongest carcinogen known till date. Indian diesel is 250 times dirtier than the world's best.

**STOP PRIVATE DIESEL CARS**  
Registration of all private diesel models should be banned in cities like Delhi. Cheap government diesel means more diesel cars, including luxury models.


**STOP POLLUTING TECHNOLOGY**  
India is moving towards unleaded petrol. But this fuel contains too much benzene. Though we use one hundred times less petrol than USA, the total amount of benzene emissions from Indian vehicles is the same as in the US.

**RETHINK DIESEL VEHICLES**  
Benzene causes blood cancer and air should have no benzene at all, says WHO. Yet the level of benzene in and around Connaught Place in Delhi is 10 times higher than the European safety limit. If you live in Delhi, your chances of getting blood cancer are twice as high as people living in Bangalore, Chennai and Mumbai.

**MONITOR ALL PRIVATE CARS**  
Manufacturers must inform buyers of the exact emission levels of their vehicles.

**MONITOR ALL PRIVATE CARS**  
Improve air quality assessment. A wide range of poisons are not monitored till date. Alert people about pollution levels in the city. It is done all over the world.

**RETHINK DIESEL VEHICLES**  
Make the industry accountable for the life-long emission efficiency of all vehicles they produce.



**Register your protest to the Prime Minister today**  
 PMS, South Block, New Delhi 110 001  
 Tel: 301 8030 Fax: 301 8031  
**Join CSE's Right To Clean Air campaign**  
 Centre for Science and Environment  
 41, Tughlakabad Institutional Area, New Delhi 110 062  
 Tel: 696 3394, 696 1124, 696 5879 Fax: 696 5879  
 Email: cse@delhi.ernet.in Website: www.cseindia.org

based in public interest by Centre for Science and Environment (CSE)

As an open letter to the then prime minister, Atal Behari Vajpayee, and also as a 'people's charter', this advertisement listed the actions needed. It gave people the chance to protest — a home phone and fax number of the prime minister

nce. Citizens of Delhi were called upon to  
and the right to

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# WHAT ACTION HAS BEEN INITIATED TO CONTROL AIR POLLUTION?



**C**ities and governments in India have woken up to the enormous crisis that we are faced with.

A string of measures have been undertaken – we bring you here a brief sketch of the actions taken, followed by some pointers on what else can be done.

To begin with, a network of air quality monitoring stations have come up, especially in the Delhi-NCR region. These stations track air quality levels and generate data on them. The national level data capture and reporting programme is called the National Ambient Air Quality Monitoring Programme, or NAMP. The monitoring stations have been linked to the Air Quality Index (AQI) dissemination system to tell us every day how good or bad is the air we breathe – you can now check every day's air quality in daily newspapers or on the internet.

The government has formulated two action plans to combat air pollution in Delhi-NCR – the Graded Response Action Plan (GRAP) and the Comprehensive Action Plan (CAP). The GRAP provides a set of measures which can be initiated as pre-emptive immediate and emergency actions when the situation reaches a critical stage: an example was the odd-even system which was introduced on Delhi's roads when air pollution levels spiked one winter. The CAP is a comprehensive set of measures – both short and long term – to control pollution from all its key sources.

Clean fuel is a pre-requisite for clean air. From April 1, 2020, only Bharat Stage (BS) VI fuel would be available in India. Only BS VI-compliant vehicles

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### What more needs to be done?

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1. Massive augmentation of public transport, so that people can shift from personal cars to buses, trains etc.
  2. A move towards cleaner fuels like natural gas or electricity generated from cleaner sources such as solar or wind.
  3. Efforts to enforce and implement directions for not burning garbage and dust management.
- 



would be registered. This fuel is expected to reduce emissions of carbon dioxide and other deadly gases from vehicles. Bharat Stage emission norms were brought into force by the government of India in the year 2000 to regulate the output of air pollutants from vehicles.

Along with this, there is a clear move to encourage non-polluting electric vehicles, with the government furthering their cause through fiscal interventions. Increasing the public transport facilities and access in our cities remains one of the most important measures.

Action is happening on containing pollution from industries as well. Import of dirty fuels like pet-coke and furnace oil, which are used by industries, have been banned and their use restricted. Industries around Delhi are being encouraged to shift to natural gas (PNG) as their source of energy. In Delhi, the Badarpur thermal power plant, a major source of emissions, has been shut down. The brick-making industry in the region (brick-kilns are another polluting source) is being forced to change from its polluting methods – the industry is now adapting a technology known as 'zig-zag' technique, which will reduce its pollution levels.

