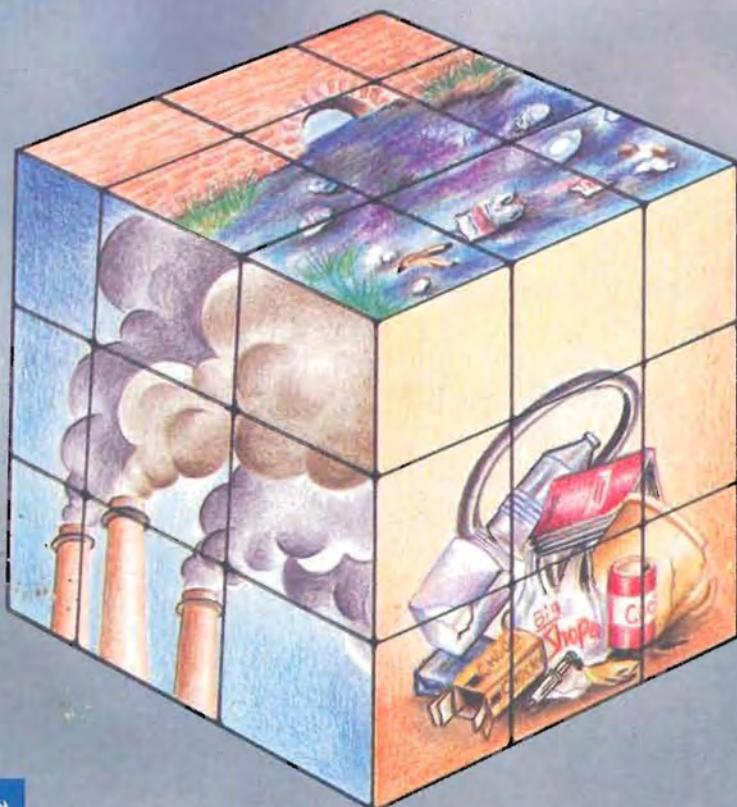


# Puzzling Out Pollution

Meena Raghunathan  
Mamata Pandya



A Centre for Environment Education Publication  
for South Asia Co-operative Environment Programme





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## About the Project

This book is one of a series of four books for children on environment-related themes. The series was commissioned by South Asia Co-operative Environment Programme (SACEP). The books have been developed and produced for SACEP by Centre for Environment Education, India.

**Centre for Environment Education (CEE)** is a national institute of excellence for Environmental Education supported by the Ministry of Environment and Forests, Government of India and affiliated to the Nehru Foundation for Development. The main objective of CEE is to create environmental awareness among children, youth, decision makers, and the general community. CEE develops innovative programmes and materials and field tests them for their validity and effectiveness. The aim is to provide models that could be easily replicated to suit local conditions.

CEE is also the Subject Matter Area Focal Point for Environmental Education as designated by the Government of India and approved by the Governing Council of SACEP.

**South Asia Co-operative Environment Programme (SACEP)** is an Intergovernmental Organization of 9 South Asian Countries namely Afghanistan, Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan and Sri Lanka. It was the culmination of two years of deep deliberations by the concerned countries on the feasibility of regional co-operation on environmental oriented development activities. It became a legal entity in 1982. SACEP is also the only specialized institution in South Asian Region concerning the formulation and implementation of Environmental Projects and Programme Activities.



# What is Pollution?

We hear about it, read about it, talk about it, add to it. But how much do we really know about it?

What is pollution?

How does it happen?

Why make such a fuss about it?

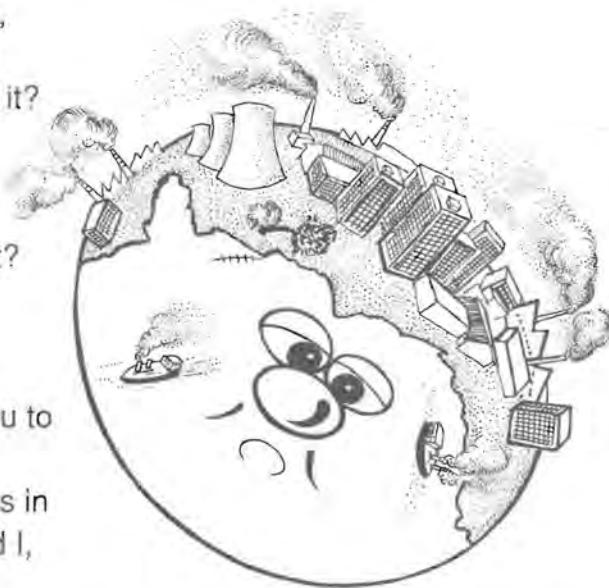
Who is responsible?

What can be done about it?

Here is a book that will help you to find some answers to these questions. And to suggest ways in which every one of us—you and I, can help to reduce pollution.

Let's begin by taking a look at what pollution is.

We can think of pollution as any undesirable change in the environment, that can have harmful effects on living and non-living things. So pollution could be caused by a factory chimney belching smoke into the atmosphere; by an industry letting out dirty water into a pond; by you or me throwing our garbage out into the street; it could be loudspeakers blaring, it could be posters stuck all over a building.



Some pollution causes physical harm to humans, animals, birds, insects or plants. Some types of pollution harm the atmosphere or soil or water. Some other types may harm buildings and other structures created by man. Some types, such as noise pollution, have an effect that may be psychological. Some effects of pollution are immediate, while others take a long time to show up. Whatever its cause and whatever its effect, pollution is not good—not for the environment, and not for us.



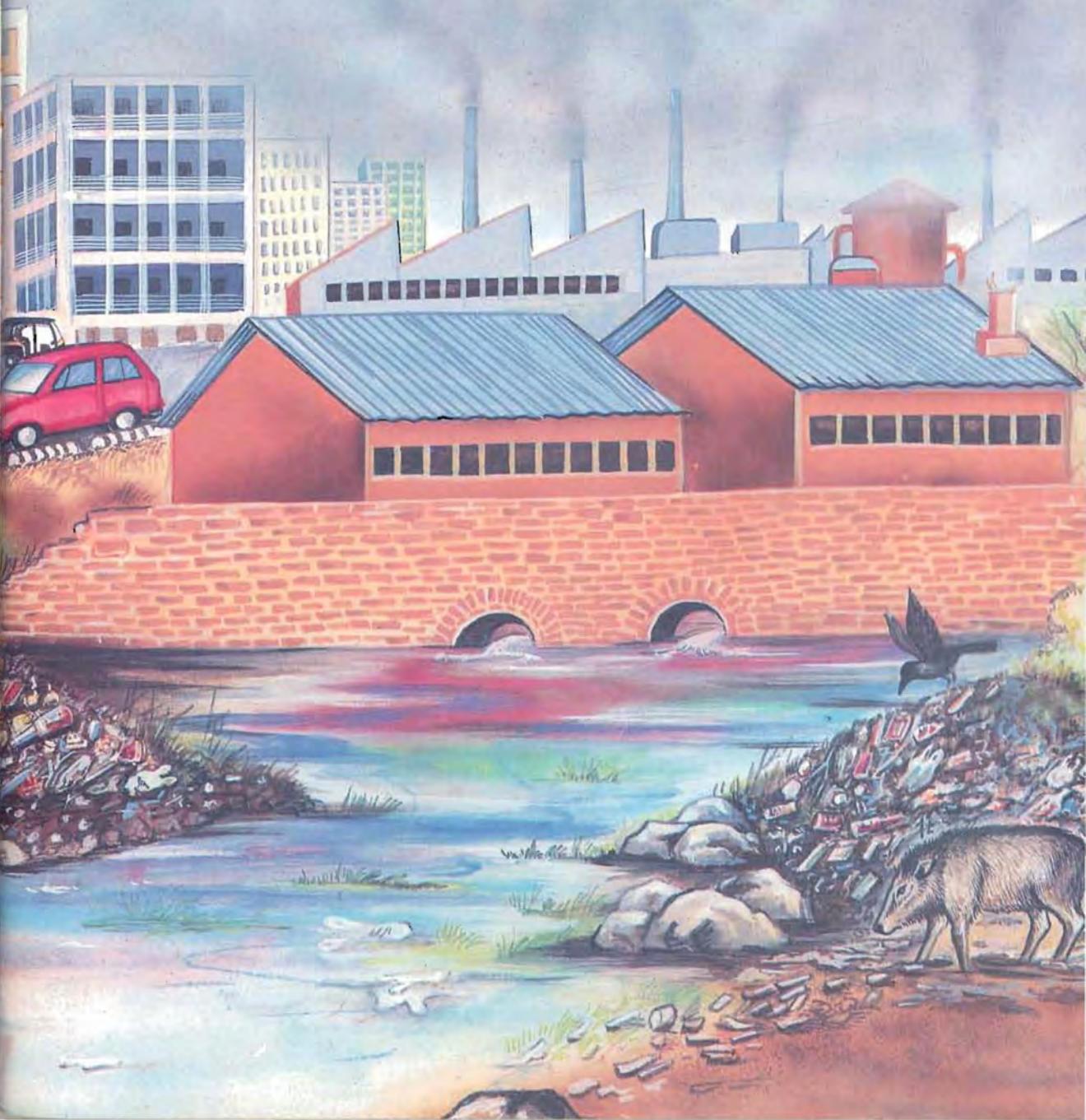
What is Pollution?

