

eCards

Research Topic Air Aware

Air Aware

Do you take air for granted? The air you breathe is colourless, usually odourless, and not something you can touch or feel. It is all around you, yet you likely don't pay much attention to it. You know you need oxygen for your body to function, but what else is in the air you breathe? How can knowing about the air you breathe help protect your health?

The earth is wrapped in a very thin layer of gases that make up the atmosphere. 99% of the atmosphere is made up of nitrogen and oxygen. Other gases, which together make up the other 1%, include argon, carbon dioxide, neon, helium, methane, ozone, krypton and hydrogen.

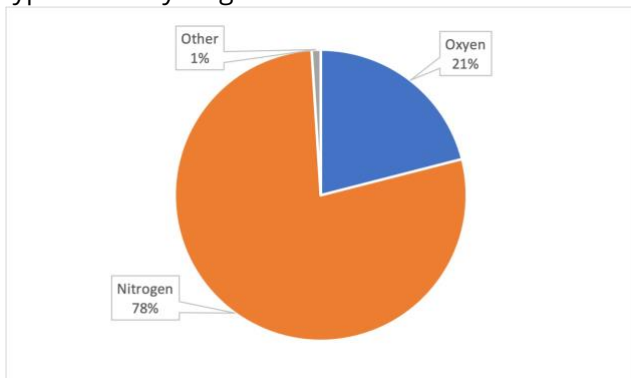


Figure 1: Gases that make up the earth's atmosphere.

These gases are not mixed together but form different layers. Lighter gases such as hydrogen and helium are found at the outer layers of the atmosphere, and heavier gases such as nitrogen and oxygen are found closer to the Earth's surface. As a result, whenever we breathe, we are mainly

breathing in nitrogen and oxygen.

Nitrogen, oxygen and argon are constant gases, their concentration has remained fairly stable over much of earth's history. Other gases are variable gases. Their concentrations change and play an important role in many of the Earth's systems, such as the overall global temperature of the Earth.

What Is Air Pollution?

Air pollution refers to pollutants that are emitted into the air. Pollutants include gases as well as small particles called particulates. By affecting the quality of the air in the atmosphere, air pollution changes the air we breathe and affects the earth's systems.

In Canada, the most commonly measured outdoor air pollutants include ground-level ozone, particulate matter, carbon monoxide, sulphur dioxide, and nitrogen oxides. Other air pollutants include toxic metals and other chemical compounds such as persistent organic compounds.

Air pollution is relatively new to this planet. Changes to the air we breathe started occurring in the late 18th century, around the start of the Industrial Revolution. Since then, the use of fossil fuels (coal, crude oil, and natural gas) and other industrial and chemical processes have been the main causes of air pollution.

Air pollution is of growing concern because of its impact on human health, the environment and the economy. We often think of air pollution as an urban

problem, but rural and suburban areas are also affected because pollution can be carried in the air over great distances. The Windsor-Quebec corridor, the Atlantic provinces, and the Lower Fraser Valley in British Columbia has the most smog episodes in Canada.

Air pollutants are either primary or secondary. Primary air pollutants are released directly into the atmosphere and have harmful impacts.

Primary Air Pollutants

1. **Nitrogen Oxides (NO_x)**
 - Gases that consist of nitrogen and oxygen, such as nitric oxide (NO — one nitrogen atom plus one oxygen atom) and nitrogen dioxide (NO₂ — one nitrogen atom plus two oxygen atoms). Under normal conditions, nitrogen and oxygen do not combine to form nitrogen oxides. High temperatures are required to create nitrogen oxides.
2. **Sulphur Dioxide (SO₂)**
 - A colourless gas that smells like burnt matches and consists of one sulphur atom and two oxygen atoms.
3. **Carbon Monoxide (CO)**
 - A colourless and odourless gas that consists of one carbon atom and one oxygen atom. It is very toxic to humans and animals.
4. **Volatile Organic Compounds (VOCs)**
 - Organic compounds that contain one or more carbon atoms (natural and man-made) that evaporate easily into the atmosphere. Of the thousands of VOCs (solvents, paints, inks, degreasing agents, benzene), about 50 to 150 of the most abundant affect air quality.
5. **Airborne Particulates**
 - Coarse particles emitted directly into the air such as dirt, ash, pollen, and smoke. These particles are 2.5 to 10 microns in size.
6. **Persistent Organic Compounds**
 - Organic compounds that contain both carbon and hydrogen atoms. Natural organic

compounds can break down easily, but man-made organic compounds are much harder to break down. Because they can stay in the atmosphere for long periods of time, they are referred to as *persistent* organic compounds.

7. Heavy Metals

- Metals that are relatively high density and toxic or poisonous at low concentrations. These metals include mercury, cadmium, manganese, chromium, and lead. They cannot be degraded or destroyed.