Efforts to control dust pollution have focused on the building and construction sector – with construction activities stopped in Delhi on

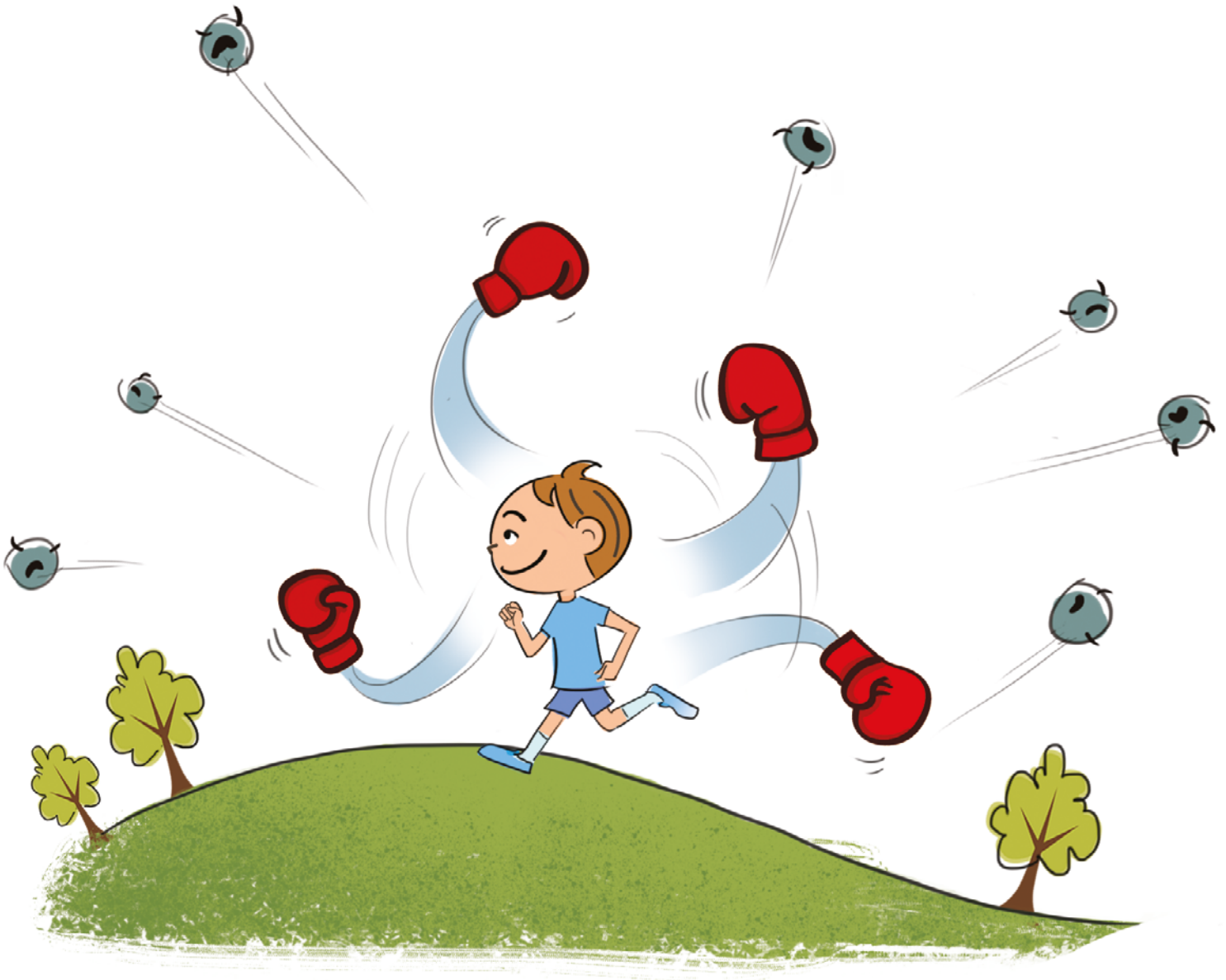
days when the air quality has been particularly bad. The Construction and Demolition (C&D) Waste Management Rules 2016 have been brought into effect, and they stipulate recycling and reuse of C&D waste (the waste and debris that is generated when buildings etc are constructed or demolished, and that give rise to a lot of dust pollution).

