

# Air Pollution Teaching Toolkit

Manual on how to teach Air Pollution to Students of Grade 7–9





# Air Pollution Teaching Toolkit

Manual on how to teach air pollution to students of Grade 7–9

**Prepared by**

Charina Cabrido

Gopal Raj Joshi

**Published by**

Clean Air Network Nepal

Clean Energy Nepal

© Copyright 2010.

Clean Air Network Nepal  
Clean Energy Nepal

All rights reserved.

Users may reproduce and use content of this Toolkit for noncommercial purposes by informing and giving due credit to aforementioned organizations and writers who hold copyright. No other uses are permitted without the express written permission of the aforementioned organizations.

**Layout Design and Printing by**

wps, tel: 01-5550289, email: [printnepal@gmail.com](mailto:printnepal@gmail.com)

## Acknowledgement

This tool kit would have not been produced in this shape without the support of staffs in CEN and CANN.

We would like to extend our gratitude to FK Network Nepal for providing financial support for printing this tool kit and piloting in schools to assess its effectiveness.



## Foreword

We are experiencing rapid growth rate of urbanization, motorization and industrialization. Our overwhelming dependence on fossil fuel to drive our daily life and economic activities has led to releasing of various green house gases and air pollutants into the atmosphere resulting in degrading of the quality of air in the urban areas and global problem of climate change.

Degrading of the quality of air in the urban areas has put at risk the lives of millions of people under direct threat due to health impacts associated with air pollution. According to estimation by the World Health Organization (WHO), about 530,000 premature deaths in Asia occur every year because of outdoor air pollution.

The quality of air in Kathmandu valley is much lower than the national and international standards and the occurrence of high level of PM 10 in the atmosphere has become a major health concern. Vehicular emission followed by road re-suspension dust, smoke and dust out of the brick kilns are the main culprits.

It is not that there is nothing done to address this grave problem. Various GOs and I/NGOs and private sector alike have shown their concern to address the problem of air pollution in Nepal but they are strikingly insufficient as compared against the magnitude and gravity of the problem.

Air pollution problem is a multi facet problem. Road and traffic management, transport, usage of energy, urbanization, industrialization directly or indirectly contribute to the problem. This is why clean air initiatives should be implemented in coordinated and integrated manner to result synergy.

In this context, public awareness and education should be integral part of such an initiative. With enhanced knowledge and information, locals and authorities concerned will be motivated to adopt clean air friendly practices and behaviors.



This integration is better earlier done, than later. School children are very good entry point to disseminate information, knowledge and skills on ways to control air pollution. Educating students mean investing on future green society that will care for the environment. Moreover, educating school children means transfer of knowledge to their peers and parents to have multiplier effect. This toolkit aims to help teachers, parents and educators to provide correct and best information regarding air pollution and thus create a pool of informed children. We are hopeful that this toolkit will contribute to expanding clean air community in Nepal by facilitating easy leanings about the various issues of air pollution in schools.

Pankaj KC  
Program Director  
CEN

Gopal Raj Joshi  
Country Coordinator  
CANN





# Overview of the Toolkit

Children are more vulnerable to airborne pollutants and they are often more susceptible to the health effects of air pollution because their immune systems and organs are still developing and thus immature.

This Air Pollution Toolkit will attempt to help teachers, educators and campaigners in helping children increase their understanding of air pollution and the ways it affects their health, family and community.

Some materials in this toolkit are compiled from various sources and redesigned to suit the local context in Nepal. This toolkit provides teachers and educators with easy to use lesson plans, engaging activities, and other resources that can teach students about air pollution, changing climate, health effects of pollutants as well as actions that they can initiate to protect their health and reduce air pollution.

The materials in this toolkit supplement the environmental, health and science lessons at seventh, eighth and ninth grades. The lessons are to be conducted by teachers, educators and youth volunteers working as campaigners to students of grades 7 to 9. The lesson plans are designed to be stand alone activities that can complement the actual lessons and can be easily incorporated in the school curriculum. For easy facilitation and effective teaching methods, all users of this toolkit are to be instructed and trained on how to use this material before carrying out an actual school activity.

## Contents of the Toolkit

This Air Pollution Toolkit includes:

- ▲ A Background Summary section of each lesson plan that summarizes the lesson's topics and procedure.
- ▲ Learning Objectives
- ▲ Materials needed for activities
- ▲ Duration of the activities












- ▲ Procedures or step by step instructions on how to conduct lessons
- ▲ Resources or background information that can assist the teachers/ educators with information regarding air pollution.
- ▲ Key Messages that provides an overview of air quality issues covered in the lesson plans.





# Lesson Plans

The contents of each lesson found in the succeeding pages aim at addressing academic learning of students from Grades 7 to 9. Below are the key leanings that can be achieved from each lesson plans.

LESSON PLANS	ACADEMIC LEARNING ADDRESSED
 <b>1</b> What is Air Pollution?	Introduction to basic concepts of air pollution and air pollutants
 <b>2</b> Air Pollution Word Search	Usage of appropriate vocabulary to describe air pollution concepts
 <b>3</b> What is Wrong with This Picture?	Identify a real-world problem, propose an environmentally feasible solution, evaluate and apply the proposed solution.
 <b>4</b> Impacts of Air Pollution	Identify patterns and relationships that suggest a cause and effect of air pollution
 <b>5</b> The Story of Kanchha	Understanding impacts of air pollution
 <b>6</b> Diagnose the Symptoms	Demonstrate an understanding of the need to protect human health by promoting personal and civic responsibility.
 <b>7</b> Taking Actions to Improve Air Quality	Questioning, Analysis, and Interpretation Skills
 <b>8</b> Getting to know the Safa Tempo	Evaluate current sustainable urban transport practices and their effect on natural resources, environment and local Economy.
 <b>9</b> Getting to Know the Vertical Shaft Brick Kilns	Evaluate the contribution made by cleaner technology in brick kiln sector to curb air pollution problem
 <b>10</b> Getting to Know the Biogas and Improved Cooking Stoves	Evaluate the contribution made by the biogas and ICS in curbing the indoor air pollution.



# What is Air Pollution?

## Background Summary

Air pollution has become a problem in Nepal. It has damaged every aspect of environment including vegetation, animals, human health, water resources and properties.

The primary causes of air pollution are both man made and natural processes. The combustion of fossil fuels in households and industrial operations is mainly contributing to emission of pollutants in the atmosphere.

The national government regulates air pollution through laws and policies in order to protect human health and the environment.

There are several words that are used when discussing the subject of air pollution and this will be further discussed in the activity.



This activity will run for  
**60 minutes**



## Materials

- Hard Card Board Paper
- Markers
- Tapes
- Erasers
- LCD Projector, Lap top, curtain and Extension cords if power point presentation is planned

## Learning Objectives

At the end of lesson, the students will be able to:

- Define the terms Air Pollution and Air Pollutants
- Distinguish between Ambient Air Pollution and Indoor Air Pollution, Urban Air Pollution and Rural Air Pollution.
- List at least 5 Criteria pollutants and 5 Hazardous Air Pollutants.



## Procedures

1. Write the following questions on a chart paper and place it on the board or use power point slide:
  - ☁ What is your understanding of Air Pollution and of Air Quality?
  - ☁ Do you think the quality of air in your area is good or bad?
  - ☁ How do you know? What evidence is there to prove air pollution?
  - ☁ Why we need to talk about air quality? Guide the students to identify the importance of clean air. Explain that bad air can contribute to a variety of illnesses such as asthma and cancer
2. Divide the whole class into groups of 6-8 students and instruct them to find the answers for above questions. Each group needs to report the group discussion findings to whole class.
3. To help the students understand better, narrate the story of “The Great London Smog” from the handout. Lead the discussion based on this real life scenario.
4. Explain the definitions of Air Pollution, Air Pollutant (criteria and hazardous pollutants), Ambient, Indoor, and Urban and Rural air pollutions using the Resource Materials or power point presentation.



## Session Materials

### The Story of Great London Smog

***SMOG is a type of large-scale outdoor pollution. It is caused by chemical reactions between pollutants derived from different sources, primarily automobile exhaust and industrial emissions. Cities are often centers of these types of activities, and many suffer from the effects of smog, especially during the warm months of the year.***

The Great London Smog in London started on December 4, 1952, and lasted until March of 1953. It was a great disaster that killed thousands and formed an important impetus to the modern environmental movement.

In early December of 1952, a cold fog descended upon London. Because of the cold, Londoners began to burn more coal than usual. The resulting air pollution was trapped by the heavy layer of cold air, and the concentration of pollutants built up dramatically. The smog was so thick that it would sometimes make driving impossible. It entered indoors easily, and concerts and screenings of films were cancelled as the audience could not see the stage or screen.





<http://www.stippy.com/wp/wp-content/uploads/2007/06/london-fog.jpg>

Road, rail and air transport were almost brought to a standstill. An estimated 4,000 people died because of it, and cattle at Smithfield, were, the press reported, asphyxiated. Many who died already suffered from chronic respiratory or cardiovascular complaints.

The industrial revolution brought factory chimneys that belched gases and huge numbers of particles into the atmosphere. Some of these particles caused lung and eye irritations and others were poisonous. From the gases, corrosive acids were formed, notably sulphuric acid, which is produced when sulphur dioxide combines with oxygen and water.



During the day on 5 December, the fog was not especially dense and generally possessed a dry, smoky character. When nightfall came, however, the fog thickened. Visibility dropped to a few metres. The following day, the sun was too low in the sky to make much of an impression on the fog. That night and on the Sunday and Monday nights, the fog again thickened. In many parts of London, it was impossible at night for pedestrians to find their way, even in familiar districts. In the Isle of Dogs, the visibility was at times nil. The fog there was so thick that

<http://chascreek.blogspot.com/a/6a00d83451ded069e2010536ba24eb970c-500wi>

people could not see their own feet! Even in the drier thoroughfares of central London, the fog was exceptionally thick. Not until 9 December did it clear. In central London, the visibility remained below 500 metres continuously for 114 hours and below 50 metres continuously for 48 hours. At Heathrow Airport, visibility remained below ten metres for almost 48 hours from the morning of 6 December.

Officials believe that as many as 12,000 people may have died in the great London smog of 1952. Many of those killed were elderly people or those who were already weak or ill. According to medical staff that treated patients at the time, few people realized the extent of the impact.

Dr Robert Waller was working at St Bartholomew's Hospital in the capital in the early 1950s. He says a shortage of coffins and high sales of flowers were the first indications that many people were being killed.

Source: <http://hubpages.com/hub/Th-London-Smog-of-1952>



## Resource Materials for Facilitators

### The Basics of Air Pollution

#### ***What is Air Pollution? What are Air Pollutants?***

Air pollution occurs when there is a high concentration of certain substances that causes the atmospheric environment to become toxic enough to have adverse impacts on every aspects of environment. The substances that are responsible for air pollution are known as air pollutants. Air pollutants can be gaseous, liquid or solid in form, and can come from natural as well as human sources.



**Ambient Air Pollution:** Ambient air refers to any portion of the atmosphere not confined by walls and a roof. The pollution of ambient air that we breathe outside the room or house is known as ambient air pollution.

**Indoor Air Pollution:** Indoor air pollution refers to the condition of the air inside a building, which can be tainted by pollutants such as smoke, combustion fuel sources, and building materials and furnishings that emit gas known as volatile organic compounds (VOCs)

Air pollution can be classified as ambient, indoor, rural and urban based on space and area.

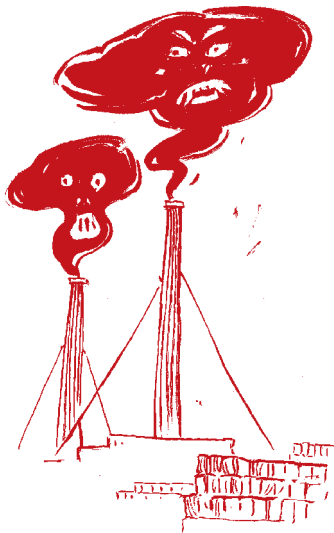


Air pollution can threaten the health of human beings, trees, rivers, crops, and animals. Abundant amounts of air pollution changes natural atmospheric processes, causing acid rains, ozone hole, and enhancing the greenhouse effect. Additionally, it causes economic losses.