The Formation of Secondary Air Pollutants

Secondary pollutants are formed when primary air pollutants react with each other and with other compounds to create new forms of air pollution.

1. Acid Precipitation

- Nitrogen oxides, sulphur dioxide and water vapour react to create acid precipitation. Acid precipitation (rain, snow, etc.) affects the pH level of water and soil, making them more acidic.

2. Airborne Particulates

- Fine particles are formed through chemical reactions involving NO_x, SO₂, water vapour, VOCs and ammonia to create particulates of sulphate, nitrate and ammonium (less than 2.5 microns).

3. Bioaccumulation

- The increase of a heavy metal compound in an organism can build over time. The organism stores the chemical faster than it can be broken down, and the concentration level increases.

4. Ground-Level Ozone (O₃)

- This colourless and highly irritating gas forms just above the earth's surface, when NO_x and VOCs react in sunlight and stagnant air. Ground-level ozone, called O₃, is different than the ozone that is naturally found in the stratosphere and protects the earth from harmful ultraviolet rays.

5. **Smog**

- Smog is mostly made up of ground-level ozone and airborne particulates. Because sunlight is required to create ground-level ozone, smog often appears on sunny days with little wind. Smog levels usually peak in the mid-afternoon.

What Are The Sources Of Air Pollution?

Although people have made efforts to reduce some air pollutants such as heavy metals, air pollution continues to increase. Over time, our growing dependence on fossil fuels and other industrial and chemical processes has created greater and greater amounts of air pollution.

The Industrial Revolution, which began in the late 1700s and early 1800s, marked the beginning of the mechanization era. It brought about new ways to use energy to operate machines to do work for us, such as manufacturing and transportation. In the early days, coal was burned to generate steam to operate machinery and steam engines.

Today, most of our energy comes from crude oil, coal, and natural gas. Oil is refined into transportation fuels for cars, trucks, buses and airplanes. Coal is often burned in power plants to generate electricity, and natural gas is used to heat our homes and water. These fossil fuels pollute the air when they are produced or refined, and again when we burn them as sources of energy.

During the 1900s, the number of chemical products used for painting, building, and controlling insects and weeds increased considerably. Other industrial processes such as making steel, aluminum and wood products also increased. These chemical and industrial processes create air pollution. Many of the products we use such as solvents, batteries, pesticides and fire retardants also release air pollutants.

The Sources of Air Pollution

1. **Nitrous Oxides (NO_x)**

- Emitted during the burning of fossil fuels. Transportation (cars, trucks, etc.) is the largest contributor of NO_x emissions, followed by coal-

fired power plants, and the exploration and recovery of upstream oil and gas.

2. **Sulphur Dioxide (SO₂)**

- Emitted when fossil fuels are burned and ores are refined. Sulphur is naturally found in many raw materials such as fossil fuels and natural ores. The main sources of pollution are smelting (copper, cobalt, lead, nickel, zinc), upstream oil and gas, and coal-fired power plants.

3. **Carbon Monoxide (CO)**

- Emitted from the incomplete combustion of fossil fuels in vehicles and from burning wood. Transportation is the largest emitter (76%) followed by the use of wood to heat homes (7%).

4. **Volatile Organic Compounds (VOCs)**

- Emitted from the evaporation of gasoline and solvents.

5. **Airborne Particulates**

- Emitted as coarse particles that are released into the atmosphere. The main sources are dust, construction, agriculture tilling, and wood heating in homes.

6. **Persistent Organic Compounds**

- Emitted by pesticides to control insects and weeds. These compounds are also used in fire retardants, solvents and pharmaceuticals. The main sources are polychlorinated biphenyls (PCBs), Dichlorodiphenyltrichloroethane (DDT), and brominated flame-retardants.

7. **Heavy Metals**

- Emitted by the mining and refining of natural resources such as lead, zinc and coal. Heavy metals are also used in many products such as batteries, cement, paint and pipes.

Since secondary air pollutants are formed from primary air pollutants, they come from the same sources.

What Are The Impacts Of Air Pollution?

Air pollution has an impact on many areas of life including human health, the economy, and the environment.

Air Pollution and Human Health

Air pollution can irritate our eyes, nose, throat, airway and lungs. In the human body, the respiratory system provides oxygen to the cardiovascular system and removes carbon dioxide. As a result, when air pollution affects the respiratory system, it can also affect the cardiovascular system by allowing pollutants to enter the bloodstream. Once air pollution enters the bloodstream, it can impact a number of biochemical and physiological systems.