## Be a pollution detective

There are at least five sources of pollution in this picture.  
Can you spot them?



## What is Pollution?





## History of Pollution





## Pollution : Past, Present, and Future

Pollution has been around for a long time—in fact for as long as humans have been around. But for thousands of years it was not a problem. There are many reasons for this.

In the past, most of the waste from human activities could be handled by the earth's natural systems. That was because many of the things thrown away in the past centuries were made of natural materials. That meant that they would decompose easily. Also, there were fewer people around. So the total amount of waste created was not too large.

Gradually as settlements grew larger and turned into cities with large populations, the wastes increased too. Transportation was revolutionized with the invention of the internal combustion engine. Which burned fossil fuels and added to air pollution.

Technological inventions made life easier than before. Factories sprouted up and began producing goods in large quantities. But they also began to spew out their

wastes into the air, into the water and on to the land.

More and more synthetic chemicals were invented. Plastics began to replace almost every kind of natural material. And pollution started taking its toll.

So the amount, as well as the kind of waste generated changed a great deal. A century ago people were dealing with pollution mainly from animal waste, household waste and coal ash from burning some of this waste.

Today, we have to deal with an onslaught from many sources, and of many types—from pesticides, fertilizers, carbon monoxide, radiation, and an army of new chemical and synthetic materials. Combined with the ever exploding populations, and ever-increasing consumption, pollution has become a threat to the fragile life-support systems of the earth.

Today almost every human activity from how we get around, to how our goods are produced, to how we grow our crops creates some type of pollution. Let's see how.



## Breathing it in

Take a deep breath. What did you take in? Air, of course: a mixture of mainly nitrogen and oxygen, with small amounts of carbon-di-oxide, argon, water vapour, etc. But did you know there are lots of other things in the air—things that should not be there? A lot of these invisible substances are harmful when they are present in large quantities. They dirty the air and our lungs. They hurt wildlife and plants. They turn rain into acid. In other words they pollute the air. Polluted air contains too much of some things that hurt living and non-living things. These are called pollutants.

Where does all this come from? Most air pollution is caused by people burning things—coal, oil, wood, and other fuels. These are called fossil fuels. People need to burn these fuels to run power plants, factories, and vehicles, to light, and cool and heat homes and offices.

Let's find out about some of the things that are dirtying the air.



## Big Bad Six

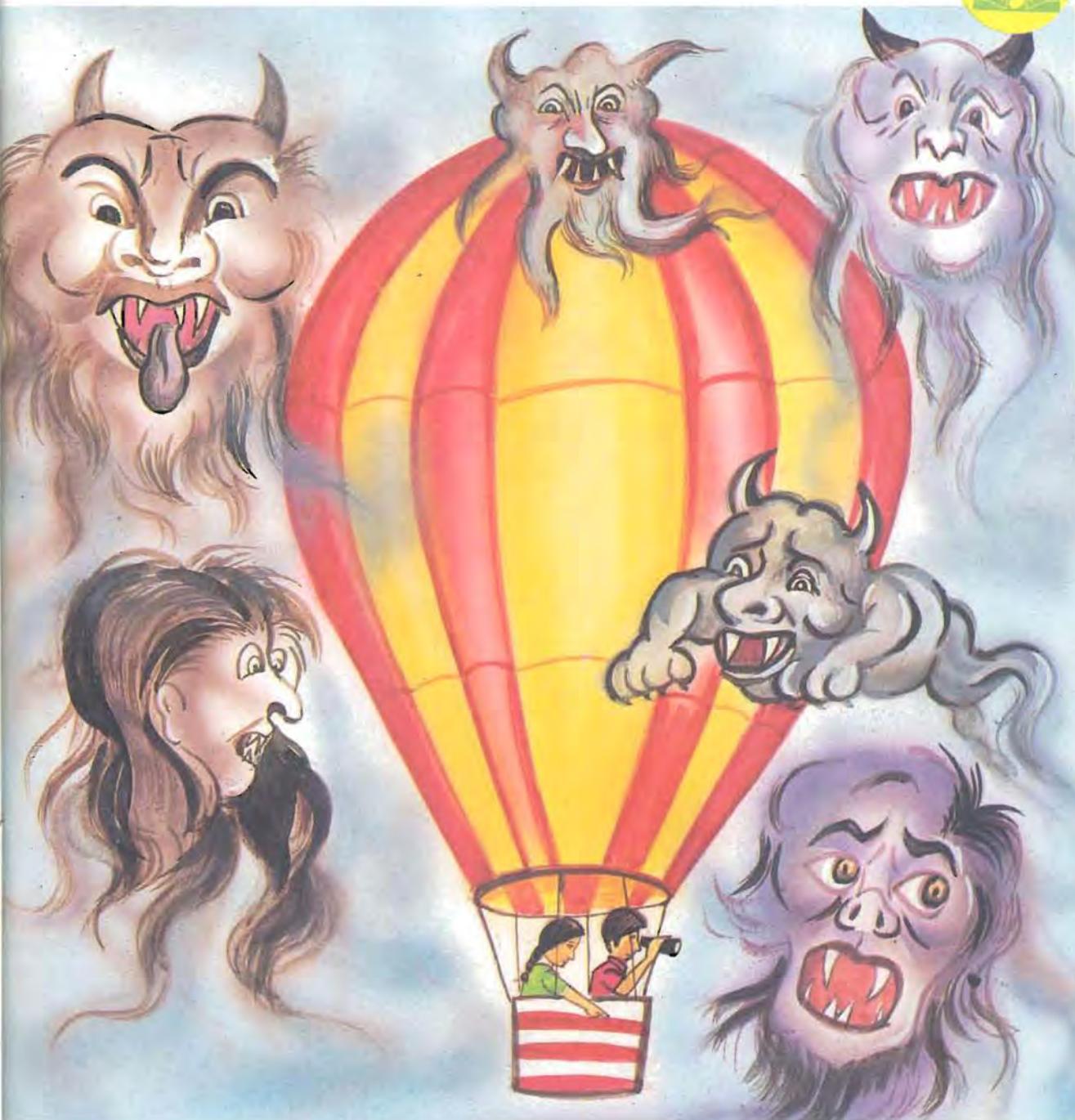
"Oh, Oh! It's very crowded up here. All we could see from the ground was a hazy grey curtain. Who'd have guessed it is so active up here? Hey, who are all of you and what do you do?"

"We are the Big Bad Six, and we just love to hear all that sniffing and coughing down below. Let's tell you more about ourselves."

**The PT gang:** "We are the particulates (PTs for short). We're the dirtiest bunch in the air. We are bits of dust, soot, and grime that fall from the sky. We're sent up into the air by almost anything that burns. And we do our dirty work no matter where we are or where we land.

"While we're in the air, our favourite trick is to dirty up the sky. We keep you from seeing as far as you could on a clear day. We try to block the sun's rays so that they can't warm the earth and help plants grow.

"When we float around, we have other tricks to play. If people





breathe in enough of us, they can get a cough and sore throat. Some people may get even sicker when we get into them.