Burning of crop wastes by farmers in their fields in Haryana and Punjab usually leads to a

haze of smog over Delhi during winter months. Governments are now offering subsidies to farmers to discourage this practice and to encourage investment in machines and technologies that can dispose of this waste in a more eco-friendly manner – for instance, some companies (like Ikea for one) have shown an interest in buying this crop waste and reusing it to develop products. There is also a ban on burning of solid waste and garbage in cities.



# WHAT CAN YOU DO?



**W**hen faced with a problem of this magnitude, we sometimes have a tendency to shift the onus of action on to someone else, usually any other appropriate authority. In most cases, it is the government. If the air is polluted, the government needs to rise up and do something about it, we say. But does that mean we can sit back and relax? Does that mean we do not have a responsibility as well?

Let's see what is it that we can do, how is that we can make a difference.



## WHAT CAN SCHOOLS DO?

### Spread awareness

■ Install a permanent display board which gives information on the daily air quality (<http://cpcb.nic.in/>) and other issues related to air pollution. The students and faculty can be encouraged to manage this display board, which could become a key tool in spreading awareness.

■ Organize assemblies, seminars and health check-up camps from time to time where expert speakers can be invited to talk to the students and faculty about air pollution and its health impacts.

### Stop exposure

■ Develop a protocol based on the prevalent air quality index (AQI) to minimize outdoor exposure for students. Avoid unnecessary outdoor activities on days which are designated as 'Very Poor', 'Severe' or 'Emergency'.

### Control vehicular pollution

■ Reduce the use of personal

vehicles. Introduce school buses. Rationalize their routes to ensure maximum utilization. Ensure regular maintenance and compliance with PUC and fitness certification requirements of all school-owned vehicles. Introduce a parking policy where parking for personal vehicles are priced. Introduce an incentive for faculty and staff for using school buses or public transport.

■ Encourage use of non-motorized transport – walking and cycling. Invest in infrastructure for this – signaling systems, junction crossings, bus stands, pavements and cycle stands within the school campus.

■ Adopt car-free days, such as once per week. This can also be helpful in gradually making everyone adjust to other alternative modes of travel. Restrict car-access areas by declaring areas on streets around the school as pedestrian-only. Institute car-pooling measures for students and teachers.

■ Regulate third-party service providers such as taxis, auto-rickshaws etc that ferry children to school. These should be registered and children should be encouraged to opt for only registered vendors. This will allow the school to have a say in the vehicle being safe and less polluting and hold the service provider accountable for any gaps.

### Minimize pollution from other sources

■ Create 'green barriers' through intensive plantation of specific trees, shrubs and bushes along entry points/parking areas and boundaries, to minimize dispersion of dust and pollutants from roads and other emission sources.

■ Ensure proper disposal of all waste including plastics, biomass waste (dead leaves, branches etc) to minimize emissions from burning of waste. Provide electric heaters to security staff and others to replace personal fires for warmth during winters.

■ Use cleaner energy sources



## LET'S CLEAR THE AIR

– LPG, solar etc – for all energy requirements within the school, including for cooking.

- Minimize the use of diesel generator sets within the school premises. Use temporary connections for occasional requirements such as annual functions etc.
- Ensure compliance with dust control norms applicable for construction sites within the school premises or within the vicinity of the school.
- Ensure sweeping of outdoor areas during non-peak hours (at least 2 hours before school timings or late evenings) to minimize re-circulation of dust. Use recycled water to spray on open spaces to allow dust to settle down.

### WHAT CAN WE, AS INDIVIDUALS, DO?

➤ The way we travel every day can make a whole lot of difference. Avoid using personal vehicles to commute to school – take the

school bus/public transport, or walk/cycle to school.

- Awareness and action begins at home. Encourage your family members to use clean fuels, follow traffic rules, and use public transport as far as possible. Raise your voice if you see anyone burning waste or driving a visibly polluting vehicle.
- If you are a teacher, lead from the front. It is important that teachers be the torch bearers for such practices, as students look up to them for guidance and learn. For instance, teachers cycling to school can have a huge impact.
- Calculate your carbon footprint based on your travel choice. This will help you become aware of what you can do daily to help the environment.
- Support the school and its management if it decides to undertake actions and measures to control air pollution



# SCHOOLS THAT MADE A DIFFERENCE



DRV DAV CENTENARY  
PUBLIC SCHOOL,  
PHILLAUR, PUNJAB

The students were aware about the dangers of air pollution, but not many knew that indoor air pollution can be deadlier than outdoor air pollution. The school wanted to check its own IAQ (indoor air quality) and increase awareness on indoor air pollution.