	Criteria or Major Air Pollutants	Hazardous Air Pollutants
<b>Definition</b>	The commonly found air pollutants for which Air Quality Standard are available are known as criteria or major air pollutants.	Hazardous Air Pollutants are chemicals that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects.
<b>Examples</b>	Particulate Matter, Ground Level Ozone, Carbon Monoxide, Oxides of Nitrogen (Nox), Oxides of Sulphur (SOx) and Lead	A range of hydrocarbons (e.g. benzene, toluene and xylenes,) and other toxic organic pollutants (e.g. polycyclic aromatic hydrocarbons (PAHs), pesticide and polychlorinated biphenyls (PCBs).
<b>Sources</b>	These are generally found in higher concentration in the air. They are emitted from the use of gasoline run vehicles; coal fired power plants, use of fossil fuel in home and industries to meet energy demand.	They are generally found in very small amount in the atmosphere. They are also emitted from vehicles, chemical industries, paintings, pesticides.

### Sources of Air Pollution

Source	Pollution
<b>Natural Sources</b>	Dust Storms: Dust Storms are produced due to wind circulation around the planet earth to cause dust pollution.
	Forest Fires: Huge quantities of smoke are emitted during forest fires.
	Volcanoes: Volcanoes release lots of solid particles, gases and radiation.
	Sea Spray: It is a continuous phenomenon, which is a major source of particulates (liquid droplets) pollution in the atmosphere.
	Plant Pollen: During spring, lots of plant pollen is produced and spread faster by wind to cause dust pollution.
<b>Man Made Sources</b>	Domestic Pollution by use of fossil fuels and chemical substances such as insecticides.
	Industrial pollution by industries, power plants, chemical plants.
	Traffic Pollution by use of fossil fuel in vehicles



One main cause of air pollution is exhaust fumes from cars and other vehicles that run on gasoline or diesel. Until a few years ago, lead was added to most gasoline to make car engines run better. The lead passes through the engine and out of the exhaust system into the air. Lead is a highly toxic metal and can cause nervous system damage and digestive problems.

Road traffic emissions, particularly from diesel vehicles are a major source of Particulate Matter (PM) and Nitrogen Oxide. On the other hand, Carbon Monoxide (CO) is a colorless, odorless gas that is formed when carbon in fuel is not burned completely. It is a component of motor vehicle exhaust. Higher levels of CO generally occur in areas with heavy traffic congestion. PM10 particles (the fraction of particulate in air of very small size ( $<10\ \mu\text{m}$ ) are also of major current concern, as they are small enough to penetrate deep into the lungs and so potentially pose significant health risks. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.



Another major criteria air pollutant in cities is ozone that occurs at ground level. Ozone forms when nitrous oxides and hydrocarbons react with sunlight. However, not everything about ozone is bad. In fact, its presence in the upper atmosphere is beneficial because it keeps out harmful ultra-violet rays from reaching the earth's surface, which is one of the major causes of skin cancer. Ozone only becomes problematic when it occurs near the ground where it can be inhaled. When inhaled, ozone causes reduced lung capacity, choking, and coughing.

Sulfur dioxide ( $\text{SO}_2$ ) is one of a group of highly reactive gasses known as "oxides of sulfur." The largest sources of  $\text{SO}_2$  emissions are from fossil fuel combustion at power plants (66%) and other industrial facilities (29%). Smaller sources of  $\text{SO}_2$  emissions include industrial processes such as extracting metal from ore, and the burning of high sulfur containing fuels by locomotives, large ships, and non-road equipment.  $\text{SO}_2$  is linked with a number of adverse effects on the respiratory system.

Listed hazardous air pollutants include benzene, found in gasoline; perchlorethylene, emitted from some dry cleaning facilities; and methylene chloride, used as a solvent and paint stripper in industry; as well as dioxin, asbestos, toluene, and metals such



as cadmium, mercury, chromium, and lead compounds. These are also known as air toxics.

Kathmandu Valley is especially vulnerable to air pollution due to rapid urbanization and the significant increase of vehicular transport on narrow streets. Furthermore, the bowl like topography of the valley restricts wind movement and retains the pollutants in the atmosphere. This is especially worse during the winter season when inversion, where cold air flowing down the mountains is trapped under a layer of warmer air, creating a lid, which keeps the pollutants sealed within the valley.



More than three billion people worldwide continue to depend on solid fuels, including biomass fuels (wood, dung, agricultural residues) and coal, for their energy needs.

In Nepal, indoor air pollution is a major concern in rural areas since biomass fuel supplies 85% of energy use. Cooking and heating with solid fuels on open fires results in high levels of indoor air pollution. Indoor smoke contains a range of health-damaging pollutants, such as small particles and carbon monoxide, and particulate pollution levels may be 20 times higher than accepted guideline value

### *Cartoon Clip – Air Quality Forecast for the Day*



*Image lifted from: montgomerycountymd.gov*








# Follow up Activity for the Lesson 1: Air Pollution Word Search



*This activity will run for*  
**60 minutes**

## Materials

-  Air Pollution Word Search
-  Handouts
-  Pencils
-  Erasers
-  LCD Projector, Lap top, curtain and Extension cords if power point presentation is planned

## Procedures

1. Place the Air Pollution Word Search written on hard card board paper on the wall.
2. Explain to the students that they need to find the words connected to air pollution in the Word Search. Ask them to go in front and encircle the words that they can identify in the Word Search.
3. Use the “List of Air Quality Terms and Definitions” handout as additional resource material.
4. After completing the Word Search activity, ask one student to discuss to the class one word in the Word Search. Encourage the student to share three interesting facts about that word (personal experiences, solutions, etc). The Handout can be used as a guide to help them explain their ideas to the class.
5. Provide information and continue calling students to explain until all words in the Word Search are covered.
6. Bring students to the conclusion that we are often unaware of how our everyday activities contribute to air pollution. Review actions that people should take to improve air quality.



## Air Pollution Word Search

DJLCOMBUSTIONXYZAGHF  
AXSTHJLWQBTIONPAQZXI  
RMKWNOISREVNILAMREHT  
OMPIAETYAMHTSATNLYGO  
N AMBIENT AIR M I G T S S R O Z I P M G  
M M E R C U R Y Z G N B C V E  
O G K N X B E N Z E N E M E T H Y L E N E  
N I T R O G E N O X I D E S S A T T X O T O I C O  
O A R S T E D I X O N O M N O B R A C X  
X Y I Z F J I E Q R D H S L E N O Z O I  
I P A R T I C U L A T E M A T T E R Z D  
D J N S S C O N T A M I N A N T D N I E  
E W A C L E A N A I R V N B F J Y V O C S  
S S E C O R P L A C I M E H C O T O H P  
A S B E S T O S R E P S E L I M N E G Y X O  
D T C Y M N A T U R A L S O U R C E S P

Here are the words to look for:

AMBIENT AIR

LUNGS

CARBON MONOXIDE

THERMAL INVERSION

NATURAL SOURCES

CLEAN AIR

VOCS

OXYGEN

OZONE

MERCURY

LEAD

PHOTOCHEMICAL PROCESS

ASBESTOS

METHYLENE

BENZENE

NITROGEN OXIDES

COMBUSTION

CONTAMINANT

ASTHMA

PARTICULATE MATTER





# List of Air Quality Terms and Definitions

- **AMBIENT AIR** — is the outdoor air in which humans and other organisms live and breathe. The content and quality of ambient air is directly affected by the day-to-day activities of humans.
- **CARBON MONOXIDE** — a colorless, odorless, highly poisonous gas, CO, formed by the incomplete combustion of carbon or a carbonaceous material, such as gasoline.
- **THERMAL INVERSION** — In meteorology, a situation in which a layer of warm air (an inversion layer) lies over a layer of cool air.
- **NATURAL SOURCES** — Forest fires, volcanic eruptions, wind erosion, pollen dispersal, evaporation of organic compounds, and natural radioactivity are all among the natural causes of air pollution.
- **VOCs** — are compounds that have a high vapor pressure and low water solubility. VOCs are often components of petroleum fuels, hydraulic fluids, paint thinners, and dry cleaning agents. VOCs are common ground-water contaminants.
- **OXYGEN** — A colorless, tasteless, odorless, gaseous, gaseous element occurring in the free state in the atmosphere, of which it forms about percent by weight and about percent by volume, being slightly heavier than nitrogen.
- **OZONE** — an unstable, poisonous allotrope of oxygen, O<sub>3</sub> that is formed naturally in the ozone layer from atmospheric oxygen by electric discharge or exposure to ultraviolet radiation and also produced in the lower atmosphere by the photochemical reaction of certain pollutants.
- **LEAD** — One of the elements, a heavy, pliable, inelastic metal having a bright, bluish color, but easily tarnished.
- **PHOTOCHEMICAL PROCESS** — A chemical reaction influenced or initiated by light, particularly ultraviolet light, as in the chlorination of benzene to produce benzene hexachloride.
- **ASBESTOS** — either of two incombustible, chemical-resistant, fibrous mineral forms of impure magnesium silicate, used for fireproofing, electrical insulation, building materials, brake linings, and chemical filters.
- **BENZENE** — A colorless, flammable, liquid aromatic hydrocarbon, C<sub>6</sub>H<sub>6</sub>, derived from petroleum and used in or to manufacture a wide variety of chemical products, including DDT, detergents, insecticides, and motor fuels.
- **NITROGEN OXIDES** — any of several oxides of nitrogen formed by the action of nitric acid on oxidizable materials; present in car exhausts.
- **COMBUSTION** — a chemical change, especially oxidation, accompanied by the production of heat and light.
- **CONTAMINANT** — A substance, element, or compound that may harm humans or other forms of life if released into the environment.
- **PARTICULATE MATTER** — Material suspended in the air in the form of minute solid particles or liquid droplets, especially when considered as an atmospheric pollutant.



## Action Day Tips!

- **CONSERVE ENERGY** — Your home energy consumption translates into air pollution, therefore any energy conservation or efficiency improvements you make will help.
- **MODIFY YOUR TRANSPORTATION** — share a ride to work or use electric vehicles. Bicycle or walk to errands when possible.
- **ELIMINATE TOXIC CHEMICAL USE AT HOME** — A surprising number of household or home shop chemicals are toxic and volatile. Many release vapors into the air, inside the home and out. This can be serious health threat to your family, and contributes to community-wide levels of air pollutants.
- **PLANT LEAFY TREES AND SHRUBS** — Deciduous trees and shrubs (the kinds that drop leaves in the fall) are excellent air filters to help reduce smog and cool the air on hot summer days.
- **GET INVOLVED AND TALK TO YOUR LEGISLATORS** — Many of our current governmental regulations are not strong enough to address our air pollution problems. You need to work with your legislators and ask for better policies.

### Did You Know?

In the high layers of the atmosphere, Ozone acts as a protective sunscreen that shields us from the high levels of UV radiation coming from the sun. At ground-level, however, it can be harmful to plants, animals, and humans.

### References

<http://www.studyenglishtoday.net/lesson19.html>  
[www.tceq.state.tx.us/assistance/education.html](http://www.tceq.state.tx.us/assistance/education.html)  
<http://www.epa.gov/air/airpollutants.html>  
[www.drivecleanacrosstexas.org/for.../pollution\\_wordsearch.pdf](http://www.drivecleanacrosstexas.org/for.../pollution_wordsearch.pdf)



## LESSON 3

### Materials

Picture Page found  
on the toolkit

# What is wrong with this Picture?



This activity will run for  
**60 minutes**

### Background Summary

Air is the ocean we breathe. Air supplies us with *oxygen* which is essential for our bodies to live. Air is 99.9% nitrogen, oxygen, water vapor and inert gases. Human activities can release substances into the air, some of which can cause problems for humans, plants, and animals.

There are several main *types* of pollution and well-known *effects* of pollution which are commonly discussed. These include smog, acid rain, the greenhouse effect, and “holes” in the ozone layer. Each of these problems has serious implications for our health and well-being as well as for the whole environment.

When people think about air pollution, they usually think about smog, acid rain, CFC’s, and other forms of outdoor air pollution. But did you know that air pollution can also exist inside homes and other buildings? It can, and every year, the health of many people is affected by chemical substances present in the air within their homes.