"There are lots of things around that send us into the air. People have built plenty of power plants that make electricity. Many of those power plants burn coal, which send tonnes of us into the sky. And there are millions of cars, scooters, trucks, and buses on the road. Some of them burn diesel fuel, which sends some of the worst of us into the air. Wood and coal burning stoves send lots of PTs flying too. We just love to make a clean neighbourhood into a sooty mess."

**Big Sneak:** "Heh, heh! Those PTs think they're so tough! I'm carbon monoxide, but I go by the name of Sneak. I'm in the air all around you, but you can't see me, and you



can't smell me. I'm one of the nastiest gases that gets into the air when combustion is incomplete. I sneak out into the air from vehicles and when kerosene, coal or wood stoves are used.

"When I'm in the air, I can cause headaches or make people feel tired. Sometimes people who breathe me can't think as easily or move as quickly as they usually do. And I sneak up on animals in much the same way. Hee, hee! I must sneak off now..."

**Super-Nasty SO<sub>2</sub>:** "Look at that! Even Sneak runs when I come near! My name is Sulfur Dioxide—SO<sub>2</sub> to you. And I can be super-nasty because I can travel for hundreds of kilometres to cause trouble.

"I get thrown into the air when power plants and factories burn coal for fuel. And as the PTs pointed out, there are lots of coal-burning power plants!

"All by myself, I'm a pretty nasty pollutant. I can make breathing very hard for some people. And I can hurt plants and trees too. But I cause even bigger problems when I mix with water in the sky. Then I become the terror that you call



acid rain. Acid rain can slowly kill creatures in lakes and rivers, and it can harm plants and trees. Acid rain is so rotten, it can even eat away at metal and some kinds of stones on buildings and statues. Imagine meeting someone even nastier than that!"

**Tricky Noxes:** "Ha! Finally it's our turn to talk! We're the nitrogen oxides, a tricky bunch of gases. We irritate your eyes and lungs. "But believe it or not, we're bad only part of the time. When we're being really good, we help plants grow strong. But we can cause trouble if too many of us are around. And when we mix with other things, we can turn into dragons! Noxes have another trick too. When we mix with certain other gases, we help make the next member of the Big Bad Six."

**Ozone Ogre:** "I'm ozone, and I can be an awful pest. What is needed to make me is nitrogen oxide, sunshine and a few other chemicals. And where there's ozone, there's smog—dirty air that isn't good for anyone.

"Too much ozone harms more than just people. Trees grow more slowly when there's a lot of me in

the air. Other plants also don't grow as well, nor do they make as many seeds or fruits.

"Animals are hurt by me too. Just like people, they probably have trouble breathing in smoggy air. And they also may not find enough food if I've harmed the plants they need.

"As bad as I am, I'm the good kid compared with the last member of the Gang."

**Dread Lead:** "The rest of the Big Bad Six are nothing compared with me. I'm lead, and I can be a real troublemaker for people who breathe too much of me. I can get into their bodies and harm them in a lot of different ways. I'm specially bad for you kids because I can even affect your brains. Animals don't escape me either.

"Most cars and scooters use leaded petrol to run, and when this petrol is burned, I go sailing out into the air. Today in some countries vehicles run on unleaded petrol. But there is still plenty of leaded petrol being sold. So I'll probably be a member of the Big Bad Six, especially in cities, for some time to come."



# Pollution Patrol

### What's in the air ?

Take two sheets of white paper or two glass dishes.

Smear them on one side with petroleum jelly. Place the sheets or dishes next to each other, on a window sill or paste them on the outer wall of your house. The sticky side should be on top. Take in one sheet at the end of one day. See how dirty it looks compared with a

clean sheet. Save the dirty sheet.

Take the other sheet in after a week. Compare it with the first sheet. How dirty is the air in your neighbourhood?

Tell your friends to do the same. Whose neighbourhood has the dirtiest air?

Which of the Big Bad Six do you think is responsible for most of the pollution in your neighbourhood?

This bird is lost in a cloud of pollution. Help it to reach its nest through the maze.





## Pollution Fossils

Fossil fuels generate most of the energy used almost through the world.

Fossil fuels are the source of power behind a lot of things we do today like driving a vehicle, running a factory, or generating electricity in a power plant, even cooking on a wood, kerosene or coal burning stove.

Fossil fuels get their name from the fact that they formed from the remains of ancient animals and plants—or fossils, as they are called.

To get the energy out of fossil fuels, they have to be burned. The process by which the burning of these fuels generates

energy is called combustion.

During fossil fuel combustion, some dangerous gases are produced. The most toxic or poisonous of these are carbon monoxide, carbon dioxide, nitrogen oxides and sulfur dioxide.

Fossil fuel combustion that takes place in diesel engines and power plants releases not only these gases, but also tiny bits of dust, metal, soot and other materials. These are called particulates. Wood burning stoves also produce large amounts of smoke and ash which also contribute to pollution.

You have just met some of these villains.

**Use the secret code given on page 48 to fill in the boxes below with the correct letter. The filled boxes will reveal the names of fossil fuels, the burning of which contributes to air pollution.**

16	5	20	18	15	12	5	21	13

14	1	20	21	18	1	12	7	1	19

15	9	12

2	15	1	12



# What's the Matter with the Water?

When something is added to the environment, that should not be there, it may cause pollution. If pollution occurs in fresh water or salt water it is called water pollution. Water in a pond, lake, river, stream or ocean can get polluted. So can the water which is under the ground, as in wells and reservoirs.

Pollutants reach water in many ways. A pipe from an industrial plant or sewage treatment plants may drain directly into the water. But pollutants can also enter water indirectly. For instance, water that drains off from fields, gardens, or city streets, located quite far from the water body may carry sewage, chemical pesticides or fertilizers and can pollute it. Let's dive into the water and find out what exactly gets carried into it, and what it can do.



## Water Villains

"Oh, oh, here come some dangerous looking characters! They're not fish. Who are they?"

**Microvillis:** "We are a deadly army. You can't see us but we can play havoc with your health. We are the bacteria and viruses that spread dysentery, hepatitis, typhoid and other diseases that you can get when we get into you with the water you drink. And we get into the water with all the sewage (that's human and animal waste) which is not treated in a treatment plant.

"We need lots of oxygen and try to grab as much of it as we can from the water, so we don't let too many other things thrive in the water with us."

**Oxyhogs:** "Ha, look who's talking about oxygen grabbing. Well you can't beat us at that. We're the team of Nitra and Phospa. That's short for nitrates and phosphates. We come in with all the water from fields which have been fertilized,



specially with chemical fertilizers. And from all the water used to wash clothes with phosphate containing detergents. We help lots of algae to thrive. And when these algae die and decompose, they draw more and more oxygen. So when you see that green film on the water, you can be sure we're hard at work."

**The Slimes:** "Who's that talking about film on water? If you really want to see film, try us. We're the oil that won't mix with the water. People only remember us when we make the headlines in the news: you know, like when there's been an accident with an oil tanker and there's an oil spill. But no one realizes that we are always at work, sliming our way into the seas and oceans from the tankers when they clean out their tanks, from oil refineries, and even washed away from city streets.

"And then just imagine the state of all those creatures that live in the water. They can't help take us in, but they sure can't digest us. And boy, does it kill them! That's the inside story. We can ruin birds' feathers and the fur of animals."

**The Acidos:** "What's so great about being slimy? We are even more sneaky. We fly in with the air and mingle with the rain to join the waters of lakes and streams. Then we work to make the water acidic. We call ourselves acid rain. When we arrive with the rain and mix with the water, the plants and animals living in it could get pretty sick. Sometimes we are joined by other sneaks that also use the air to travel many kilometres to reach the water. These poisonous substances too can kill animals and sometimes even humans who may eat these affected creatures."

**The Creeps:** "If the Slimes and the Sneaks think they're nasty, they can't beat us for sheer variety and numbers. We are chemicals.

There are thousands of types amongst us, and hundreds of ways by which we creep into the water—some direct, some indirect, and some not even intended. We flow in with the water that runs off fields sprayed with pesticides, from factories, from drains. Once in the water, we can outright kill fish, birds and animals. We can



also be more sneaky by gradually collecting in the bodies of the fish or bird or animals for many years and showing our nasty effects much later."