#### Action initiated:

- To determine the indoor air quality, students, under the supervision of teachers, set up an MQ 135 air quality sensor.
- Once the sensors were in place, students tested IAQ before and after Dussehra.
- It was observed that the air quality after Dussehra was poor but even the IAQ before Dussehra could be improved.
- Next, to improve IAQ within

the school premises, students assembled a cost-effective air purifier using waste material like sponge, an exhaust fan, waste mould from a car air filter, etc. Students used activated carbon in the model— about 1g of activated carbon can purify pollutants in an area of 800–1,000 square metre easily.

➤ Concurrently, sessions were conducted by the team to make other students aware about the issues involved in IAQ.

#### Immediate results:

- While using the air purifiers, the school could monitor air quality through the sensors and work on improving it.
- A significant decrease in the level of noxious gases at different

places in the school was observed. Long term benefits:

- Researching IAQ and finding a cost-effective solution can be replicated by other schools to the problems associated with bad IAQ
- Improving IAQ at the school will improve the health of students and staff, and protect them from respiratory diseases.
- The air purifier model project, prepared by the school children under their teachers' guidance, has been selected by NITI Aayog under the Atal Innovation Mission, an initiative of the Government to promote a culture of innovation and entrepreneurship. The school has been given the grant to escalate the proposal into a fully functional system.



**NEW DIGAMBER PUBLIC SCHOOL, INDORE, MADHYA PRADESH**

A GSP Network school, New Digamber Public School, Indore, brought about change in their energy and fuel consumption by reducing the number of school buses and discouraging use of personal vehicles by staff. Though their contribution in the fight against air pollution may not be tangible, the school knows that every effort counts in improving the quality of our atmosphere. Importantly, the teachers themselves became the torch bearers for such practices and played a pivotal role in setting an example.

#### **Action initiated:**

New Digamber Public School introduced the following to nudge the school community towards sustainable and NPT modes of transport:

- Reworked bus routes to optimize seating capacity
- Levied monthly parking charges of Rs 500 on two-wheelers and Rs 1500 on four-wheelers parked at the school, though parking charges were waived off in cases of car pooling
- Introduced Green allowance of Rs 500 for every staff member who opted for the school bus

#### **Immediate Results:**

- Number of buses reduced from 46 to 41
- Number of personal vehicles reduced from 100 to 54 – 42 two-wheelers and 12 cars
- Number of staff members availing public transport rose to 68.5 per cent

#### **Long term benefits:**

- Acceptance of public and sustainable transport increased among staff members.