There are many sources of indoor air pollution. Tobacco smoke, firewood cooking and heating appliances, and vapors from building materials, paints, furniture, cause pollution inside buildings.

Both indoor and outdoor pollution need to be controlled and/or prevented. How can we prevent the damaging effects of air pollution?



## Learning Objectives

Students will learn how to:

1. Identify the sources of air pollution (manmade and natural).
2. Identify preventive measures that people can take to reduce air pollution.

## Procedures

1. Draw the pictures given in the picture pages of this toolkit on hard card board paper. Instead of drawing, pictures from magazines or books can be cut and pasted on the paper.
2. Place the paper on the wall so that everyone sees it.
3. Call a student and ask what is wrong in this picture (Referring to the first picture).
4. Encourage the student to provide explanation for each of the picture.
5. Call other student and do the same until all pictures are covered.
6. Bring the class into a discussion on the sources and effects of air pollution and the preventive measures on how to reduce it.

## Session Materials: PICTURE PAGE

**PICTURE 1** — Little Arya is excited to paint his room with bright colors.





**PICTURE 2** – Most farmers use chemical fertilizers in their daily work.



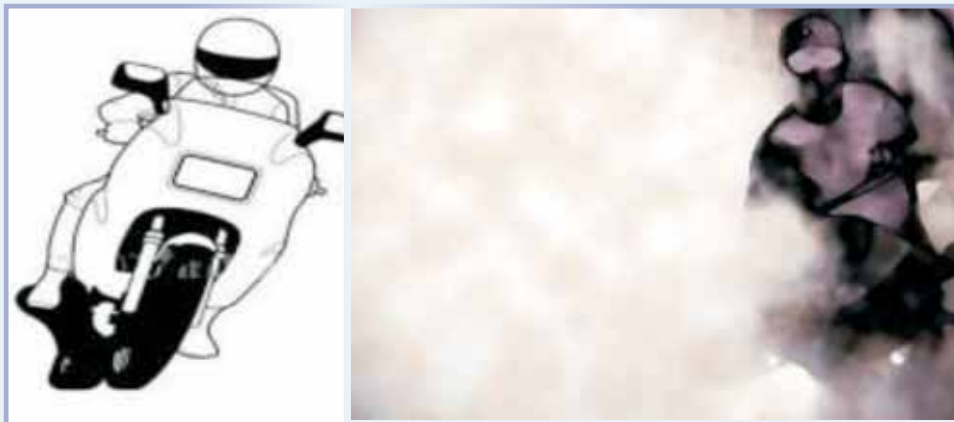
**PICTURE 3** – Amita gathers firewood and uses it in cooking their food.



**PICTURE 4** – Deepak burns their garbage at their backyard.



**PICTURE 5** – Aasif’s motorcycle did not pass the emission test and he still drives it on the street.



**PICTURE 6** – Bimal is working on a brick kiln factory since he was 10 years old



## Resource Materials

### **PICTURE 1 – Little Arya is excited to paint his room with bright colors**

Most paints give off fumes that evaporate in the air, causing a variety of symptoms, from headache to trouble breathing. The most common immediate symptoms from paint fumes include eye and throat irritation, headache, dizziness, and trouble breathing. More long-term exposure to paint fumes can lead to neurological problems (such as chronic headaches) and chronic breathing problems (such as asthma).

To avoid getting sick from paint fumes, first be sure to pick a paint that does not have any lead or mercury in it. Lead was removed from paint in the late 1970s, but mercury was only recently removed. Read paint can labels carefully before making any purchases.



When painting a room, be absolutely sure that the room is properly open to the air outside (ventilated) both when you're painting and when it's drying. Keep windows open to allow fresh air to circulate throughout the room and use exhaust window fans to move air from in the room to the outside. This is particularly important for very young children. Exposure to high levels of lead can affect a child's mental development, leading to learning problems.



### **PICTURE 2 – Most farmers use chemical fertilizers in their daily work**

Chemical fertilizers are manufactured from synthetic material that has equal distribution of three essential nutrients: phosphorous, nitrogen, potassium. Several chemical fertilizers have high acid content. Examples of these are ammonium sulfate, ammonium phosphate, ammonium nitrate, urea, ammonium chloride and the like.

A relatively small amount of the nitrogen contained in fertilizers applied to the soil is actually assimilated into the plants. Much is washed into surrounding bodies of water or seeps into the groundwater. This has added significant amounts of nitrates to the water that is consumed by the public. Some medical studies have suggested that certain disorders of the urinary and kidney systems are a result of excessive nitrates

in drinking water. It is also thought that this is particularly harmful for babies and could even be potentially carcinogenic. The nitrates that are contained in fertilizers are not thought to be harmful in them. However, certain bacteria in the soil convert nitrates into nitrite ions. Research has shown that when nitrite ions are ingested, they can get into the bloodstream. There, they bond with hemoglobin, a protein that is responsible for storing oxygen. When a nitrite ion binds with hemoglobin, it loses its ability to store oxygen, resulting in serious health problems.



**PICTURE 3 – Amita gathers firewood and uses it in cooking their food**

Most Nepali households still use open fire places inside their homes for cooking, heating and lighting. Thus respiratory and eye diseases are wide spread, especially among women and children, as the wood used in the kitchen burns with lots of black smoke. The average daily levels of exposure to particular matters are significant higher than the international maximum allowed levels of exposure. An average household in Humla uses 20 - 40 kg firewood a day for cooking, heating and lighting. Cooking in particular uses large amounts of fire wood as the traditional meal, 'daal bhat' (rice, lentil and vegetables), has to be cooked one after the other. Finally the enormous fire wood consumption in open fire places has also to be mentioned as main reason for deforestation in rural areas of Nepal. The use of efficient Improved Cooking Stoves and biogas produced from animal dung are some potential solutions to curb this problem.

**PICTURE 4 – Deepak burns their garbage at their backyard**

Burning open garbage creates pollution that's dangerous to human health and contaminates the air, water, and soil. Small fires mean big trouble. They produce a lot of smoke, as well as a variety of toxic substances—even burning seemingly harmless materials like paper.



### **What is the Problem?**

- 🌄 Garbage has changed. Today's household trash contains a lot of plastics and paper treated with chemicals, coatings, and inks.
- 🌄 Smoke. Pollutants from backyard burning of trash are released primarily into the air and close to ground level where they are easily inhaled—with no pollution controls!
- 🌄 Ash that remains contains concentrated amounts of these toxic materials that can blow away or seep into the soil and groundwater.
- 🌄 The practices of reducing reuse, recycling and household composting of waste are the best ways to solve the problem solid waste management.

**PICTURE 5 – Aasif's motorcycle did not pass the emission test and he still drives it on the street.**

Air pollution is increasing in urban areas of Nepal, and the major source of this problem is transport sector. Number of vehicles increases at the rate of over 10 percent per year. Nepal distributes unleaded petroleum all over the country but there are records of adulterated fuel supply by dealers thus making the condition worst. Nepal has set vehicular emission standards of CO, HC and smoke. In general 23% vehicles emit more than the standard fixed.



Maintenance of vehicles and monitoring systems are relatively unsatisfactory, making people aware about traffic norms, proper maintenance of vehicles and close guarding of the quality of fuel should help overcome this problem. Inspection on road and air quality monitoring programmes should be launched by the government. Inspection of vehicles on roads for emission level is required, as several vehicles entering Kathmandu valley violate the emission standards. An urgency of air quality measuring centre is realised. Because of bowl shape topography of Kathmandu valley, pollution scenario becomes alarming.



**PICTURE 6 – Bimal is working on a brick kiln factory since he was 10 years old**

The brick sector in Kathmandu valley, whose functioning and growth is directly linked to construction activity, is presently in the eye of a storm. Positive rate of growth in construction activity in past few years has resulted in a proliferation of brick kilns, which have reappeared in the Valley with spectacular speed raising serious concerns about the deteriorating air quality. It has been reported that brick kilns, producing in excess of 350 million bricks are the major single source of SO<sub>2</sub> and SPM in the environment of Kathmandu valley; contributing over 60 percent of the emissions.

The brick manufacturing industry in Nepal is under the process of technology shift to curb this problem. Vertical Shaft Brick Kiln is one of such cleaner technology which uses lesser amount of coals resulting reduction in emission of air pollutants and green house gases.

## Key Messages

**Air pollution can make you sick.** It can cause burning eyes and nose and an itchy, irritated throat, as well as trouble in breathing. Some chemicals found in polluted air cause cancer, birth defects, brain and nerve damage and long-term injury to the lungs and breathing passages.

**Air pollution can damage the environment.** Trees, lakes and animals have been harmed by air pollution. Air pollutants have thinned the protective ozone layer above the Earth; this loss of ozone could cause changes in the environment as well as more skin cancer and cataracts (eye damage) in people.











**Air pollution can damage property.** It can dirty buildings and other structures. Some common pollutants eat away stone, damaging buildings, monuments and statues.

**Air pollution can cause haze, reducing visibility in national parks and sometime interfering with aviation.**

## Activity Sheet

*It is important that we use CLEAN FUELS.*

*Can you match the fuels (left) with the vehicles (right)?*

	A. Traditional fossil fuel for cars	___ ETHANOL	
	B. Liquefied petroleum gas (LPG)	___ ELECTRIC	
	C. Corn to make alcohol fuel	___ PROPANE	
	D. Used cooking oil	___ GASOLINE	
	E. Recharging station	___ BIODIESEL	





## References

<http://hawaii.gov/dbedt/ert/activitybook/cleanfuels.html>

[http://www.diffen.com/difference/Chemical\\_Fertilizer\\_vs\\_Organic\\_Fertilizer](http://www.diffen.com/difference/Chemical_Fertilizer_vs_Organic_Fertilizer)

[http://www.rids-nepal.org/index.php/Smokeless\\_Metal\\_Stove\\_SMS.html?fontstyle=f-larger](http://www.rids-nepal.org/index.php/Smokeless_Metal_Stove_SMS.html?fontstyle=f-larger)

<http://www.pca.state.mn.us/oea/reduce/burnbarrel.cfm>

<http://www.un.org/esa/gite/iandm/jhapaper.pdf>

[http://www.devalt.org/newsletter/jun03/of\\_5.htm](http://www.devalt.org/newsletter/jun03/of_5.htm)

[http://www.edie.net/news/news\\_story.asp?id=3923&channel=0](http://www.edie.net/news/news_story.asp?id=3923&channel=0)

<http://www.cleanairnet.org/caiasia/1412/article-71954.html>

Adapted from: "Ozone Action! Let's Clear the Air Educational Activities 6th Grade - 8th Grade" West Michigan Clean Air Coalition. [www.wmcac.org/grades6-8.pdf](http://www.wmcac.org/grades6-8.pdf).

CLIMATE AND AIR QUALITY: A CASE STUDY OF PM10 POLLUTION IN KATHMANDU, NEPAL

Mark L. Hildebrandt<sup>1</sup> and Sumit Pokhrel<sup>2</sup>, Southern Illinois University Edwardsville  
Edwardsville, IL 62026-1459

[www.searo.who.int/.../National\\_Environment\\_&\\_Health\\_Action\\_Plan\\_chp9b.pdf](http://www.searo.who.int/.../National_Environment_&_Health_Action_Plan_chp9b.pdf)

[http://www.deq.state.id.us/air/educ\\_tools/inversion\\_in\\_cup\\_lp.pdf](http://www.deq.state.id.us/air/educ_tools/inversion_in_cup_lp.pdf)

<http://www.ew.govt.nz/environmental-information/All-about-air/Weather-affects-air-quality/>





# Impacts of Air Pollution



This activity will run for  
**90 minutes**

## Background Summary






Air pollution does not only damage the air; it also damages environments on Earth's surface and their inhabitants. Plants and animals are harmed by air pollution. Sometimes it is the pollutants themselves that cause damage. Other times pollutants combine and change the resources that plants and animals depend upon such as water, soil, and nutrients.

The impacts of air pollution are diverse and numerous. Air pollution can have serious consequences for the health of human beings, and also severely affects natural ecosystems. Because it is located in the atmosphere, air pollution is able to travel easily. As a result, air pollution is a global problem.




In this activity, students will explore more about the ways that air pollutants can damage health, ecosystem, property and the country's economy using concept maps.