**Dirty Dozen:** "We don't slime or sneak or creep. We just choke. We are the silt and dirt, disturbed by bulldozers, trucks and heavy machinery, that flows into the water from construction sites and other land areas. We can block sunlight from entering water, and

that can kill water plants. We can clog gills of fish, and we can smother small creatures that live at the bottom of the water body."

**Water Villains:** "Aren't we a dangerous gang? Once we're around, there is no escape! Why, most of us can even seep through the ground to infiltrate the water that's underground. That's the water you get from your wells and through the water pipes. So look out."



# Pollution Patrol

## Water Watch

Is there a body of water near your home or your school? It could be a small pond, or stream, lake, a river, or even the ocean. Take a closer look at it.

Is there anything unwanted floating on the surface? How dirty are the banks? Are there any pipes leading into the water? Do people dump garbage around the water? Do they

bathe or wash clothes there? Or maybe bathe their cattle? Or wash trucks or tractors? Are there fields or factories around the water?

Where does the sewage from the nearby houses go?

Try to find out answers to these questions and you will discover which of the water villains are finding their way into the water in your neighbourhood.

This fish has lost its way in the polluted ocean. Can you help it safely through?





## What Rubbish!

Solid waste is whatever we throw out in a semi-solid or solid state. It is what we throw out of our homes, schools, offices, hospitals, etc. This is called municipal solid waste. But besides this, there are huge amounts of solid waste from factories and industries (scrap metal, plastic, paper, ash from power plants, sludge, etc.) and mines, (piles of rock, dirt, sand, etc.) and even from agriculture (manure and plant leftovers). Let's take a closer look at what makes up solid waste. What we call garbage or rubbish.

### The Trashy Company

"Oh, oh! Here I go again! I forget to look where I'm going. And I find myself ankle-deep in garbage. Yuck! What's all this muck?"



**Kitchen Gang:** "Welcome to the giant dustbin. We are the kitchen gang: the peels and the cores, the egg shells and the food left-overs that everyone throws out of their kitchen. We're a nuisance if we are thrown out on the roadside because we smell bad and attract flies, dogs and rats.

But actually we're the good guys of the bunch, because left to ourselves we quickly decompose, helped by lots of little creatures, and become a part of the soil. In fact, some smart people make what they call compost pits in their gardens and put us in there. We love it in those pits where it is dark, moist and warm. After we've turned into compost, they spread us out in the garden where we help the plants to grow. But there are some people who are even smarter. They never seem to waste food. They don't leave leftovers, and even eat many fruits with their peels. There is not much of us coming out of such houses."

**Leafys:** "We're related to the Kitchen Gang because we're



biodegradable too—that is, we get broken down by natural processes and become part of the soil. We're leaves, grass clippings, twigs and other things from the garden. If people were smart enough to put us into compost pits, we'd be happy to work for their soil. But many don't. They just pile us up and leave us. We love that, because then we can fly around and have a riot. And if they decide to burn us we can really pollute the air and make everyone cough."

**Plasticats:** "Poor biodegradables! They think they cause trouble. But we're the real villains of the gang. We are almost indestructible. We are the plastic bags that people use to carry things in, and then throw away.

We're the plastic bottles and jars in which so many things are packed nowadays—shampoos and creams; jams and spices. People love to buy us because we look so good sitting on the shelves. And they think we are practical to use and dispose off.

Well, we think we look good lying on the garbage heap too. Only when we really pile up, people

don't think so. But there's not much they can do, because if we are burnt, we give off deadly fumes. Unlike our biodegradable friends, no creatures can break us down. So like it or not, once they throw us, we're there to stay!"

**Compositicats:** "The Plasticats think they're something. But they don't tell you that most of those plastics can be recycled. Used plastic bottles can go to a factory and come out as buckets or balls or mugs. Sure these factories too cause pollution, but so what?

We're the ones who are really indestructible. We are the composites—that is, we are made of two or three different materials like cardboard, some kind of plastic, metal foil, etc, all joined together tightly. Many soft drinks, edible oils, milk and other things are being packed in us these days. Because we're made of more than one material, we are usually not easy to recycle. And, of course parts of us are non-biodegradable—that is, we don't break down through natural processes. So we're going to be around for ever and a day!"

**Brickbats:** "Listen to all these lightweights talk! A few here, a few there. But us, we're the real heavyweights! We are all the broken bricks and cement, mortar and stones that lie around when a building is broken down. There's tonnes of materials that comes down and then has nowhere to go. So we lie on roadsides and vacant sites, just piling up. How about that?"

**Infectos:** "Silly lumps of bricks lying around! But if you want style, come to us. We're the dirty bandages and cotton, injection needles and medicine containers from hospitals and homes. We're great at spreading infections, but no one pays much attention to us. All the better—we can get on with our jobs. We are thrown out of

hospitals but sneakily work to get more people ill, and into hospitals! And that means that more of us get thrown out too. Funny isn't it?"

**Toxicos:** "We are the nastiest! We're the poisonous stuff thrown out of here and there. We lie around in rubbish heaps waiting for the rain or some water to come by and then our poison just gets washed out into that water. And travels far and wide. We end up in the soil where your vegetables grow. Maybe even in a pond near your house. Maybe in the river flowing nearby. And then we can get really nasty! Around homes, we Toxicos are mainly the used batteries, the leftover paints, the insecticides, some of the cleaning agents, and other chemicals that you throw out, often unthinkingly."





# Pollution Patrol

## Waste Watch

How much waste does your family generate in a day or a week?

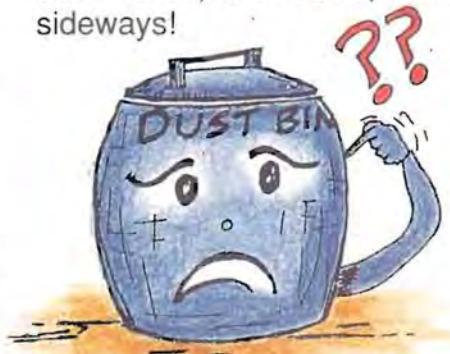
Keep track of the contents of your dustbins. Check at the end of each day what's in the bin, and how much. You are sure to meet some or all of the Trashy Company. Are there vegetable peels and tea leaves, aluminium foil or cans, soft drink packets or plastic bags?

Which of these are the most in terms of number or weight? How many Infectos and Toxicos are lurking in your own home? Observe, classify and record for a week. At the end of a week, review. How much of the waste could have been avoided? How much reduced and how much reused? Share your findings with your family. Work out strategies to deal with the Trashy Co.

B	A	I	R	S	A	N	S	Y	M	E	N
M	A	M	A	Z	B	P	A	P	E	R	F
P	I	N	E	S	U	P	O	T	D	O	G
A	D	U	D	I	L	S	J	K	I	D	S
I	N	I	T	A	K	U	L	T	C	A	P
N	R	V	S	C	G	O	D	O	I	E	M
T	O	T	I	L	A	E	O	G	N	A	L
S	I	R	M	A	S	I	S	O	E	V	E
C	B	A	T	T	E	R	I	E	S	E	A
O	H	S	Y	R	I	N	G	E	S	E	V
C	R	H	T	A	S	T	E	S	C	A	E
A	C	T	N	O	B	O	T	T	L	E	S

## Dig out the Trashy Company

Several members of the Trashy Co. are hiding in this box. See if you can find and circle them. Just a hint—the names could read upwards, downwards, backwards, forwards or sideways!



Answers on page 48



## Radiating Danger

Radiation is the passage of energy through matter and space. This may be in the form of waves or particles. When this energy passes through matter, it can cause changes. When some types of radiation pass through living cells, they may cause damage to them. Sometimes this damage may be in the form of problems which may show up during a person's lifetime—e.g. cancer, burns, etc. Sometimes it may alter genes and chromosomes—the effect of which may show up only in succeeding generations. Here are the culprits singing their own song! Let's hear what they have to say.

### The Song of the Energetix

We are the Energetix  
The unstoppable radiation.  
The alphas and the betas,  
And the powerful gamma rays.  
All of us whom folks call  
R-A-D-I-A-T-I-O-N.  
Some of us can penetrate skin  
Some of us can penetrate bone.  
Just give us a chance  
We'll get up to some nasty  
mischief!