For more information, refer to Paving the Path

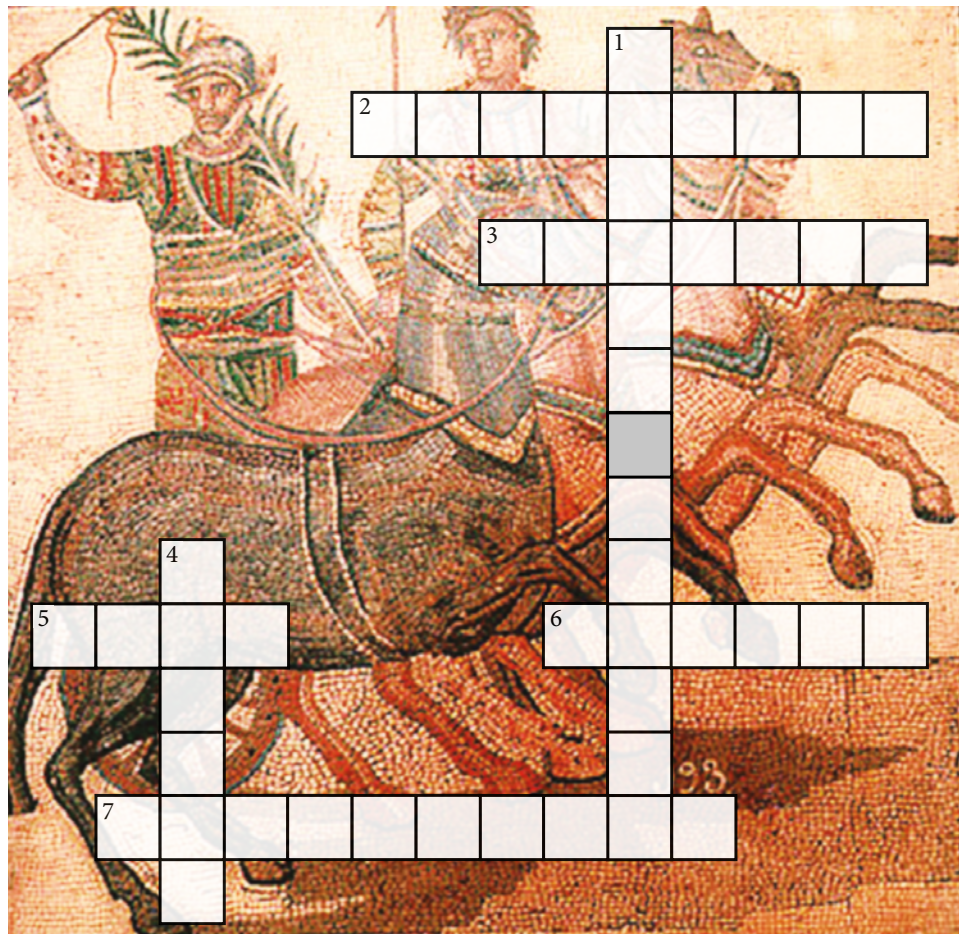
<https://csestore.cse.org.in/paving-the-path-a-selection-of-best-environmental-practices-in-schools-across-india.html>

# ACTIVITY 1

## ACROSS

2. The introduction of contaminants into the natural environment that cause adverse change
3. City that issued first pollution red alert as smog engulfed the capital
5. A type of air pollutant. The word was coined in the early 20th century as a portmanteau of the words smoke and fog
6. The capital city of a Latin American country introduced the Hoy No Circula ('today it doesn't circulate') in 1989 to combat rampant air pollution
7. A layer of gases surrounding a planet or other material body of sufficient mass

## POLLUTION-SOLUTION



## DOWN

1. This Roman statesman implemented a temporary road space rationing in Rome in 45 BC
4. Capital city set in place the scheme of Pico y Placa ('peak and plate'). This policy banned cars from driving during the peak traffic hour, two days per week

- |                  |               |
|------------------|---------------|
| 1. Julius caesar | 5. Smog       |
| 2. Pollution     | 6. Mexico     |
| 3. Beijing       | 7. Atmosphere |
| 4. Bogota        |               |