Concept maps encourage understanding by helping students organize and enhance their knowledge on any topic. They help students learn new information by integrating each new idea into their existing body of knowledge.

### Concept Maps can:

-  demonstrate an understanding of a body of knowledge
-  explore information and relationships
-  access prior knowledge
-  share knowledge and information
-  visualize problem solving options

## Materials

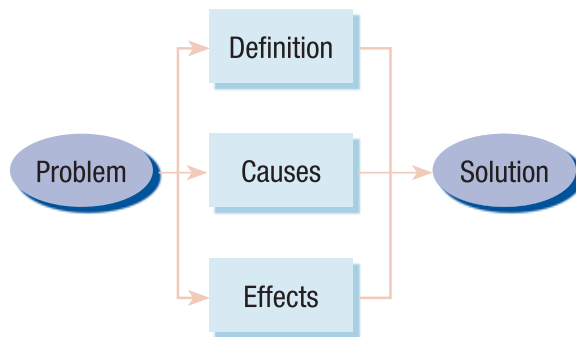
-  Chart Papers
-  Colored Pens
-  Topic Headings

## Learning Objectives

Students will be able to identify key concepts related to impacts of air pollution to health, ecosystem, property and economy and link the concepts together in an understandable manner. This activity will help the students construct and understand meaningful relationships using concept maps.

## Procedures

1. Divide the students into four groups. Assign the groups into the following topics:
  - ☁ Air Pollution impacts on Health
  - ☁ Air Pollution impacts on Ecosystem (Plants and Animals)
  - ☁ Air Pollution impacts on Property
  - ☁ Air Pollution impacts on Economy
2. Distribute the materials to each group.
3. Ask each of the groups to work together and brainstorm appropriate terms to come up with a Problem Solution Concept Map. Each group will use their respective topic as the main problem for the concept map.



4. Ask them to write in the chart paper the problem (topic assigned to each group), its definition, causes, and effects, leading to a possible solution.
5. Ask them to link the subtopics and topic headings together to form a complete loop or cycle map. They can use words, sentences and arrows to link the terms.
6. Call the students to explain and provide information related to the local scenarios in Kathmandu Valley. Relate the story of Kanncha found in the Resource Materials.
7. Bring the students to a discussion of solutions on how to mitigate the negative impacts of air pollution.

## Session Materials

AIR POLLUTION IMPACTS ON HEALTH

AIR POLLUTION IMPACTS ON PROPERTY

AIR POLLUTION IMPACTS ON ECOSYSTEM (PLANTS AND ANIMALS)

AIR POLLUTION IMPACTS ON ECONOMY



## Resource Materials

Air pollution in Kathmandu has reached critical conditions. Because of its bowl shape and being surrounded by mountains, pollutants created by exhaust fumes from vehicles and industry gets trapped. People can wear masks when they are outside, but that only helps a little. Air pollution controls and programs are under way, but it will take some time for air quality to return to healthy standards.

## Impacts on Human Health

The health impact of air pollution in the Kathmandu valley can be assessed by the increase in number of patients suffering from diseases related to air pollution. Medical records from hospitals in the Kathmandu valley revealed that urban residents have more respiratory diseases than rural residents (LEADERS, 1998).



<http://southiaspeaks.files.wordpress.com/2009/07/road-pollution.jpg>

Similarly, looking at the database of human health, total outpatient (OPD) visits, and the percentage shared by the respiratory disease (ARI) for two years, it quite clearly reflects the increasing trend of respiratory disease. From 1996 till 1998, number of ARI patient is increasing at the rate of 22.89 percent per year. Similarly, share of ARI patient out of total OPD visit has been increased from 9.99 to 10.11 percent within the same span of time.

Similarly, the total annual mortality cases in the Kathmandu valley due to air pollution is estimated to be 84 and the number of respiratory symptom days at about 1.5 million using the data of 1990. The cost of morbidity resulting from PM10 was found to be NRs. 180 million and total health damage to be NRs. 210 million.

It is estimated that among the sources of air pollution, traffic sources (exhaust and resuspension) might have the largest impact on health. Furthermore, it is estimated that the reduction in vehicle exhaust emissions is most effective in terms of reduced health damage (NRs 341 per kg emission reduction) (World Bank, 1997).

## Impacts on Ecology and Historical Sites

Air pollution in Kathmandu is also causing damage to many historical building that represent the cultural heritage of the Kathmandu valley. Acid made as a result of various sulphurous and nitrous oxides reacting with water can damage fine wood carving, marble and metallic exteriors common to many historical building in Kathmandu. Air pollution also has a negative impact on the local environment and ecology, with acid rain resulting from pollution being detrimental to plant and animal life.

## Did You Know?

Concept maps were developed in 1972 in the course of Novak's research program at Cornell where he sought to follow and understand changes in children's knowledge of science (Novak & Musonda, 1991). The fundamental idea in Ausubel's cognitive psychology is that learning takes place by the assimilation of new concepts and propositions into existing concept and propositional frameworks held by the learner. Out of the necessity to find a better way to represent children's conceptual understanding emerged the idea of representing children's knowledge in the form of a concept map.



## Impact on Tourism and Economy

It is estimated that NRs. 0.5 billion per year in tourism revenue is lost due to air pollution in Kathmandu valley (World Bank, 1997). Findings of a survey conducted among 1,702 tourists between May and June 2001 by MARG Nepal indicate that the quality of air is the number one area where tourists feel improvement is needed. This shows that Kathmandu's poor transportation system and pollution is not only affecting human health and environmental quality, but also the tourism industry (Business Age, 2001).

### *What is Acid Rain?*

Acid rain describes any form of precipitation with high levels of nitric and sulfuric acids. It can also occur in the form of snow, fog, and tiny bits of dry material that settle on to the Earth.

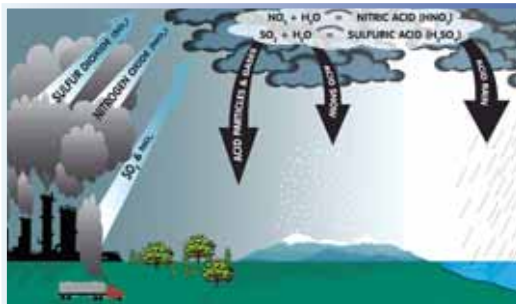
The biggest culprit of acid rain is the burning of fossil fuels by coal-burning power plants, factories, and automobiles.

When humans burn fossil fuels, sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) are released into the atmosphere. These chemical gases react with water, oxygen, and other substances to form mild solutions of sulfuric and nitric acid. Winds may spread



these acidic solutions across the atmosphere and over hundreds of miles. When acid rain reaches Earth, it flows across the surface in runoff water, enters water systems, and sinks into the soil.

Acid rain has many ecological effects, but none is greater than its impact on lakes, streams, wetlands, and other aquatic environments. Acid rain makes waters acidic and causes them to absorb the aluminum that makes its way from soil into lakes and streams. This combination makes waters toxic to crayfish, clams, fish, and other aquatic animals.



[http://www.dec.ny.gov/images/air\\_images/acidrain.gif](http://www.dec.ny.gov/images/air_images/acidrain.gif)

Acid rain also damages forests, especially those at higher elevations. It robs the soil of essential nutrients and releases aluminum in the soil, which makes it hard for trees to take up water. Trees' leaves and needles are also harmed by acids.

The effects of acid rain, combined with other environmental stressors, reduce the capacity of the trees and plants to withstand cold temperatures, insects, and disease. The pollutants may also inhibit the ability of the trees to reproduce. Some soils are better able to neutralize acids than others. In areas where the soil's "buffering capacity" is low, the harmful effects of acid rain are much greater.

## Key Messages



"The ultimate test of man's conscience may be his willingness to sacrifice something today for future generations whose words of thanks will not be heard."

- **Gaylord Nelson**, former governor of Wisconsin, founder of Earth Day

"Let every individual and institution now think and act as a responsible trustee of Earth, seeking choices in ecology, economics and ethics that will provide a sustainable future, eliminate pollution, poverty and violence, awaken the wonder of life and foster peaceful progress in the human adventure."

**John McConnell**, founder of International Earth Day





## LESSON 5

# Story Page: The Story of Kanncha

Perched on the mountains to the north of the Kathmandu Valley is Helambu, a land famous for its red apples. Kanchha remembers it vividly how he and his three sisters would harvest the apples and sell it in the village the same day just to bring food in the family's table. But this was long ago; the apple farming has been slowly decreasing. An unknown disease has destroyed the apple farming. Buckwheat, potato, pumpkin crops still continue to flourish on the terraced fields, supporting life in the central Himalayan "Sherpa" country.



Kanchha's family relied on agriculture and they decided to leave their village for greener pastures in Kathmandu. On their way there, Kanchha has observed signs of climate change everywhere. The Himalayan glaciers are slowly melting as the snowline shifts higher; indigenous people along the way expressed their worry about the arrival of new bug and plant species in the highlands; floods and landslides were common and triggered by unpredictable rains. He picked up a rock that he had never seen before, because it had been buried under the thick snow-cover.

As they approached the city, Kanchha saw a blanket of gray pollution covering the buildings and houses below. Kathmandu city resides in a bowl shape valley, and this prevents the escape of industrial and vehicle fumes.

Kanchha's father immediately found a job in a brick kiln factory not very far from the city. These kilns produce highly concentrated amounts of fine particulate matter, which interact with other industrial and vehicle fumes over Kathmandu. Brick kilns use coal as their main fuel source, and this contributes to the air pollution in Kathmandu by pumping considerable quantities of sulfur dioxide (SO<sub>2</sub>) and other toxic substances into the atmosphere. After a few months, Kanchha's father started to cough. The money that they have saved from farming back in Helambu has to be spent on few medications to cure his father's respiratory problems. Over the time, his father could not fully recover due to the prolonged exposure to toxic substances from the brick kiln factory.



One day, Kanchha and his three sisters were roaming around visiting some temples and monuments in the city. Kanchha had heard about them before and was overwhelmed with the intricate designs of the temples in Durbar Square. The square teems with colorful life. Vendors sell vegetables, flutes, and other crafts around the site. However, he noticed that some woodcarvings, statues, and architecture in the area had not been maintained and some were

destroyed. Locals in the area mentioned that this was one of the effects of the changing climate.

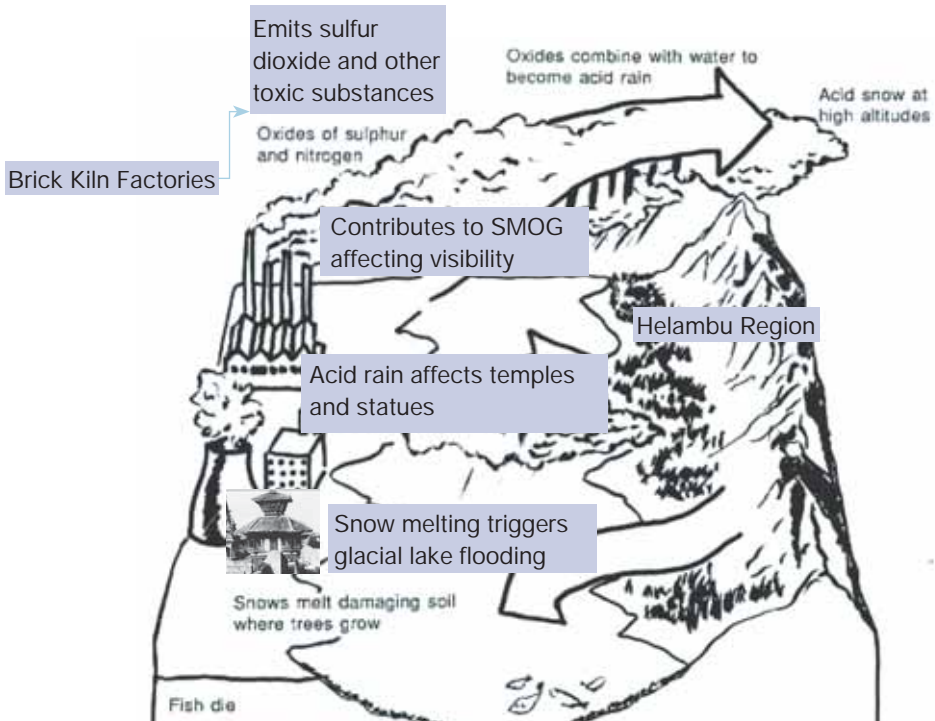
Now, Kanchha is not sure why this is happening. He wants to do something about it but is not certain how to start it.