The Potential Health Impacts of Air Pollution

1. **Nitrous Oxides** (NO_x)
 - Reduces lung function and can lead to tightness of the chest, difficulty breathing, coughing and wheezing. Can injure biological tissues and cells.
2. **Sulphur Dioxide** (SO₂)
 - Causes wheezing and shortness of breath and can lead to lung disease.
3. **Carbon Monoxide** (CO)
 - Reduces the body's ability to use oxygen. Low-level, short-term exposure decreases athletic performance and aggravates cardiac symptoms.
4. **Volatile Organic Compounds** (VOCs)
 - Irritates the eyes and nose and may lead to allergies for some people.
5. **Airborne Particulates**
 - Irritates the eyes, nose and throat. Can cause coughing, breathing difficulties, and reduced lung function. Particulates can lodge in lung tissue causing damage.
6. **Persistent Organic Compounds**
 - Irritates the eyes and nose, and may lead to allergies for some people.
7. **Heavy Metals**
 - Damages the nervous system. Some heavy

metals are carcinogenic, meaning they can cause cancer.

8. **Ground-Level Ozone**

- Makes the eyes itch and burn. Lowers our resistance to colds and pneumonia and leads to increases in asthma. Can cause permanent lung damage and lead to premature death.

9. **Smog**

- Irritates the eyes, nose and throat. Can cause coughing and wheezing. Worsens systems of lung and heart conditions. Lowers resistance to infections and can lead to premature death.

The combination of air pollutants can create a cumulative effect and lead to significant health challenges for people. Air pollution can impair our ability to live long and healthy lives. It increases the number of illnesses we experience, especially asthma, lung disease, and cardiovascular disease. In some cases, air pollution can lead to premature death.

An active lifestyle can help protect the health of your respiratory and cardiovascular systems. Maintaining your health is one of the best things you can do to reduce your vulnerability to air pollution.

Some people are more sensitive to air pollution than others. They have to be more aware of the air they breathe and take precautions on days with poorer air quality. Four groups of people are considered to be more at risk for health complications due to poor air quality:

1. **People with underlying respiratory or cardiovascular conditions** are more sensitive to air pollution. Because air pollution can make it harder to breathe, it can make existing lung or heart-related symptoms worse.
2. **Young children** are more at risk because they breathe more frequently than adults. Young children have an elevated metabolic rate and a developing immune system which make them more vulnerable to air pollution.

3. **Elderly people** are at higher risk of health complications from air pollution. As a result of age, they may have weaker lungs, a weaker heart, a compromised immune system, or undiagnosed respiratory or cardiovascular health conditions.
4. **People participating in sports or strenuous work outdoors** are also at a higher risk because they breathe more deeply and rapidly. That increases the amount of air pollution that enters their lungs.

Air Pollution and Economics

Air pollution affects the economy in a variety of ways. For example:

- An increase in health-care costs from more visits to the doctor, more emergency room visits, and more hospital admissions.
- A loss of productivity in the workplace when people must miss work due to suffering and illness caused by air pollution.
- A loss of productivity from agriculture and lake fisheries as air pollution harms land and water ecosystems.

Air pollution also has costs that are difficult, even impossible, to measure. Climate change, for example, is already taking a toll on people in some communities and on their economies.

Air Pollution and Ecosystems

When pollution affects the air, it also affects water and land ecosystems. Changes to ecosystems directly impact the many plants and animals that depend on them. For example:

- Water ecosystems experience increased acidity and higher nitrogen and mercury levels. Acid precipitation causes algae and bacteria to grow which depletes oxygen supplies for plants and living organisms. Mercury bioaccumulates in living organisms such as fish.
- Land ecosystems experience increased acidity of the soil which impacts crops and other plants in forests and grasslands. Ground-level ozone reduces photosynthesis which affects the amount of energy that plants have to grow.

Air Pollution and Climate Change

Air pollution also contributes to climate change because it sends some greenhouse gases into the atmosphere. In doing so, it alters the natural greenhouse effect. The greenhouse effect is a natural process in which greenhouse gases act as a layer of insulation for the planet, reducing the amount of heat that is lost into space. As they blanket the Earth, greenhouse gases keep the average surface temperature of the Earth at 14.9° Celsius, which supports life on Earth. Without the greenhouse effect, the average surface temperature of the Earth would be -18° C, and the planet would be uninhabitable.

With air pollution, greater quantities of some greenhouse gases, especially methane, ozone, and nitrous oxide have been sent into the atmosphere. Scientists now distinguish between a *natural* greenhouse effect and an *anthropogenic*, or human-caused, greenhouse effect which is warming the Earth and causing climate change. As scientists have reported, in recent decades global warming has caused glaciers to begin to melt and sea levels to rise. As the Earth's climate changes, extreme weather events are also occurring more often.

By changing the concentrations of variable gases in the atmosphere, air pollution has an impact on the climate of the planet as a whole. Global warming, in turn, also contributes to more air pollution. Hotter days combine with sunlight to produce ideal conditions for the creation of ground-level ozone which is the main component of smog.