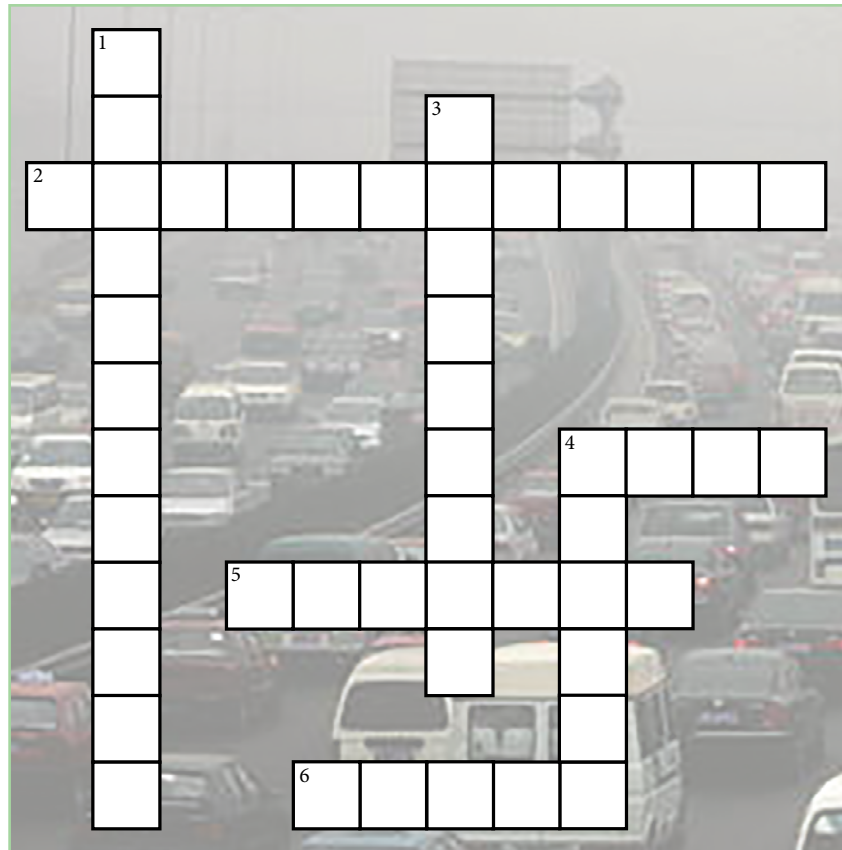
# ACTIVITY 2

## ACROSS

2. The presence in or introduction into the environment of a substance which has harmful or poisonous effects
4. A popular device to avoid air pollution
5. Considered to be the world's cleanest city, located in Canada, even though the country has a large oil and gas industry
6. The colour for the least severe kind of air pollution

## DOWN

1. The original name for the mixture of smoke and fog in the air
3. Important part of our respiratory system besides lungs and trachea
4. The colour for the most severe kind of air pollution



1.Smog 2.Pollution 3.Diaphragm 4.Maroon 5.Calgary 6.Green

# A GLOSSARY ON AIR POLLUTION

## A

**Acute exposure:** One or a series of short-term exposures generally lasting less than 24 hours.

**Aerosol:** Particles of solid or liquid matter that can remain suspended in air from a few minutes to many months depending on their particle size and weight.

**Air:** A mixture of gases containing 78 per cent nitrogen, 21 per cent oxygen, less than 1 per cent carbon dioxide, argon and other gases, and varying amounts of water vapour. **Air pollution:** Degradation of air quality resulting from unwanted chemicals or other materials occurring in the air, which may result in adverse effects to humans, animals, vegetation and/or materials.

**Air Quality Index:** Numerical index used for reporting severity of air pollution levels to the public.

**Air toxics:** Generic term referring to a harmful group of chemicals in the air that have the potential of causing health effects.

**Ambient air:** Often used interchangeably with 'outdoor air'. The air occurring at a particular time and place outside buildings.

**Ambient air quality monitoring:** Sampling for and measuring of pollutants present in the ambient air.

**Ambient air quality standard:** Health- and welfare-based standards for outdoor air, which identify the maximum acceptable average concentrations of air pollutants during a specified period of time.

## B

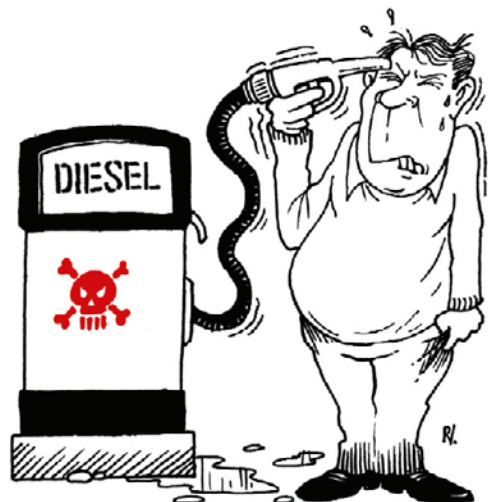
**Biodiesel:** Alternative fuel that is produced from animal fats or vegetable oils. It is reacted with alcohol (ethanol or methanol) in the presence of a catalyst to form ethyl or methyl ester.

## C

**Carbon dioxide (CO<sub>2</sub>):** A colourless, odourless gas that occurs naturally in the Earth's atmosphere. Significant quantities are also emitted into the air by fossil fuel combustion.

**Carbon dioxide equivalent:** Is computed by multiplying the weight of the gas being measured (for example, methane) by its estimated global warming potential (21 for methane).

**Carburettor:** A fuel delivery device for producing a proper mixture of petrol vapour and air, and for delivering it to the intake manifold of an internal combustion engine. **Carcinogen:** A cancer-causing substance.



**Catalytic converter:** A device that has a catalyst bed and is fitted in the engine exhaust system. It converts harmful constituents of the exhaust such as carbon monoxide into more benign ones like CO<sub>2</sub> etc.

**Chronic exposure:** Long-term exposure, usually lasting one year to a lifetime. Combustion: The act or instance of burning some type of fuel to produce energy. This process powers automobile engines and power plant generators.