We don't care what's in our way  
We just try to go right through!  
People think we're only where  
There are atom bombs and  
reactors,  
How very, very wrong they are!  
Because some amount of  
background radiation  
Is natural and always there!  
But people, they don't realize that!  
And they don't realize that  
X-rays are also a part of our gang!  
We are the Energetix!  
Some can zap your body cells.  
Some can cause cancer  
And meddle with genes too!  
We're the nastiest, the nastiest.  
The nasty Energetix...



## Vehicle Wise

Emissions from vehicles in a city like Delhi amount to almost 800 tonnes/year.



Motor vehicles burn petrol or diesel, and pollute the air we breathe.

A scooter can transport 2 people a distance of about 50 km per litre. A bicycle can do it for nothing.



Use public buses where possible. A bus can carry 52 people a distance of 4 km. for only 1 litre of diesel.

If you must use private vehicles, try vehicle-pools. And keep vehicles well-tuned to reduce pollution.





Convinced grandmother to use a solar water heater instead of a wood-burning stove to heat water. Go ahead two steps.

Birds don't come to the pond anymore because it is now a landfill for the city garbage. Go back seven steps.



Cycled instead of using a vehicle. Helped reduce air pollution and saved fuel. Cycle ahead three steps.



Saw hot water from industry being let out into the river causing thermal pollution and harming river life. Go back four steps.

Threw away used batteries, which could leach toxics polluting the soil and water. Go back four steps.



Burnt house garbage causing air pollution. Lost out on benefits of recycling and reusing. Go back four steps.

Played music softly and convinced friends to do so too, reducing noise pollution. Go ahead two steps.

Told father to switch off vehicle engine at traffic light. Helped reduce air pollution and saved fuel. Go ahead five steps.



Used a perfume containing CFCs. Go back two steps.



I AM PART OF THE SOLUTION TO POLLUTION!

START

**To play:** Two or more of you can play this game. You will need coloured counters and a die. Take turns to throw the die. Each one has to move his/her counter according to the number on the die. If the counter lands on a blue circle, read the message and move the counter accordingly. The first to reach 'Jump Ahead for Action' wins.



Tested exhaust. For prescribed s ahead and

JUMP AHEAD FOR ACTION

DROOP!

SLITHER AWAY!  
THAT LEAKY THING  
IS LETHAL.

Wrote a letter to  
the local newspaper about  
lack of garbage clearance  
in the neighbourhood. Go  
ahead two steps.



Burst loud  
crackers to celebrate  
a party, causing noise  
pollution. Go back  
four steps.

Presented a  
sapling to a friend on  
her birthday and explained  
how these are good air  
purifiers. Go ahead  
four steps.



Helped raise  
environmental awareness  
in the city through a street  
play with friends. Run ahead five  
steps to the next street.



Tested water  
quality of a river. Found it  
polluted with industrial waste.  
Go ahead two steps to report to  
pollution control  
authorities.



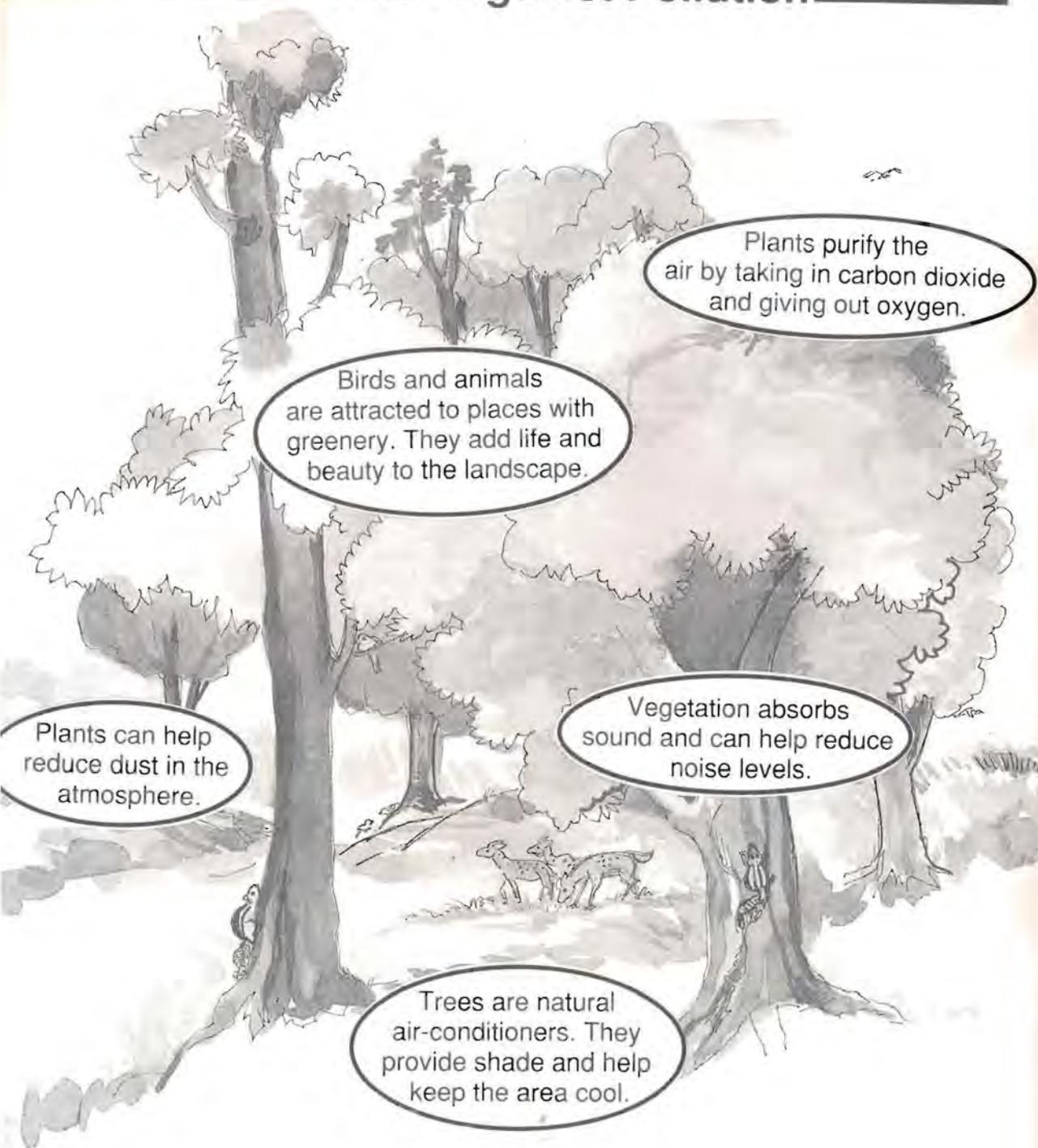
Organized  
a signature campaign  
against a polluting industry in  
the city. Go ahead two steps  
and attempt to involve  
more people.



Convinced uncle  
to stop smoking. Explained  
that non-smokers also suffer. Go  
ahead three steps.



# Green Against Pollution





## Hot and Loud

Oh! What a bore. Here goes the teacher again, listing causes and forms of pollution. As if we don't know ... air pollution, water pollution, ... Oh! But what's that? She's also putting down 'heat' and 'noise'. In a lesson on pollution? Looks like she's all mixed up ...

### Beat the Heat

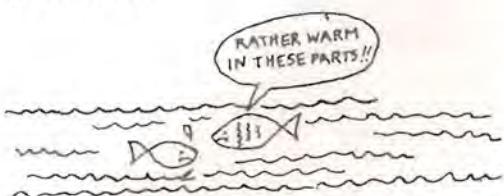
**Therma:** "Hold it! Hold it! You mean you kids don't even know that I cause pollution? There's even a special name for me: 'thermal pollution'! Guess where I come from? Mostly power plants and industries. A lot of heat is given off in a power plant when electricity is being generated and in some factories. This heat has to be removed. So what power plants do is to pipe in cool water from a pond or river nearby and circulate it where its really hotting up. The water cools down the plant, but ends up getting heated itself, thanks to me!"

"And when the heated water goes back into the water body the fun begins! The hot water makes trouble for the poor fish! They are cold-blooded creatures you know,

and that means their temperature goes up when the temperature of the water around them goes up. And that really messes up all their systems. In some cases it can even lead to death!