## Procedures

1. Read “The Story of Kanncha” found on the Story page.
2. Ask the students to identify key environmental problems that Kanchha has seen or experienced in the Humla region and on his way to the city.
3. Ask the students to identify key environmental problems that Kanchha has seen or experienced in Kathmandu City.
4. Encourage discussion of these identified environmental problems focusing on the causes and how it impacts the people living there.
5. Ask the students how they can contribute solutions to the problems.
7. Call each student and ask him/her what is wrong in this picture (Referring to the first picture).
8. Encourage the student to provide explanation for each of the picture.
9. Call other student for and do the same procedure until all pictures are explained by the students.
10. Bring the class into a discussion on the sources and effects of air pollution and the preventive measures on how to reduce it.



Can you help Kanchha identify some of the environmental problems that he has experienced? Can you help him identify solutions to these problems?



Original image lifted from Energy and The Environment, Nevada Environmental Educational Network newsletter, 1992

Identified Problems	Example of Impacts	Suggested Actions/Solutions for the identified problems and subsequent impacts

Students Working Sheet



## Action Day Tips!

- ☁ Skip the paper or plastic at the grocery store
- ☁ There are many reusable shopping bags available, and they are even available in fun colors, patterns, or with fun sayings on them. There are reusable bags that fold up into tiny little packages, making it easier than ever to pop them in your purse or pocket and take them with you wherever you go. Keep a supply in your bag so that even when you make an unexpected stop at the store, you don't have to use paper or plastic.



## References

<http://www.ekantipur.com/2009/11/21/oped/changing-landscapes/303236/>

<http://www.world-weather-travellers-guide.com/air-pollution-in-kathmandu.html#brick>

[dougsamu.wordpress.com/?s=water](http://dougsamu.wordpress.com/?s=water)

<http://www.i-heart-god.com/images/earth%20cartoon%20drawing.jpg>

# Diagnose the Symptoms



*This activity will run for*

**1 hour**

## Background Summary

Breathing clean air is important to maintain our health. Thousands of us live in areas where the air is sometimes considered unhealthy to breathe because it is polluted. One common air pollutant is ground-level ozone. The effects of ground-level ozone pollution are different than the effects of the ozone layer high up in the atmosphere, which helps protect us from receiving too much of the sun's ultraviolet radiation. At ground level, ozone can cause breathing difficulties, aggravate lung diseases, such as asthma, and may cause permanent lung damage. An easy way to remember the different types of ozone is: "Good up high, bad nearby." Ground-level ozone pollution is formed when certain pollutants, known as precursors, are released from vehicles, industries, and power plants, and in the presence of sunlight and heat react together to form ozone.

Another common air pollutant is particle pollution, which can cause breathing difficulties, aggravate heart disease as well as lung disease, and may cause chronic bronchitis or reduced lung function in children. Particle pollution consists of tiny particles of dust, dirt, smoke, and liquid droplets that contain chemicals.

In this lesson, students first read background materials about the health impacts of air pollution, followed by a teacher-led discussion. Students then role-play realistic case studies, as patients with health symptoms and their family members. The rest of the class interviews the patient and family members to try to determine which air pollutant may have caused the symptoms. The class then discusses what they can do to protect their health when air quality is poor.



## Learning Objectives

Students will learn how to:

- Identify some of the health symptoms associated with specific air pollutants (ozone and particle pollution).
- Identify preventive measures that people can take to protect their health.
- Understand which segments of the population are most at risk from air pollution.



Image lifted  
from: [nptel.iitm.ac.in/.../Module3/3a.htm](http://nptel.iitm.ac.in/.../Module3/3a.htm)

## Materials

- Background Reading: What Are the Health Impacts of Air Pollution? (one for each student)
- Pollutants Chart: Sources and Effects of Air Pollutants (one for each student)
- Group Task Cards (one set for each of three groups; cut to card size before distributing)
- Symptoms Scenarios A, B, and C (a different scenario for each of the three groups)
- Student Worksheet: Which Pollutant? (one for each student)

## Procedures

- Distribute among the students the Background Reading material and the Pollutants Chart and give them 5 minutes to read.
- Hold a brief class discussion of the reading materials. Ask them if they already knew about the health effects of air pollution discussed in the Background Reading and the Pollutants Chart? Were you surprised at any of these health effects? Have you or anyone you've known experienced any of these effects?
- Select 12 students and divide them into three groups of four students each for role-playing.
- Distribute materials to the groups and others to the class, as indicated:
  - To the three groups of role-playing students:
  - Symptoms Scenario



- Hand out Scenario A to one group, Scenario B to a second group, and Scenario C to the third group. Give the role-playing groups the Pollutants Chart and Student Worksheet so they have the same information as the rest of the class.
- To the rest of the class, distribute the Student Worksheet: Which Pollutant?
5. Explain the students in the three role-playing groups that each member of their group will choose and assume a specific responsibility, as defined on the Group Task Cards, and will present their Scenario to the class. Explain that one "patient" and one "family member" (or, "second patient") from each group will introduce themselves to the class based on the information in their Symptoms Scenario. Another group member will act as class monitor, maintaining order during questions and answers; and another will act as scribe, writing answers on the board. Each of the cards describes the tasks in more detail.
  6. Give the groups time to prepare (5 to 10 minutes), allowing them to briefly read and discuss their Symptoms Scenario and Group Task Cards amongst themselves to prepare for their presentations, while the rest of the class continues to review the Background Reading and Pollutants Chart materials.
  7. Tell students in the audience that they are going to be "doctors" trying to determine the pollutant most likely associated with or causing the symptoms presented. Tell them to listen carefully to each of the three presentations and make doctor's notes on Student Worksheet: Which Pollutant? As they listen. Tell them they will be asking the patient and family member in each group questions to help the class come up with answers.
  8. Have the first group present its Symptoms Scenario to the class. Assist the group as needed.
  9. After the presentation, tell the rest of the class to go ahead and ask "doctor" questions to try to determine possible causes of the symptoms. Tell them they can use their Student Worksheet: Which Pollutant? The Pollutants Chart and the background reading as guides. Have the presenters respond. Assist the class as needed in asking targeted questions to obtain pertinent information included in the Symptoms Scenarios.
  10. Each presenter should respond as best as they can from their assigned Scenarios. Other members of their group (e.g., family member, class monitor, and scribe) can help them answer questions.
  11. After a reasonable amount of time questioning the Scenario presenter group, have the class as a whole (presenting group, other groups, and audience) together continue to try to determine the pollutant associated with or causing the symptoms, as well as identify health prevention measures, with teacher guidance-but don't tell students yet which pollutant it is or possible preventive measures.
  12. Discourage students from arriving at answers too quickly. Encourage questions about other aspects of the patient's life (e.g., cigarette smoking) that could also be an influence. Inform students that even when air pollution is a primary factor, many other factors can still influence our health.

13. Using Teacher Answer Sheet : Which Pollutants?, share and discuss the answers with the class, including the pollutant most likely associated with or responsible for each group's symptoms/ illness, and precautions that people can take to protect their health.
14. Repeat Steps 8 through 13 with each of the other two groups. Each group is given 10 minutes each in presenting their Symptom Scenario and answering questions from students.

## Session Materials

### Symptoms Scenario A



**Patient:** Allay (if man) or Pabitra (if woman)

**Family Member:** Ankur (cousin)

**Patient-** Use this information to introduce yourself and your family member to the class:

My name is Allay (or Pabitra). I used to be a runner years ago. I stopped for a few years, but took it up again last year. Lately I've been feeling short of breath in the middle of my run. This is my cousin Ankur, who is also my roommate. He'll tell you that I'm a pretty serious runner.

Now, ask the class to ask you questions.

**Patient and Family Member -** Use this information to answer class questions about the patient:

- 34 years old
- Lives and works in Lalitpur
- Works as a computer programmer
- Works with a small, independent company
- The office building he works in is well-ventilated
- Running is an important personal interest
- Other hobbies include hiking and surfing the Net
- Smoked from age 14 to 16, but "I quit when I got smart enough to know better"
- Roommate smokes, but only outside, so Allay is not breathing Ankur's smoke
- Ran pretty regularly from age 20 to around age 30

- 🌊 Started running again last year, in December
- 🌊 Ran in the early morning, about 6:00 to 6:30 a.m., all winter
- 🌊 In April, started working an early schedule and running after work, around 2:00 pm
- 🌊 Last winter, felt refreshed and really “up” after running, just like years ago
- 🌊 Has been running very regularly and is confident he’s in good shape
- 🌊 Lately has been feeling short of breath halfway through a run
- 🌊 He also notices that he seems to cough and needs to spit while running, which didn’t happen before
- 🌊 Has never had any lung or respiratory problems in the past
- 🌊 Cousin Ankur will vouch that Allay has been running as regularly as he says— five or six times a week, for over a year—so this can’t be happening because he’s in poor shape.

## Symptoms Scenario B

**Patient:** Iswar Humagai

**Family Member:** Emma Humagai (his wife)



**Patient** - Use this information to introduce yourself:

My name is Iswar Humagai. I have been having chest pain and chest tightness for the last two or three months. Since these problems didn’t seem to be going away, I went to see my doctor last week. She told me that I have arrhythmia, which is an irregular heartbeat. I had a minor heart attack when I was 56, but have felt pretty good since then.

Now, ask the class to ask you questions.

**Patient and Family Member** - Use this information to answer class questions about the patient:

- 🌊 Iswar is 62 years old
- 🌊 He retired early, at age 50
- 🌊 Never smoked cigarettes or anything
- 🌊 Used to work for the city as a technician installing and repairing traffic lights.
- 🌊 They live in Putalisadak because they like living near their children and grandchildren
- 🌊 Love kids
- 🌊 Every Monday through Friday, ever since retiring, Iswar volunteers as a school crossing guard at a busy intersection, helping kids get across the street
- 🌊 He does this for an elementary school and a middle school, that start at two different times, so he’s out there almost two hours early each morning and two hours each afternoon
- 🌊 Likes to wear white shirts, even though they always look really dirty after doing the crossing guard work

- ▲ They live in an apartment near the same intersection
- ▲ Several factories are nearby
- ▲ His hobbies include bowling, going to grandchildren's soccer games, babysitting for the youngest granddaughter, and staying in close touch with world news
- ▲ Not really into exercise or working out
- ▲ Iswar and Emma take a walk around the neighborhood a couple of times each week, usually right after he finishes crossing guard duty

### Symptoms Scenario C



**Patient:** Anamul Shrestra

**Second Patient:** Dot Shrestra

**Patient:** Use this information to introduce yourselves:

My name is Anamul Shrestra and this is my wife Dot. We live in Chaunni. We came back from our afternoon walk feeling just awful.

Now, ask the class to ask you questions.

**Patient and Second Patient:** Use this information to answer class questions about the patients:

- ▲ He's 58 years old
- ▲ She's 48 years old
- ▲ They take a brisk walk together almost every day, in mid-afternoon
- ▲ Usually walk two miles, along river, where it's quiet and there's no traffic
- ▲ Anamul interests include cooking, woodworking, and fishing
- ▲ Dot's interests include painting and playing drums with a jazz band
- ▲ Today was a beautiful sunny day and the first really hot day of spring
- ▲ Today they took a different route than usual
- ▲ The traffic was backed up for several blocks on one road, and they were curious why, so they decided to turn up that road and see for themselves
- ▲ Ended up sitting by the road for an hour in the middle of the walk, talking with a friend who was stuck in the giant traffic jam
- ▲ Near the end of the walk, both Anamul and Dot started wheezing and coughing
- ▲ Dot was feeling some nausea
- ▲ Anamul felt like his asthma was acting up for the first time in years



## GROUP TASK CARDS



### GROUP TASK CARD PATIENT

You will play the role of the primary character described on the Symptom Scenario card. Using information on the card, you will introduce yourself to the class and then answer questions from them.

A member of your family will help you answer questions. After some time has passed, if you feel that there is important information on your Scenario card that has not been covered by the questions, you may decide to volunteer that information.