**Combustion chamber:** Is the area in the engine where the combustion of the mixture of air and fuel takes place.

**E**  
**Electric vehicle:** A vehicle that uses an electric motor as the basis of its operation. Such vehicles emit virtually no air pollutants.

**Emission rate:** Amount of pollutant emitted per unit of time (for example, tonnes per year).

**Emissions standard:** Maximum amount of pollutant allowed to be discharged from a source such as automobile or smoke stack.

**Ethanol (Ethyl alcohol):** A volatile alcohol containing two carbon groups (CH<sub>3</sub> CH<sub>2</sub> OH). For fuel use, ethanol is produced by fermentation of molasses or other plant products. Exhaust emissions: Exhaust pollutants emitted through the tailpipe of a vehicle. Principal exhaust pollutants are CO, HCs, NO<sub>x</sub> and particulate matter (PM).

**Exposure:** Concentration of pollutants in air multiplied by the population exposed to it over a specified time period.

**G**  
**Greenhouse gases:** Gases such as CO<sub>2</sub>, methane, chlorofluorocarbons, nitrous oxide, O<sub>3</sub> and water vapour that slow the passage of re-radiated heat through the Earth's atmosphere and, therefore, lead to atmosphere warming.

**H**  
**Hydrocarbons (HCs):** Compounds containing various combinations of hydrogen and carbon atoms. They may be emitted into the air by natural sources and due to fossil and vegetative fuel combustion, fuel volatilisation and solvent use. HCs are the major contributors to smog.

**I**  
**Ignition:** Process of initiating burning of a mixture of fuel and air.

**L**  
**Liquefied natural gas:** Natural gas that has been refrigerated to cryogenic temperatures where the gas condenses into a liquid.

**Liquefied petroleum gas:** A by-product of the processing of natural gas and petroleum refining. Its major components include propane, butane and propylene.

**N**  
**Nitrogen oxides (NO<sub>x</sub>):** A general term pertaining to compounds of nitric oxide (NO), nitrogen dioxide (NO<sub>2</sub>) and other oxides of nitrogen. They are typically created during combustion processes and are major contributors to smog formation and acid deposition. They may result in adverse health effects.





## O

**Oxidation:** The chemical reaction of a substance with oxygen in which atoms in an element lose electrons and its valence is correspondingly increased.

**Ozone (O<sub>3</sub>):** Strong-smelling, pale blue, reactive toxic chemical gas consisting of three oxygen atoms. It occurs naturally approximately 15 to 45 km above the Earth's surface. It is also produced at ground level through a chemical reaction of various air pollutants in presence of sunlight.

## P

**Particulate matter (PM):** Small liquid and solid particles in the air. Some are small enough to be inhaled deep into the lungs. These include particles of size less than 10 micron (PM<sub>10</sub>) — about 1/7th the thickness of a human hair, and particles of size less than 2.5 micron (PM<sub>2.5</sub>).

**Peak hour peak period:** The period with the highest ridership during the entire service day. Generally refers to either the peak hour or peak several hours (peak period).

## R

**Retrofit:** To change a vehicle or engine after its original purchase, usually by adding equipment such as conversion systems.



## S

**Smog:** Combination of smoke, particulates, O<sub>3</sub>, HCs, NO<sub>x</sub>, and other chemically reactive compounds which, under certain conditions of weather and sunlight, may result in a murky brown haze that causes adverse health effects.

**Soot:** Fine carbon particles that have a black appearance.

**Sulphur oxides (SO<sub>x</sub>):** Strong smelling, colourless gases formed primarily by the combustion of sulphur-containing fossil fuels, especially coal and oil.

## T

**Toxic air contaminant:** An air pollutant, identified by the California Air Resources Board, which may cause or contribute to an increase in deaths or serious illnesses. Benzo[*a*]pyrene, benzene and diesel PM are examples.

# RESOURCES

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4. Delhi's Emergency Action Plan to tackle Air Pollution <https://www.youtube.com/watch?v=65ncYWqOG98&index=3&list=PLmiRlMn-Wmot462HsblV-lcK3CaZaDv-E>
5. Sunita Narain on how developing world will leapfrog to clean air <https://www.youtube.com/watch?v=05hJ9Sk-Ub0&index=11&list=PLmiRlMn-Wmot462HsblV-lcK3CaZaDv-E>
6. Stopmotion: Why Diesel Vehicles should be Regulated in Delhi <https://www.youtube.com/watch?v=G191gLOSc8E>



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