"In fact I mess up the whole ecosystem in the water—that is all the plants and animals that live in the water. I even affect the creatures who don't always live in the water, but lay their eggs there in the spring or summer when the water is warm and there is more food. Now, when I play my tricks and heat up the water in winter, these creatures may lay their eggs then. When the eggs hatch, there may not be enough food for the little ones and it may be too cold for them to survive.

"Even some plants which disperse their seeds depending on the warmth of the water get tricked! In short I create a lot of confusion all around."





## Noise Pollution

### High Deciba: "Brag, brag!"

Therma does it, but I'm the one who gets labelled a loudmouth! The noise pollution that I create is just as much of a pain as all that heat. But will Therma give me a chance to talk? No!



"But if there's one thing I do know well, it's how to get myself heard. That's what my job is! I thrive in cities where there's a lot of traffic and drivers honk loudly and continuously on the roads. I'm at my loudest best wherever there are loudspeakers. I'm always around where there are markets, with people out-shouting each other. I am present near factories and places with machines that make a lot of noise; near airports where planes land and take off.

And, even in homes where music is played loudly. And, as you all know best, in classrooms when the teacher is not around!

"I can be a real headache, you know. I'm not joking. I can actually give you people a headache. In really noisy factories, many workers suffer hearing loss, some temporary and sometimes permanent, thanks to me. And doctors say that continuous exposure to me can lead to increase in blood pressure, gastric ulcers and even psychological problems! With achievements like this, can you blame me for blowing my trumpet really loud?"





## Sounds Around

The human ear is sensitive to a wide range of sound intensities—from the roar of a motorcycle to the sound of raindrops against a window pane.

Sound intensity is measured on a scale of values called a decibel (dB) scale. On this scale, each 10 dB rise indicates a ten-fold increase in sound pressure. Thus the rise in sound intensity on the ear from 10 dB to 20 dB represents a hundred-fold

increase in sound level.

A small instrument called decibel metre or noise level metre is used to measure sound level.

Sound intensity becomes painful at around 120 dB and can even kill at 180 dB.

Given below are some examples of dB levels of common sounds around us, and what prolonged exposure to these can do to us.

So next time, hear with care!

Sound Sources	Sound Level, dB	Effects of Prolonged Exposure
Jet plane at takeoff	150	Eardrum rupture
Live rock music	120	Human pain threshold
Auto horn, 1 metre away	110	Hearing damage
Busy city street	90	Hearing damage
Average factory	80	Possible hearing damage
Conversation in average office	60	Disturbing
Rustling leaf	20	Quiet
Breathing	10	Very quiet

Source: Environmental Science: An Introduction, Tyler Miller Jr.



# What Does Pollution Do?

Pollution does not affect just people. It also harms wildlife and forests, plants and animals. It defaces buildings, and has the potential to disrupt the natural systems of our planet, including the weather patterns round the globe. Some kinds of pollution cause immediate problems. Other kinds don't show their effects right away, but can create problems that take years to show up. Let's take a look at some of the problems that pollution causes.

## Human Health

Pollution often causes health problems. Sometimes the effect is direct as in the case of illness by breathing poisonous fumes or drinking contaminated water. The source can be easily traced, and if caught in time, measures to remedy the problem be taken immediately. But sometimes it is difficult to even find out what is causing the problem.

## Fishy Story

The Minamata story is an example of pollution's insidious effects. In 1953 people living around the Minamata Bay in Japan began to suffer from a mysterious disease that affected their eyesight and physical co-ordination. Plants and animals too were affected. It was clear that it was some kind of epidemic, and investigations to trace the cause began. Nearly 50 people died before investigators realized that these were symptoms of mercury poisoning.

But where was the mercury coming from, and how was it affecting people? Further investigation traced the source to a plastic factory located on a stream which was flowing into the Minamata Bay. The factory was discharging its waste product, high in mercury content, into the stream. The mercury entered the food chain and became concentrated in the fish. People who ate the fish were in turn affected by these high mercury levels. This was recognized as a disease which came to be known as the Minamata disease.



## Occupational Health

People are often exposed to various kinds of pollution where they work. This pollution may be a result of the type of material they are working with, the kind of work they do, or the pollution around them. Because they have to work 8-10 hours a day for 5 to 6 days a week, they are exposed to a lot of it. This continuous exposure may affect the health of the workers. Health problems, caused due to such exposure while at work, are called occupational diseases.

Some of the most common types of occupational diseases are caused by inhaling dust. Such diseases are called pneumoconioses. The dust could be of different kinds depending on the nature of the industry. It could be dust from building sites. It could be silica dust which is found in different kinds of mines and quarries, asbestos dust, etc.



### Deadly Dust

In India it has been found that the slate pencil factories are responsible for the silicosis deaths of a large number of workers. Silicosis is caused by inhaling silica dust. Not just the men who work in the factory, but even the women and children often breathe in dangerous levels of silica dust when the pencils are taken home for packing.

Another deadly dust is from asbestos. This is, in fact, in the form of invisible asbestos fibres that workers in asbestos factories inhale. The fibres that are inhaled line the air tubes and collect in the lungs, causing a serious lung disease, known as asbestosis.

Workers in cotton textile mills suffer from a disease called byssinosis. During the course of their work, invisible cotton dust and fibres are breathed in by workers, affecting their lungs and ultimately causing chronic breathing problems.



### Animals and Birds

Just as human health is affected by pollution, so is the health of animals and birds. Sometimes, when there is a major accident like an oil spill, animal and plant life may be seriously disrupted.

Plastic bags and garbage we throw into water may choke them. Untreated sewage draining into water may also harm them. Pollution may also have long-term effects on animals and birds.

### Poisoned Waters

When pesticides came into wide use in the 1950s, the long-term effects of the chemicals were not yet known. Around the world however, fish-eating water birds in lakes and marshes that were treated with pesticides to control mosquitoes, began dying in large numbers.

Autopsies revealed that the dead birds contained pesticides in concentrations many times greater than the quantities of the chemicals carried in the water.

How did these chemicals build up to such high levels? Toxic chemicals introduced into a body of water are absorbed by phytoplankton or small plants there. Small fish eat these plants containing pesticides. Big fish eat small fish. These fish are then

eaten by birds. At each link in the food chain, the chemicals do not pass out of the body, but keep accumulating and get increasingly concentrated.

This phenomenon, whereby a substance accumulates in ever greater densities as it moves up the food chain is known as biomagnification.

One effect of accumulation of high levels of pesticides such as DDT is that birds lay eggs with shells that are much thinner than normal. When the parents sit on the eggs to keep them warm and hatch them, the eggshells break, killing the chicks developing inside. Hawks, eagles and other fish-eating birds are specially affected by such pollution.



## Vegetation

It is often difficult to directly see the effect of pollution on vegetation. But plants are affected by the pollutants that they take in from the soil, the water and even the air. For example, the gases that come out of car exhaust pipes

and factory chimneys rise into the air and combine with moisture in the atmosphere. So when the rain falls it is acidic. This acid rain soaks into the soil and is taken up by trees and plants, ultimately destroying them.

### Dying Forests

In the 1970s, scientists discovered that some forests in Europe and North America were dying, especially those with large tracts of coniferous trees. Atmospheric testing revealed that pollution from power plants, cars and trucks was to blame. Tall smokestacks and chimneys from industries were spreading acid rain far and wide. Chemicals called sulphur dioxide and nitrogen oxides were rising with the smoke into the atmosphere, combining with other

molecules and falling to the ground as precipitation 10 times more acidic than normal. This came to be known as acid rain. Sometimes as strong as vinegar, the acid rain was dissolving out important nutrients from the soil and allowing in other substances, like aluminium and manganese, which harmed the roots. Weakened trees lost their needles and were attacked by insects and disease. It was like an epidemic in which whole forests died due to this kind of pollution.





## Buildings

Pollution affects not only natural elements. It is today causing serious damage even to manmade objects. Houses, statues, old monuments and other buildings in your town may look scarred and discoloured, thanks to pollution. Acid rain and acidic pollutants in the air are specially harmful. In industrial cities, most monuments are continuously

attacked by the sulphur-containing releases that are given out by the burning of coal and oil. The sulphur dioxide is converted into sulphuric acid which gets deposited on the buildings, along with fine particles of soot. This slowly discolours the stone and wears it away, eventually damaging the building itself.