### GROUP TASK CARD FAMILY MEMBER (or SECOND PATIENT)

You will play the role of someone in the patient's family. The patient will introduce you to the class, using information on the Scenario card. You will then help the patient answer questions from the class.

If questions are asked which are not answered on the Scenario card, you will consult with the patient about how to best answer the questions (in a way that would not alter the conclusion reached by the class).



### GROUP TASK CARD SCRIBE

You are responsible for writing information on the board as the patient and his or her family member answer questions from the class.

Making a list of this information will make it easier for the class to focus on what they know so far, choose good questions to ask next, and determine the pollutant that is associated with or causing the patient's symptoms.



### GROUP TASK CARD CLASS MONITOR

It is your responsibility to maintain order and designate whose turn it is to ask a question.

Call on those with their hand raised so that they can ask questions one at a time and everyone can hear the answers.

You will have to pace the questions so that the Scribe has time to write the answers on the board.

## Background Reading: What are the Health Impacts of Air Pollution?

### *Air Pollution and Our Health*

Every minute of every day, we breathe six to ten liters of air. If the air carries unhealthy levels of pollutants, those pollutants can enter our bodies and affect us in many ways. Thousands of us live where the air is often unhealthy to breathe. A large number of people are affected leading to the health impacts of air pollution being costly in the long run.

Air pollution is especially harmful to the very young and old. Infants and children are at risk because their lungs are not fully developed until they are about 18 years old and because they breathe faster. The elderly are at risk because they are more likely to have undiagnosed heart or lung disease.

Since the respiratory system comes in direct contact with the air we breathe, it is the body system most likely to be affected by air pollutants. People who already have asthma, emphysema, or other respiratory conditions, as well as people with heart or other circulatory problems, are especially susceptible to the effects of air pollution.



Even healthy people can be affected by air pollution. Air pollution can affect anyone. Healthy teenagers, young adults, and strong athletes can suffer negative effects from high pollution levels, especially when exercising outdoors.

People who live in heavily polluted areas are exposed to not just one pollutant but to many pollutants. And, the concentration of each pollutant changes during the day. All of this makes it difficult to separate out the effects of each pollutant.

In addition, how susceptible people are to the effects of air pollutants can vary widely. Think about a roomful of healthy people who are all exposed to the same cold virus. Some will develop a bad cold, others a mild cold, and others no cold at all. In a similar way, susceptibility to pollutants can vary greatly even among a group of healthy individuals.

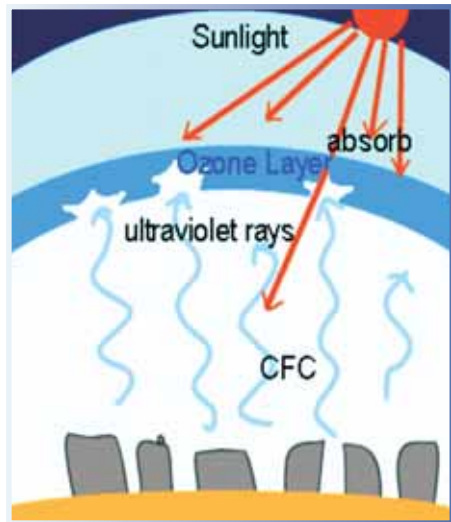
Finally, there are always many influences on our health. If you develop symptoms that might be caused by air pollution, it's often difficult to be sure that pollution was "the" cause. Just as with other health problems, there are likely to be several factors affecting your health.

## How Much Do We Know?

Although the part of our bodies most affected by air pollution is the respiratory system, the circulatory system can also be affected. Exposure to unhealthy levels of air pollutants can result in low oxygen levels in red blood cells, abnormal heart rhythms, and increased risks of blood clots and narrowing of blood vessels. These effects can lead to worsening of heart diseases such as heart failure and increased risks of heart attacks or strokes.

The Pollutants Chart: Sources and Effects of Air Pollutants summarize the sources and health effects of criteria air pollutants. When we inhale particle pollution (dust, soot, dirt, and liquid droplets, which may or may not be visible), tiny bits of foreign matter can travel deep into the lungs where they become lodged in the alveoli, which are small balloon-like sacs in which oxygen exchange occurs. This is where carbon dioxide from the blood is exchanged for oxygen from the air. Some particles can be exhaled or moved out by the cilia; other particles may sink into underlying tissue or move into the blood stream. Health effects from particles range from coughing and aggravated asthma to chronic bronchitis and even premature death. For people with heart disease, exposure to particle pollution can cause serious problems in a short period of time—even heart attacks—with no warning signs.

Ozone pollution, which is invisible, can irritate the respiratory system, reduce lung function, inflame and damage the lining of the lungs and the cilia, and cause structural damage of the lungs. Ozone pollution can also reduce the number and functioning ability of bacteria-destroying white blood cells. Ozone pollution can aggravate asthma and increase people's susceptibility to respiratory illnesses like pneumonia and bronchitis. Symptoms to watch for when ozone is in the air include coughing, pain when taking a deep breath, and breathing difficulties, especially when active or exercising outdoors. But ozone damage can also occur without any noticeable signs. For some people, several months of repeated exposure to ozone can permanently damage the lungs. It is important to know that ozone can have two very different effects, depending on where it is in the atmosphere. "Good" ozone occurs naturally high up in the atmosphere (the stratosphere), where it helps protect us from receiving too much of the sun's harmful ultraviolet rays. "Bad" ozone at ground level is air pollution, as we have been discussing, and can result in health and environmental problems. An easy way to remember the difference is: "Ozone: good up high, bad nearby."



## Pollutants Chart: Sources and Effects of Pollutants

Pollutant	Sources	Possible Effects on Humans	Other Effects	Comments
Particle Pollution (also called Particulate Matter or PM)	<ul style="list-style-type: none"> <li>☞ Dust</li> <li>☞ Motor Vehicles</li> <li>☞ Exhaust</li> <li>☞ Factories</li> <li>☞ Burning of Coal for Power</li> <li>☞ Natural Sources: forest fires and volcanoes</li> </ul>	<ul style="list-style-type: none"> <li>☞ Irritates nose and throat</li> <li>☞ Difficult and painful breathing</li> <li>☞ Coughing, chest tightness</li> <li>☞ Reduces Lung function</li> <li>☞ Lowers resistance to respiratory infection</li> <li>☞ Aggravates asthma and existing lung and heart diseases</li> <li>☞ Chronic bronchitis and reduced lung function in children (long term exposure)</li> <li>☞ Premature death</li> </ul>	<ul style="list-style-type: none"> <li>☞ Reduces visibility</li> <li>☞ Discolors buildings, statues and painted surfaces</li> <li>☞ Interferes with photosynthesis, may damage crops</li> <li>☞ May alter climate</li> </ul>	<ul style="list-style-type: none"> <li>☞ 75% from motor vehicles</li> <li>☞ Usually refers to particles less than 10 or 2.5 microns (1 micron = 1/1,000,000 of a meter)</li> <li>☞ Particle pollution is usually worse in winter, or near busy roads or factories.</li> </ul>
Ground Level Ozone	<ul style="list-style-type: none"> <li>☞ Formed when Nitrogen Oxides (NOx) and Volatile Organic Chemicals (VOCs) react in heat and sunlight.</li> <li>☞ Sources of NOx and VOCs include vehicle exhaust, industrial emissions, gasoline vapors and chemical solvents.</li> </ul>	<ul style="list-style-type: none"> <li>☞ Coughing, pain with deep breathing and shortness of breath</li> <li>☞ Nausea</li> <li>☞ Irritates respiratory system, chest tightness</li> <li>☞ Damages lung tissue</li> <li>☞ Reduces lung function</li> <li>☞ Aggravates existing lung condition including asthma</li> <li>☞ Structural Changes (long term exposure)</li> <li>☞ Premature deaths</li> </ul>	<ul style="list-style-type: none"> <li>☞ Deteriorates rubber, paints and some building materials</li> <li>☞ Damages fruits and seeds</li> <li>☞ Injures crops and trees</li> <li>☞ Affects whole ecosystem by altering wildlife habitat</li> </ul>	<ul style="list-style-type: none"> <li>☞ Ozone pollution is often worse in warmer weather, in late afternoons and early evenings. Ozone is good up high in the upper atmosphere where it helps to protect us from too much of the sun's harmful ultraviolet rays.</li> <li>☞ Ozone is bad at ground level where it can result in health and environmental problems. Remember, Ozone: good up high, bad nearby.</li> </ul>

Pollutant	Sources	Possible Effects on Humans	Other Effects	Comments
Carbon Monoxide	<ul style="list-style-type: none"> <li>➤ Construction Equipment</li> <li>➤ Motor Vehicles Exhaust</li> <li>➤ Forest Fires</li> <li>➤ Industrial Process</li> </ul>	<ul style="list-style-type: none"> <li>➤ Reducing oxygen delivery to the body's organs (like the heart and brain) and tissues.</li> <li>➤ Vision problems</li> <li>➤ Reduced ability to work or learn</li> <li>➤ Reduced manual dexterity, and difficulty performing complex tasks.</li> <li>➤ At extremely high levels, CO is poisonous and can cause death.</li> </ul>	<ul style="list-style-type: none"> <li>➤ CO contributes to the formation of smog ground-level ozone, which can trigger serious respiratory problems.</li> </ul>	<ul style="list-style-type: none"> <li>➤ Carbon Monoxide (CO) is a lethal poison that is produced when fuels such as gasoline are burned. Because CO is colorless, tasteless, odorless and non-irritating, it can overcome an exposed person without warning.</li> </ul>
Nitrogen Oxides	<ul style="list-style-type: none"> <li>➤ Agricultural soil</li> <li>➤ Animal manure</li> <li>➤ Wastewater treatment</li> <li>➤ Human sewage</li> <li>➤ Mobile and Stationary source of fossil fuel combustion</li> </ul>	<ul style="list-style-type: none"> <li>➤ Adverse respiratory effects including airway inflammation in healthy people and increased respiratory symptoms in people with asthma.</li> <li>➤ Small levels of NOx can cause nausea, irritated eyes and/or nose, fluid forming in lungs and shortness of breath</li> </ul>	<ul style="list-style-type: none"> <li>➤ Helps form acid rain</li> <li>➤ It contributes to global warming</li> <li>➤ It hampers the growth of plants</li> <li>➤ NOx can form with other pollutants to form toxic chemicals</li> </ul>	<ul style="list-style-type: none"> <li>➤ Component in ground-level ozone and smog</li> <li>➤ Combines with particles to reduce visibility</li> <li>➤ Is a greenhouse gas that contributes to global warming and climate change</li> </ul>



Pollutant	Sources	Possible Effects on Humans	Other Effects	Comments
Sulfur Dioxide	<ul style="list-style-type: none"> <li>➤ Fossil fuel combustion at power plants (66%) and other industrial facilities (29%).</li> <li>➤ Industrial processes such as extracting metal from ore, and the burning of high sulfur containing fuels by locomotives, large ships, and non-road equipment.</li> </ul>	<ul style="list-style-type: none"> <li>➤ Irritates the nose, throat, and airways to cause coughing, wheezing, shortness of breath, or a tight feeling around the chest.</li> </ul>	<ul style="list-style-type: none"> <li>➤ Sulfur dioxide dissolves easily in water to form sulfuric acid. Sulfuric acid is a major component of acid rain. This damage forests and crops, change the acidity of soils, and make lakes and streams acidic and unsuitable for fish.</li> </ul>	<ul style="list-style-type: none"> <li>➤ Sulfur dioxide also contributes to the decay of building materials and paints, including monuments and statues.</li> </ul>
Lead	<ul style="list-style-type: none"> <li>➤ Lead based Paint</li> <li>➤ Dust</li> <li>➤ Drinking Water</li> <li>➤ Smelting plants</li> <li>➤ Exhaust emissions from lead driven cars</li> </ul>	<ul style="list-style-type: none"> <li>➤ Stomach pain and vomiting, diarrhea, and black stools.</li> <li>➤ Severe exposure can cause nervous system damage, with symptoms such as intoxication, coma, respiratory arrest, and even death.</li> </ul>	<ul style="list-style-type: none"> <li>➤ Lead accumulates in the bodies of water organisms and soil organisms. Leading to poisoning.</li> <li>➤ Lead is a particularly dangerous chemical, as it can accumulate in individual organisms, but also in entire food chains.</li> </ul>	<ul style="list-style-type: none"> <li>➤ Once lead enters the body it affects the peripheral and central nervous system (PNS, CNS), blood cells, metabolism of vitamin D and calcium, and reproductive toxicity. The nervous system seems to be the most sensitive to lead poisoning.</li> </ul>



## Student Worksheet: Which Pollutant?

Refer to the Background Reading: What Are the Health Impacts of Air Pollution? and the Pollutants Chart: Sources and Effects of Air Pollutants as needed as you try to determine the following information about the “patients” in each group.