How Do We Measure Air Quality?

Air monitoring is a relatively new system. Measuring air quality began in the 1940s. Many advances were made in the 1950s and 60s and continue up to the present day.

A number of significant smog incidents occurred during the 19th and 20th centuries. In England, the London Great Smog of 1952, for example, caused thousands of deaths. These events led governments to develop legislation to reduce air pollution in the

1950s and 60s usually through legislation called *Clean Air Acts*.

Today, atmospheric monitoring stations are located around the world. Together, they measure and record the concentration of air pollutants in the atmosphere over time. There are many air monitoring stations in Canada.

How Do We Communicate Air Quality?

In many countries, air quality data is publicized using an air quality index rating system that rates the quality of the air from good to very poor. Canada uses a new system called the *Air Quality Health Index (AQHI)* to provide Canadians with an air quality rating on a scale of 1 to 10+. Canada's AQHI also includes the categories low, moderate, high and very high to describe the level of health risk associated with each index rating.

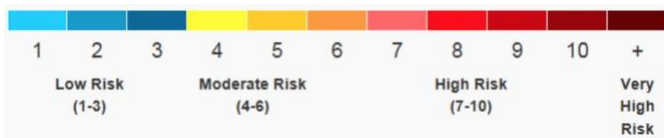


Figure 2: Air Quality Health Index (AQHI), Environment Canada.

The AQHI reports on a combination of air pollutants that are known to be harmful to human health. They include ground-level ozone (O₃), particulate matter (PM_{2.5}), and nitrogen dioxide (NO₂).

On the Environment Canada website, you can use AQHI Local Conditions to find the air quality rating for your area. The AQHI provides the current conditions and a forecast in the provinces across Canada. For more information please visit:

<https://www.canada.ca/en/environment-climate-change/services/air-quality-health-index/about.html>

What Role Will Air Pollution Play In Our Future?

Air pollution is a growing concern. Some air pollutants have decreased in recent decades, but many continue to increase. As air pollution worsens, it will take a greater toll on human health, the economy, and the environment. Poor air quality is

everyone's problem and requires action at all levels, such as at the level of government, industry, and the individual.

What Can You Do As An Individual To Reduce Air Pollution?

- 1. Transportation.** Because transportation relies on fossil fuels, it is a leading cause of air pollution. To reduce pollutants related to transportation:
 - Walk or ride a bike rather than drive or ride by car.
 - Live close to where you work or go to school.
 - Choose an energy-efficient vehicle such as a hybrid car.
 - Don't own more vehicles than you need.
 - Choose public transportation such as buses, trains, and subways.
 - Travel by bus or train instead of an airplane.
 - Drive in a vehicle that is well-tuned to increase efficiency.
 - Purchase locally grown and locally made products since they require less transportation.
- 2. Homes.** We use energy in our homes for heat and hot water and for electricity to run appliances. Heat often comes from natural gas, while electricity often comes from coal-fired power plants. We can reduce air pollution by using energy more wisely:
 - Heating and air conditioning
 - Use a programmable thermostat. For heat, set the thermostat for 21 °C during the day, and select a lower setting overnight and when no one is at home. For air conditioning, set the thermostat for 24 °C to 27 °C, higher when the house is unoccupied and lower at night for sleeping.
 - Purchase energy-efficient furnaces and air conditioners.
 - During home renovations, add extra insulation and ensure the attic and basement are well-insulated.
 - Install energy-efficient windows, weather-stripping around doors, and foam insulation around window and door frames.

- Appliances and lighting
 - Replace old appliances with energy-efficient appliances, especially refrigerators, freezers, washers, dryers and dishwashers. A new refrigerator uses about half the energy of a refrigerator from 1990!
 - Turn off electrical items when they are not being used, including your computer. Choose compact fluorescent light bulbs and/or light-emitting diodes (LED) lights.
 - Install motion and light sensors, especially outdoors rather than leave lights on all the time.

- 3. **Consumer products.** Many of the things we buy include VOCs, persistent organic compounds, and in some cases, heavy metals. To reduce air pollution-related to consumer goods:
 - Use less toxic paints, paint removers, stains, varnishes, waxes, glues, adhesives and cleaners.
 - Use EcoLogo products where possible. Products marked EcoLogo are certified to meet environmental standards.
 - Contain and dispose of products at hazardous waste facilities, such as EcoStations.
 - Choose organic foods, grown without pesticides and fertilizers.
 - Reduce the use of pesticides and fertilizers on your lawn and garden as much as possible.

Many of the steps we take to reduce air pollution will also reduce the emission of greenhouse gases. When we rely less on fossil fuels and use energy more wisely, we take action to protect human health and the earth's ecosystems, and we also take action against climate change. Air pollution affects us all, but we can all take steps to reduce it.