### Threatened Treasures

One of the world's most famous monuments, the Taj Mahal, is under threat from the damaging effects of air pollution. There is an oil refinery 40 km away which gives out tonnes of sulphur dioxide daily. These fumes, combined with the smoke from hundreds of small industries and foundries in the surrounding

area, as well as increased vehicular exhaust fumes, is affecting the snow white marble of the Taj Mahal. The story is the same all over the world, where grand historic monuments and ordinary everyday buildings are finding it difficult to remain untouched by the pollution all round.





## Wheels of Destruction

There are four wheels of pollution shown below. Take a close look at each one of these. Write down on the line given below each wheel, what pollutant causes this pollution—pesticides, garbage, acid rain, oil spill.





# Global Effects

## Changing the Climate

Weather records of this century indicate that the average annual temperature of the earth has risen slightly during the last hundred years or so. Many scientists today believe that increasing levels of carbon dioxide and other gases in the atmosphere are leading to a rise in the temperature of the earth. These gases act as a blanket and don't allow heat to escape from the earth.

But need we worry about such a small thing. Well, even if the earth's temperature rises by a few degrees, the effects could be serious. Polar ice-caps will start melting and the amount of water in oceans and seas will increase. As the sea levels rise, low-lying coastal areas will be flooded. Some islands may even disappear under the rising oceans.

Other things will change too. Places which are cold today may become warm. Places which are warm will become warmer. And this will affect the kinds of crops grown there, the animals, birds, etc., that can live there, and even the landscapes. In short, there will be a number of changes, which may give rise to many problems.

## Greenhouse Effect

The Greenhouse Effect is a natural process in which certain gases, known as 'greenhouse gases', trap heat that's radiating from the earth's surface. It is as though the earth were inside a giant greenhouse, with the gases acting like the glass walls that allow the sun's radiation in, but keep the heat it produces from getting out. Under normal circumstances this phenomenon wouldn't be a problem. In fact, it helps to keep the earth from getting too cold to sustain life.

Though there are lots of greenhouse gases, one is a worse offender than any of the others, mainly because of the sheer quantities of it that human activities generate through burning of fossil fuels. That gas is carbon dioxide.

People today are adding more greenhouse gases to the atmosphere in greater quantities than those that occur there naturally. And scientists are getting concerned that by this, we may be drastically changing the atmosphere's chemistry.



## Hole in the Sky

The ozone layer is one of the most important parts of the earth's atmosphere. Without it, nearly all living things would die. It forms a protective shield around the earth.

Twenty to thirty-five kilometres above the earth's surface, ozone occurs naturally in a zone of the atmosphere called the stratosphere, where it blocks out harmful ultraviolet rays from the sun. Ironically though, certain pollutants have been reacting with this 'good' ozone, causing it to break down and become a villain.

The depletion of ozone has resulted in a thinning of this layer in various places

around the world—particularly over Antarctica, where scientists have discovered a huge hole.

Nobody can say for sure exactly what will happen because of this, but without an adequate ozone shield blocking the UV rays from entering the earth, many things will be affected. Scientists say that plants, especially crops will be damaged, and the number of skin cancer cases, and other UV related health problems will increase, and even the climate will undergo change.

Let's hear the Ozone story from none other than ozone itself!





### The Ozone Story

Hi! I'm an ozone molecule. I spend my time about 25 km above the earth, soaking up ultraviolet rays from the sun before they hit you people on earth. But recently something's been happening to us. There aren't as many of us as there used to be.

You see, it all started when you people began using chemicals called chlorofluorocarbons—CFCs for short. You may not realize it, but you are probably using something made with CFCs almost every day. CFCs are used to make cups, plates, and other containers that are made of a plastic-like material called styrofoam. CFCs are also used to make the coolants that are in refrigerators and air conditioners; as well as in some computer parts and in spray cans.

But the CFCs don't stay in those products forever. CFCs leak out of old air conditioners. They also leak out of plastic foam cups and plates as they slowly break apart. Lots of CFCs also leak into the air as plastic foam is being made in factories.

Once they get into the air, CFCs slowly drift higher and higher. In

fact, it may take them 10 or 15 years to get way up here where I am. Once they get near us ozone molecules—well, that's when the trouble begins.

Before they reach the ozone layer where we ozone molecules stay, CFCs are protected from the sun's powerful UV rays. That's because me and my ozone friends soak up these UV rays. But when those CFCs drift through us ozone molecules and come out above the ozone layer... WHAM! They get hit by those rays! And a terrible change takes place in CFCs. They become Ozone Eaters!

Once that happens, CFCs can do a lot of damage. As more of us ozone molecules are destroyed, the ozone layer is becoming thinner, and more harmful ultraviolet rays are reaching the earth. And that means trouble for you people on earth.

Well, that's the end of my story. Now that you know what's happening up here, I sure hope you'll do something to help us ozone molecules. After all, we've been saving your skin for years!





# Accidents and Disasters

Pollution slowly creeps into the air and water, day after day, and over a period of time reaches dangerous levels. But sometimes, when there is an accident or disaster, large quantities of pollutants

suddenly enter the environment in a particular place. The effects of such accidents can be tragic and often reach far beyond the immediate surroundings. Here are some examples.

### Oil on the Ocean

On March 16, 1978, an oil tanker 'Amoco Cadiz' was blown ashore by strong winds near the coast of Brittany in France. The ship was badly damaged and broke apart, spilling approximately 1.6 million barrels (220 thousands tonnes) of crude oil into the water and along the shores.

The crude oil ruined the beaches. It clogged the feathers and respiratory tracts of sea birds. Millions of them died in just a few days following the disaster. Not only birds but fish, shellfish and other sea animals, including the plankton in the area died due to the oily waters.

The film of oil on the surface reduced the amount of light and oxygen passing into the water

causing underwater marine life to suffocate to death.

Oil spills from oil tanker accidents are not uncommon. While accidents such as these make headlines, it is the smaller, almost daily discharges from oil tankers—especially when the oil tanks are cleaned out, that account for almost 90 percent of the oil in the oceans.

Oil drilling operations offshore also contribute to this. In 1979 an oil well near the Mexican coast began to spill oil through an unsealed pipe. It took nine months to control the spill by which time 440,000 tonnes of oil had been spilled in the Gulf of Mexico. It is estimated that about one million tonnes of oil are spilled into the ocean each year from ships and oil rigs.



## Pollution Patrol

What can oil in the water do to a bird? Try this, to find out.

Take the feather of a bird. Feel it. Look at it. Examine it with a hand lens or magnifying glass. Sketch what you see.

Now dip the feather into water for a couple of minutes. Take it out. Feel it, look at it and examine it with a hand lens.

Note down your observations. Then add some cooking oil to the water. Dip the feather again in the oily water. Take it out and once again feel and examine it. Does it feel and look different? How would a bird with oily feathers be affected?





### The Big Blast

On April 26, 1986, at 1:23 am, Chernobyl, in the former USSR, became the site of the world's worst nuclear power plant accident.

Operators were shutting down one of the reactors for maintenance when the power suddenly surged and the reactors exploded. The blast blew the reactor apart and sent radioactive gases and particles as high as five km. into the atmosphere. Two of the plant workers were killed by the explosion. Later, 29 others died from radiation exposure.

Within days, more than 1,20,000 people were evacuated from a 30 km radius around the plant. As fires inside the reactor burned, helicopters dumped tonnes of lead, sand, and other materials on the flames. Despite these efforts, the fires burned for 10 days after the blast, continuing to release radioactive pollutants into the air.

The explosion resulted in a huge cloud that soon split into two parts. One part of the cloud moved east, across Asia, over Japan and the North Pacific, and eventually

reached western North America. The other part of the cloud moved northwest towards Poland and Scandinavia, and then southwest across central Europe.

The first few weeks following the Chernobyl blast were filled with confusion. Some European countries ordered the destruction of millions of dollars worth of contaminated agricultural products, milk, and livestock. But in other nearby European countries, people were told that there was no danger and that it was safe to consume these products. Farmers suffered huge financial losses when countries in other parts of the world refused to import agricultural and dairy produce from Europe.

The damaged reactor at Chernobyl now stands buried under thick layers of concrete and steel, while the other reactors at the plant are again producing energy. But the disaster is still taking its toll. Some scientists fear that within the next few decades, thousands of people who were exposed to the radiation could develop cancer.