Enter your answers for each patient below during group presentations and afterwards during class question and answer sessions. You will be seeking information about:

- ☁ Symptoms—Note key symptoms or behaviors in the patient.
- ☁ Pollutant most likely to be associated with or causing symptoms-Note the pollutant most likely to be associated with or cause these symptoms.
- ☁ Health Precautions—Note precautions that could have been taken to prevent or decrease the likelihood of the problem arising.

### **1. Allay (or Prabitra) (young adult runner)**

*Symptoms:*

*Pollutant most likely to be associated with or causing symptoms:*

*Health Precautions:*

### **2. Iswar Humagai (crossing guard)**

*Symptoms:*

*Pollutant most likely to be associated with or causing symptoms:*

*Health Precautions:*

### **3. Anamul and Dot Shrestra (middle-aged walkers)**




*Symptoms:*

*Pollutant most likely to be associated with or causing symptoms:*

*Health Precautions:*

## Teacher Answer Sheet: Which Pollutant?

**Note:** Instructions to students on Student Worksheet: Refer to the Background Reading: What Are the Health Impacts of Air Pollution? and the Pollutants Chart: Sources and Effects of Air Pollutants as needed as you try to determine the following information about the “patients” for each group. Enter your answers for each patient below during group presentations and afterwards during class question and answer sessions. You will be seeking information about:

-  *Symptoms*—Note key symptoms or behaviors in the patient
-  *Pollutant most likely associated with or causing symptoms*—Note the pollutant this is most likely to be associated with or causing these symptoms
-  *Health Precautions*—Note precautions that could have been taken to prevent or decrease the likelihood of the problem arising

### 1. Symptoms Scenario A: Allay (or Prabitra) (young adult runner)

*Symptoms:* Feeling short of breath, coughing and spitting while running, symptoms occurring during outdoor exercise on summer afternoons

*Pollutant most likely associated with or causing symptoms:* Ground-level ozone

*Health Precautions:* Exercise outdoors in the early morning before ozone levels begin to rise

**Teacher Notes for Discussion of Symptoms Scenario A:** *Exposure to high ground-level ozone concentrations can affect even healthy teens and active adults. In this scenario, the time of day and time of year during which the problem occurs provide clues that ground-level ozone, rather than another pollutant, is likely to be responsible.*

### Did You Know?

Ozone has a very characteristic pungent odor. You can sometimes detect it after lightning strikes or during electrical discharges. Individual humans vary in their ability to smell ozone. Some can smell it at levels as low as 0.05 ppm.





## 2. Symptoms Scenario B: Iswar Humagai (crossing guard)

**Symptoms:** Chest pain and chest tightness, previous heart attack, white shirt gets dirty after crossing guard work

**Pollutant most likely associated with or causing symptoms:** Long exposure to high levels of air pollutants, especially particle pollution, from work installing traffic lights, working as a crossing guard, and taking walks in the area

**Health Precautions:** Be sure to take walks on less busy roads with less traffic pollution. (And don't wear white shirts!)

**Teacher Notes for Discussion of Symptoms Scenario B:** *The busy traffic intersection and the presence of several factories in the area are indications that high amounts of particle pollution may be present. Also, particle pollution can be high at any time of day or year, even early mornings, and in winter (while ozone is usually higher in the afternoons and evenings, in warmer weather.)*

## 3. Symptoms Scenario C: Anamul and Dot Shrestha (middle-aged walkers)

**Symptoms:** Coughing, feeling queasy, asthma acting up

**Pollutant most likely associated with causing symptoms:** Ground-level ozone

**Health Precautions:** Avoid exercising along busy roads. Avoid exercising during the times of day when ozone levels are highest (which is late afternoon or early evening).

**Teacher Notes for Discussion of Symptoms Scenario C:** *The time of day (mid afternoon) and the fact that it's a warm, sunny day are clues that ozone is the problem, in addition to the actual physical symptoms. Even young, trained endurance athletes can suffer similar symptoms at unhealthy ozone levels.*



## Key Messages

Breathing polluted air is unhealthy. For example, you might find it more difficult to breathe, you might cough or your chest might feel tight.

Two main types of air pollution are ozone pollution and particle pollution.

The ozone we breathe at ground level is bad. But very high in the atmosphere (the stratosphere) is a natural layer of ozone that is good because it helps protect us from the sun's harmful ultraviolet rays. A rhyme that can help you remember this is "Ozone: Good up high, bad nearby."

Both people's activities (such as transportation, energy use, and materials production) and nature (such as forest fires) can cause air pollution.

You can help reduce pollution. For example, turn off lights and equipment that use energy when you don't need them. Walk, bike, carpool, or use electric vehicle when possible.



## Action Day Tips!

You can protect your health in three ways when the air is polluted:

- ☞ You can always find the air quality on TV during the weather forecast or on the radio, or you might see it on the weather page in the local newspaper.
- ☞ If you're outside when you know the air is polluted, you can protect your health by taking it easier. It's important to exercise and be active to maintain good health. But when the air is polluted, you can reduce the time you spend exercising, walk instead of run, take frequent breaks, or go outside at another time or on another day when the air is cleaner.
- ☞ If you notice any symptoms when you're outside like coughing, pain when you take a deep breath, chest tightness, or wheezing, stop your activity and tell an adult. This is especially important if you have asthma.



## References

*Adapted from AQI Toolkit for Students, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. EPA-456-B-08-001*

*California Environmental Protection Agency, Air Resources Board, "Ozone and Health", Aug. 24, 2005*



# Taking Action to Improve Air Quality

## Background Summary

*Having clean air requires that we all work together to make a difference. Individuals, communities, industry, all levels of government, non-government organizations (NGOs) as well as the international communities have a role to play to reduce air pollution.*

Numerous initiatives have been developed to provide opportunities for participation, along with the necessary support, information and guidance to help individuals and communities improve the quality of our air. Every sector of society is part of the solution. Working together to take action will go a long way to making our air cleaner. Learn more about what is being done and what you can do to take action.

Lead the students into a discussion on how they can help improve air quality on individual level.

## Discussion Points

Individuals can take action at the local level to reduce energy use at home, on the road, at work, and at play. They can also take advantage of a number of tips (with interesting facts) and other resources to help them reduce the amount of air pollution that they create.

### **1. Engage in environmentally-friendly lifestyle**

Changing your driving habits, reducing your driving time, maintaining your car, and using cleaner fuels, such as ethanol, can help to maximize fuel efficiency and reduce emissions. Use alternative forms of transport, such as public transit, biking, walking, or saffa tempos.



## 2. Get involved in volunteer works

Are you looking for a worthy cause to help clean the air? Then consider teaming up with your friends for volunteer works.

**Clean Energy Nepal (CEN)/Clean Air Network Nepal** is a nonprofit organization focusing on research based education and advocacy campaigns on issues related to sustainable energy use and environmental conservation. Check their site at <http://www.cen.org.np/> for volunteer works.



Community action is also important. Organizing outreach activities to promote greater community involvement is a very effective way of achieving progress. Communities, along with their municipal governments, can become involved in planning more sustainable forms of transportation as well as developing community social marketing programs to promote necessary changes on air quality.



## 3. Participate and celebrate the World Environment Day!

World Environment Day (WED) was established by the UN General Assembly in 1972 to mark the opening of the Stockholm Conference on the Human Environment.

Commemorated yearly on 5 June, WED is one of the principal vehicles through which the United Nations stimulates worldwide awareness of the environment and enhances political attention and action. The day's agenda is to:



- ☁ Give a human face to environmental issues;
- ☁ Empower people to become active agents of sustainable and equitable development;
- ☁ Promote an understanding that communities are pivotal to changing attitudes towards environmental issues;
- ☁ Advocate partnership which will ensure all nations and peoples enjoy a safer and more prosperous future.

#### 4. Adopt the 3Rs (REDUCE, REUSE, AND RECYCLE) rule in your community.

TIPS! To reduce contamination and improve recycling efficiency, wash and squash!



#### Wash

- Scrape out any food remains/pour away excess liquid.
- Rinse the container (use your washing-up water)
- Don't put recycle in the dishwasher – no need to waste resources to achieve an unnecessary level of cleanliness!

#### Squash

- Crush metal cans.
- Squeeze plastic bottles flat to expel as much air as possible.

These steps help prevent contamination and reduce the volume of recycle, making collections more energy efficient.

Lead the students into a discussion on how they can help improve air quality on the community level.

## Resource Materials

### *Government Response to Kathmandu's air pollution*

- 1991: Ban on import of new three-wheelers
- 1995: In-use vehicle standards & emission testing
- 1997: Incentives to electric vehicles
- 1999: Introduction of unleaded fuel
- 1999: Removal of 600 diesel 3-wheelers
- 2000: EURO 1 norms for new vehicles
- 2000: Ban on import of new 2-stroke vehicles
- 2004: 2-stroke 3-wheelers to be removed
- 2004: Bulls Trench Brick kilns to be banned

There are several non-governmental organizations involved in research, advocacy, public awareness, and pilot project demonstration work related to air pollution control.

### *Response of non-government sector*

Private Sector - Invested more than Rs. 450 million (US\$ 6.4 million) in operating 600 EVs and 39 charging stations

NGOs - CEN, ENPHO, LEADERS Nepal, NEFEJ, ProPublic, Martin Chautari

- 🏔 Research - monitoring, health impacts, polices
- 🏔 Public education - schools, colleges, media
- 🏔 Advocacy - street demonstration, public interest, litigation, government committees

### *Private Sector Initiation*

The best example of private sector participation in controlling Kathmandu's air pollution is the investment in approximately 600 electric three wheelers, locally called 'SAFA Tempos', running in Kathmandu valley as a public transportation. The private sector has also shown interest in operating the trolley bus system.

### *International Agencies Involved in Air Quality*

Danida/MoPE's ESPS

- 🏔 Air Quality Monitoring
- 🏔 Promotion of electric vehicles
- 🏔 Promotion of cleaner production in industries
- 🏔 SDC promoting Vertical Shaft Brick Kilns
- 🏔 Winrock International together with other partners in Kathmandu Electric Vehicle Alliance
- 🏔 (KEVA) is promoting electric vehicles
- 🏔 ICIMOD studying transboundary air pollution
- 🏔 Studies being done by IGES, IUCN



## References

[http://www.adb.org/Vehicle-Emissions/NEP/docs/Kathmandu\\_Air\\_Quality.pdf](http://www.adb.org/Vehicle-Emissions/NEP/docs/Kathmandu_Air_Quality.pdf)



# Getting to know the SAFA Tempo

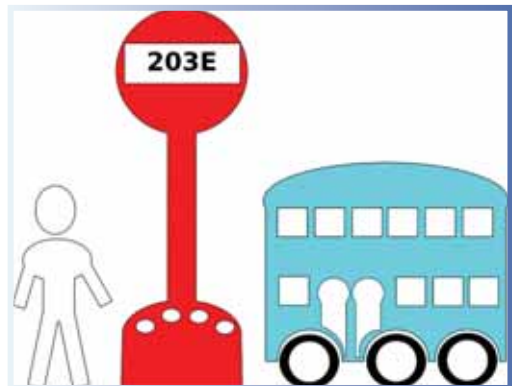


*This activity will run for*  
**half day session**

## Background Summary

Traffic moves slowly in Kathmandu’s ancient and narrow city streets and distances travelled are relatively short. Currently, there are 3,500 three-wheeled vehicles, tempos, clogging Kathmandu’s streets. These three-wheelers are the most common form of public transportation in the Kathmandu Valley. They account for 25 percent of all vehicular traffic in the city and contribute over 60 percent of vehicular emissions. A very conservative estimate of the cost of this level of air pollution is \$10 million per annum in lost worker productivity, health care costs, and losses from tourism. Electric vehicles provide an exceptional opportunity to reverse this trend.