## The Bhopal Tragedy

The fourth of December 1984 had not yet dawned in Bhopal, in the central Indian state of Madhya Pradesh. The city was still asleep when a deadly chemical blanket spread over it. The chemicals came from the Union Carbide pesticide factory situated in the city.

Something had gone wrong in one of the storage tanks there and close to 40 tonnes of a deadly chemical—methyl isocyanate (MIC), escaped into the air.

The city woke up, coughing, wheezing, vomiting. And the terror began. A terror which still goes on. A terror which left hundreds dead and thousands with health problems including eye damage and breathing, sleeping and digestion problems. A number of birth defects have also been reported in the exposed population. A terror which is estimated to have killed more than 2500 people and injured 2,00,000 more.

How could such a tragedy have happened? There were many things that contributed. One reason was that the safety measures put

into this factory which made and used such hazardous stuff were not adequate and did not work when they were most required. Another factor that contributed was that there were so many people living so close to such a factory. Moreover, there was little information available about what the chemicals being processed in the factory were, what effects they could have, and how they should be treated. As a result, when MIC leaked out, few people even knew what gas it was. Doctors did not know how to treat the patients. Helpless citizens did not know what precautions to take. City authorities did not know how to handle this midnight crisis.

The controversy about whether the victims got enough money as compensation still goes on. But can money compensate for lost lives, lost health and sick babies?

As a result of Bhopal, India and other countries have made stricter laws regarding such industries. But there is a long way to go to ensure that there are no more Bhopals.



# Pollution: You can be part of the Solution

Ozone hole! Greenhouse effect!! Acid rain !!! You have been reading all about them. You have discovered that they are complex things. While governments, industries and scientists work at finding solutions to pollution problems, each one of us can also help in this effort. How? By not contributing to pollution and by cleaning up a little of it. This won't, by itself, solve all the problems, but it certainly will help to reduce it. So let's start right here, right now, right with ourselves, right?

Come on! Be a part of the solution!

## Care for Clean Air!



**Be Vehicle Wise:** You can cut down your contribution to air pollution by walking or cycling

where you want to go, rather than using a vehicle that runs on petrol or diesel. Try to use public transport, rather than private vehicles whenever you can.

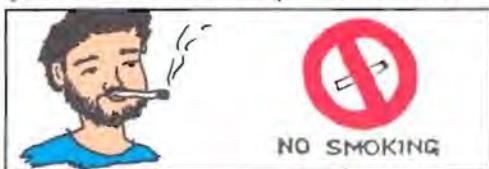
**Get Electric-smart:** Generating electricity usually involves burning of fossil fuels. If we waste less electricity, less of it will need to be generated. And the air will be that much cleaner.

So switch off fans and lights when you leave a room—not just at home, but also in school, or wherever you might be. Switch off the television or radio as soon as the programme of your interest is over. Don't open the fridge too often and for too long.

Discuss with your parents the possibility of using tube lights in the house, rather than bulbs: a 40 watt tubelight gives as much light as a 100 watt bulb. And help keep bulbs, tubes etc. clean: dust can decrease lighting levels by 20 to 30 per cent.



**Stop that smoker!**: Factories and vehicles are not the only things contributing to air pollution. The man who sits beside you in the bus and smokes, contributes to air pollution too. And is a threat to your health. So stop that smoker!



### Worry about Water!

**Hold it:** Lots of things we pour down the drain pollute our water. So avoid the use of chemical cleaners and acid for cleaning tiles. Cut down on the use of phosphate-containing detergents.

### Beware X-Rays!

**Take care:** Ensure that you or your family members go in for X-rays only on the doctors advice. And remember, only the patient should go in to the X-ray room when X-ray is to be taken.

**Don't dump:** Garbage that is not disposed off properly may end up in a water tank or river or the sea. And it can cause havoc there. So make sure you don't use a water body to dump garbage in.

### Clean up your Act!

**Don't be a litter bug:** Take care not to throw paper, plastic, soft drink containers, ice-cream cups, sweet wrappers and other nasties around. If there are no dustbins, why don't you just bring them home and throw them into the garbage can at home?

**Be a wise consumer:** Don't buy products which you know contribute to pollution— aerosols for example. And do try to avoid overpackaged goods.

**Put waste to work:** Dig a compost pit at the end of your garden. Put the kitchen waste—egg shells, vegetable peels, stale food—as well as garden waste into it. Cover with a thin layer of soil and keep it watered. In a few months, you'll have rich manure for your garden.





### Shhh...!!!

**Turn it down:** Noise can give you a headache, lead to tension, and make you irritable. So make sure that you don't play your radio or TV or music system unnecessarily loudly. Try to get your bus-driver not to honk when it is not needed.



### Green is Clean!

**Plant a Tree:** Vegetation absorbs pollution and also gives out oxygen. So it is a double bonus. Plant a tree, or a shrub, or some grass, wherever you can—in your school, your home, or in your neighbourhood. If you live in a flat, you can still use your balcony or verandah to keep potted plants. Create your own green corner.



**Be a paper saver:** Trees or bamboos have to be cut down to make paper. And that means that they can't perform their air cleaning role. So if you cut down on waste of paper, you can save trees and help keep the air clean. So don't waste paper; write on both sides; pass on your old text books to younger students.

**Plant an idea:** Share your pollution-solutions with your friends and your family. Get them concerned about pollution too. Go on—plant the idea.

**Spread the message:** Think of unusual ways of sharing your concern... write letters to the editor of your newspaper about local pollution issues; create and enact a street play; lead an awareness march; start a clean green movement!





# Test Your Pollution IQ!

What is pollution?

How does it happen?

Why make such a fuss about it?

What can be done about it?

If you remember, we started with these very questions. Now you have gone through the book, and met many of the pollutants. And

you would have discovered many of the answers. How much do you remember of what you've just read?

Why don't you find out?

Try answering these questions, and try them on your family and friends too!

## Pollution Puzzlers

1. Which of the following is an example of pollution?
  - a. litter in a stream
  - b. noise from a nearby airport
  - c. cigarette smoke in a bus
  - d. posters stuck on a monument
  - e. black smoke from a vehicle.
2. Give an example of noise pollution and explain how it can hurt people and other living things.
3. What is the connection between plastic foam and the ozone layer?
4. What are fossil fuels?
5. Name two possible problems of global climate change.
6. Why is it important to protect the ozone layer?
7. What air pollutant is the main contributor to the greenhouse effect?
8. More ocean oil pollution comes from:
  - a. large oil tankers
  - b. routine cleaning of empty oil tankers.
9. Give three examples of hazardous waste.
10. Name three ways in which people can reduce pollution caused by vehicles.
11. Name two ways in which acid rain affects the environment.
12. Find out if there is a national law in your country that has been passed to help reduce pollution.

You'll find the answers in the pages you've just read through!

## Secret code to Pollution Fossils (Page 13)

1	2	3	4	5	6	7	8	9	10	11	12	13
A	C	B	D	E	F	G	H	I	J	K	L	M
14	15	16	17	18	19	20	21	22	23	24	25	26
N	O	P	Q	R	S	T	U	V	W	X	Y	Z

## Answers to Dig Out The Trashy Company (Page 21)

Bandages, Plastic, Sludge, Medicines, Batteries, Sand, Dirt, Ash, Syringes, Paper, Bricks, Bottles, Leaves, Paints.

## Special Thanks

*NatureScope's Pollution: Problems and Solutions* has been a source of inspiration and information for many parts of this book. *NatureScope* is an environmental education publication for elementary and middle school educators. It is published by the National Wildlife Federation, the world's largest membership organization promoting the wise use and conservation of natural resources. More information regarding the National Wildlife Federation and its programmes can be obtained directly by writing to the NWF at 1400 Sixteenth Street, N.W., Washington, D.C. 20036, USA.

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## Books in this Read and Discover Series

### Where's Away?

On the waste trail with Worryworm and Litterbug in search of a place called Away.

### Forest Tales

Stories, old and new, about forests and forest dwellers.

### A B C ... Naturally!

An alphabet book with a difference! Verses and drawings about natural resources.

### Puzzling Out Pollution

A facts, fantasy and activity book on pollution.



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