The increased awareness on the need to invest on sustainable urban modes of transport and the investment opportunities associated with it has sparked the growth of a dynamic private sector. Recently, the government has reduced duties on electric vehicle components and reduced income taxes for investors. Nepal is poised to take the lead in importing, manufacturing, assembling and operating appropriate types of electric vehicles. To encourage development of this nascent industry, development organizations are assisting investors to establish viable electric vehicle enterprises, establishing training programs for technicians and operators, and lobbying government for additional incentives for investors.



This activity aims to conduct a field visit in Nepal Vehicle Industry Company in order to learn more about the electric vehicle industry and promote sustainable urban transport in Nepal.






## Procedures

-  Coordinate with the Electric Vehicle Manufacture Company to schedule a field visit. Make sure that there is a representative from the organization who can briefly explain about electric vehicles to students.
-  Prior to the scheduled field visit, ask the students to read the Electric Vehicle Fact Sheet.
-  After giving them enough time to read, initiate a discussion focusing on the need of electric vehicles in Nepal, the issues being faced in the implementation of vehicle operators and the current status of initiatives to promote electric vehicle in the country.
-  Tell the students that today, they will visit the Electric Vehicle Manufacture Company to learn more about the *safa tempos*.
-  Ask the students to list down questions that they need to ask to the operators during the field visit.
-  Request the students to prepare a field visit report.

## Learning Objectives

Students will learn about the

-  technical aspects of electric vehicles,
-  experiences and challenges related with the *safa tempo* operations,
-  existing project initiatives that provide assistance to the electric vehicle sector,

## Resource Materials

### ***Electric Vehicle in Kathmandu Nepal***

Increased number of the diesel vehicles in the street of Kathmandu is the major cause of the air pollution. In addition to this, urbanization, industrialization and the congested roads are also the causes of the air pollution. Use of zero emission vehicles can combat the air pollution in Kathmandu valley. In context of Kathmandu valley, electric vehicles are the most suitable and proven means of transportation.



### *History of EV in Kathmandu Valley:*

Significant Years	Significant Milestones
1975	Trolley bus system was introduced by Chinese government along 13km route between Tripureshowr and Surya Binayak.
1975 –1989	Fuel crisis took place as a result of trade embargo imposed by India.
1992	The Electric Vehicle Development Group converted an old car into an EV in 1992.
1993	The Global Research Institute with assistance from USAID, converted 7 diesels operated three wheelers in EVs, and operated successfully as a public vehicle for six months.
1996	A group of Nepali professionals and entrepreneurs bought the 7 EVs and started the first EV company in Kathmandu.
2001	Trolley bus was closed down.

### *SAFA Tempo - Three Wheeler Electric Vehicle*

SAFA is a Nepali word for clean. Here SAFA tempos are the first electric vehicles in Kathmandu. It was introduced in Nepal in 1996. Currently there are more than 600 SAFA tempos in Kathmandu valley alone. Around 120,000 passengers benefit on a daily basis from the service provided by the SAFA tempo in 17 different routes within the city. The EV industry in Nepal consists of five manufacturers; Nepal Electric Vehicle Industry (NEVI), Electric Vehicle Company (EVCO), Green Electric Vehicle (GREV), Green Valley and Bagmati Electricals. There are thirty seven charging stations and several hundreds of vehicle owners. Private sector has invested more than NRs. 450 million in this industry. The higher operating cost of the electric vehicles (NRs. 11.62/km) in comparison with the Liquid Petroleum Gas operated three wheelers (NRs. 6.17/km) and petrol vehicles (7.06/km) have made the entrepreneurs difficult to survive. The high tariff rate and the high cost of battery are the main reasons of its high cost. Despite of the high cost of the SAFA tempo, Kathmandu valley provides technical feasibility for the promotion of these vehicles.



Around 120,000 passengers benefit from the service provided by three-wheel SAFA tempos on a daily basis. Kathmandu perhaps has more number of battery-powered commuter electric vehicles than any other urban centers in the world.

The EV drivers get NRs. 4,000 to NRs. 5, 000 per month. The tempo owners need NRs. 6000 – 7000 per months for charging and NRs.10, 000 per month for depreciation of the batteries.

When the batteries are new, the SAFA Tempos can get a range of 70 or more kms. But, due to the aging, the capacity of the battery is reduced and the SAFA Tempo can cover only about 55 kms. Many owners cannot afford to buy new batteries and the suppliers are giving a warranty period of only 6 months. It is said that about 50 to 60 SAFA tempos are grounded, since the owners cannot afford to buy new batteries.

### **Government Policies for EVs**

Although the government policies are contradictory, the overall impression is that they are favorable. The plan to expand the trolley bus system was mentioned in all the five year plans since the sixth plan but this never happened

The National Transportation Policy 2001 has mentioned that environmentally friendly electric vehicles shall be promoted but the government has stopped registration of new SAFA tempos in Kathmandu has been stopped. Instead, hundreds of diesel vehicles and other vehicles continue to be added every day. Government is also creating unnecessary problem to private entrepreneurs who are willing to introduce four wheeler EVs.

The government does not charge any Value Added Tax (VAT) and only one percent custom duty for import of SAFA chassis, engine, motor, battery, and battery charger for the SAFA Tempo,. Similarly electric vehicles are not required to pay annual vehicle tax. Imposition of 10% VAT on locally manufactured EV is still a matter of dispute between entrepreneurs and the Government (Department of Revenue)



### **Advantages of EV**

- ▲ Zero emission thus less pollution
- ▲ Low noise level
- ▲ Short distances & low speed – thus appropriate for Kathmandu where streets are narrow, traffic speed is low and travel distances are short
- ▲ Promotes the use of clean energy (hydro-electricity) thus reduces the use of fossil fuel.
- ▲ Uses off peak hour electricity since battery are charged during nights.
- ▲ Local industry - creates employment for local people.
- ▲ Attract tourists.
- ▲ Revenue source for government from the sale of electricity.

The Ministry of Environment, with the assistance of DANIDA has established a Clean Vehicle Fund, under a project to support the EV sector, to support R&D and promotion of EVs. In the past, MoE with the support of DANIDA also provided some easy loan plans (up to 70%) to establish two battery charging stations in Lalitpur and to procure 48 EVs for private owners.



## Format for Field Visit Report

1. Background
  - Why is this field visit being organized? If you are going to visit an electric vehicle manufacturing company, can describe the role that Electric vehicles play in the context of Nepal or Kathmandu?
2. Description of the field visit site such as location and other relevant information
3. Description of technology that were explained during the field visit
  - Benefits
  - Disadvantages
4. Document Questions and Answer sessions during the field visit
5. Lesson Learned or your personal experience/observation
6. Conclusion
7. Annex : Photographs

## References

*CEMAT 2002: Study for Revival of Kathmandu-Suryabinyak Trolley Bus System, Winrock International, Kathmandu, Nepal.*

*Markus Eisenring, 2000, Assistance to the Electrical Vehicle Sector in Nepal (Report submitted to Swiss Development Corporation, SDC), Kathmandu, Nepal*

*Martin Chautari 1999: Bottlenecks in the Proliferation of Electric Vehicles in Nepal (Report Submitted to REPSO/Winrock International, Nepal), Kathmandu, Nepal.*

*CEN, 2002, "Fact Sheet on Electric Vehicles in Kathmandu" Clean Energy Nepal, Kathmandu.*  
<http://www.energyhimalaya.com/energy-efficiency/transportation.html>



## Field Visit 2

# Vertical Shaft Brick Kilns VSBK

### Vertical Shaft Brick Kilns (VSBK)

The construction sector in Nepal is booming because of rapid urban growth. Bricks are still the major building material in many parts of Nepal and will remain so in the near future as well. The brick industry is the single most important building material producer in Nepal and is a highly energy consuming sector also.

The traditional Bhuse Bhatta (clamp kilns) used to be the dominant technology to produce bricks in Nepal. With the technology shift movement initiated in early 1950, traditional clamp kilns were replaced by Bull's Trench Kiln. The common type of Bull's Trench Kiln (BTK) is either movable chimney (MCBTK) or fixed chimneys (FCBTK). These kilns use coal as the main fuel for firing of bricks. The traditional BTK technology has inefficient fuel burning process resulting high consumption of coal during brick firing work. Because of this, the main problem associated

with the BTK is the excessive local air pollution as well as their high greenhouse gas emissions. Local people often complain about brick kilns for the high local pollution that they cause. In response to public pressure, Government of Nepal has banned the use of MCBTK in the Kathmandu valley and brick entrepreneurs made their shift towards Fixed Chimney BTK (FCBTK). FCBTKs emit less air pollutants compared to the MCBTKs but still use almost the same excessive amount of coal per brick. But MCBTK is still dominant technology in other parts of Nepal.



In a bid to reduce environmental pollutions and GHGs emissions caused by BTK, various cleaner and energy efficient technologies are being promoted in Nepal. Vertical Shaft Brick Kiln is one of such technologies. As compare to BTK, Vertical Shaft Brick Kiln (VSBK) is more energy efficient technology that reduces greenhouse gas (GHG) emissions and local air pollutants significantly. The air pollution emissions from VSBKs are within the permissible limit of the government's emission standard.

Vertical Shaft Brick Kiln (VSBK) technology is common in many countries including China, Vietnam and India. It has now been introduced in Nepal as well by **Vertical Shaft Brick Kiln/Cost Effective Social and Environment-Friendly building material (VSBK/CESEF) Project Nepal**.

Although VSBK is energy efficient and cleaner technology, entrepreneurs in Nepal are not being attracted towards it due to its high initial investment and lower returns compared to BTK.

For detail information please visit: <http://www.vsbknepal.com/>



## Field Visit 3 Biogas and ICS

### The Biogas Plant

Biogas is the mixture of gas produced by methanogenic bacteria while acting upon biodegradable materials in an anaerobic condition. It is mainly composed of 50-70 percent methane, 30-40 percent carbon dioxide, and some other gases. It is about 20 percent lighter than air. It is an odorless gas that burns with clear blue flame similar to that of LPG gas.

The biogas plant construction under Biogas Sector Partnership Nepal (BSP-Nepal) has following characteristics:











-  Fixed Dome (GGC 2047 Model)
-  Sizes 2, 4,6 and 8 cubic meters
-  Feeding materials:
  - Cattle dung & water
  - Human excreta
-  Individual household plant
-  Feasible up to 2,100 meters altitude
-  Modified GGC-2047 with heap composting technique is recommended for up to 3,000 meters altitude.



Photo © Winrock International, RESPO Nepal Office

### Savings and Generation from Biogas Plants

-  Fuel wood saving (tones/year) - 335,344
-  Kerosene saving (liters/year) - 5,365,258
-  Bio-compost fertilizer produced (tons/year) - 285041
-  Total employment in biogas sector- 11,000



**Source:** <http://www.bspnepal.org.np/biogas-design>

## The Improved Cook Stoves



The traditional biomass fuel is burnt in the rudimentary stoves (three stones or tripod stoves), with poor combustion process and lacking chimneys completely. Hence, the rudimentary cooking stoves are responsible for over consumption of fuel wood and indoor air pollution. The exposure to indoor air pollution (IAP) has been a serious health risk for women and children as cooking generally takes place inside the houses with little ventilation.

Improved cook stove (ICS) is a device that is designed:

-  to consume less fuel wood through increased thermal efficiency
-  to create smokeless environment in the kitchen with help of chimney attached to Cook Stove

**For Further information please visit:**

[http://www.aepc.gov.np/index.php?option=com\\_content&view=category&layout=blog&id=73&Itemid=94](http://www.aepc.gov.np/index.php?option=com_content&view=category&layout=blog&id=73&Itemid=94)

<http://www.crtnepal.org/>

<http://cen.org.np/>







**Clean Energy Nepal**

108 Vinayak Marg, Kamaladi Ganeshthan

PO Box 24581, Kathmandu Nepal

Tel : +977 01 4257481/0169115649

Email : [cen@mos.com.np](mailto:cen@mos.com.np)

URL : [www.cen.org.np](http://www.cen.org.np)