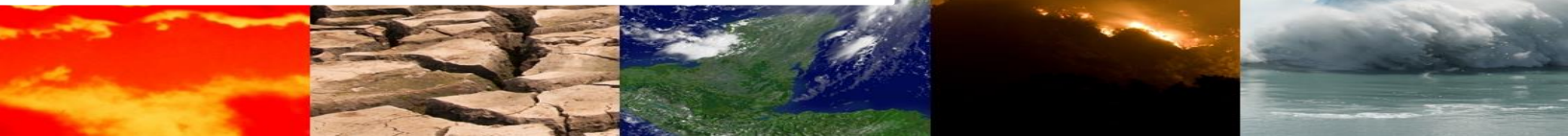


INTRODUCTION TO AIR POLLUTION AND CLIMATE CHANGE



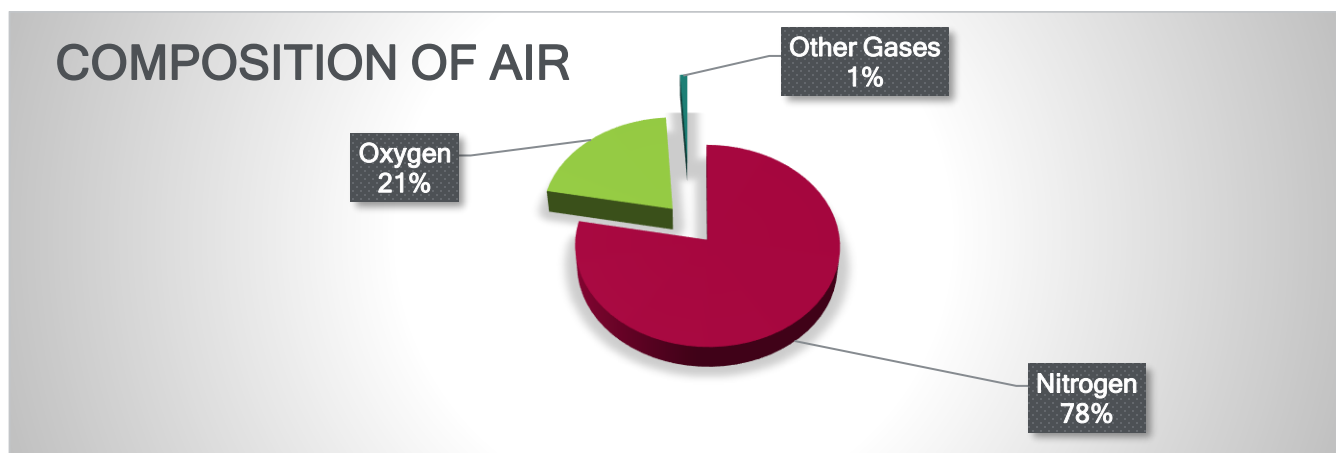
Air Pollution refers to the contamination of the air we breathe.

Climate change is the impact on environmental conditions in a region over time.

What is ambient air quality

Ambient air quality is the state of the surrounding air that we breathe which gives us life. Air quality is the condition of air within an any area and the level to which that air is free from pollution.

Ambient air is atmospheric air not contaminated by pollution. Ambient air is made up of 78% nitrogen (N) and 21% Oxygen (O₂). The extra 1% is made up of a mixture of Carbon, Helium, Methane, Argon and Hydrogen.



Atmospheric air composition in its natural state.

The air that we breath is made up of gases and particulate substances that are present in the air. Due to human and natural activities the ambient air is not always in its natural form and may contain contaminants that we refer to as air pollutants.

Definition

Gases: are air-like substances that can move around freely, and they don't have a shape either. You could put your hand through gases, and you wouldn't feel a thing.

Particulates: are small, distinct solids floating in a liquid or gas. Examples: Dust and soot are particulates in air.

What are Air Pollutants

Air pollutants are substances that are present in the air at concentrations that are above their normal background levels which can have a harmful effect on humans, animals and plants.

Definitions

Air pollutant concentrations: The amount or level of a pollutant in relation to the ambient air. Measured as a mass per unit volume. The higher the level of air pollution, the greater the health concern.

Low concentration = good air quality

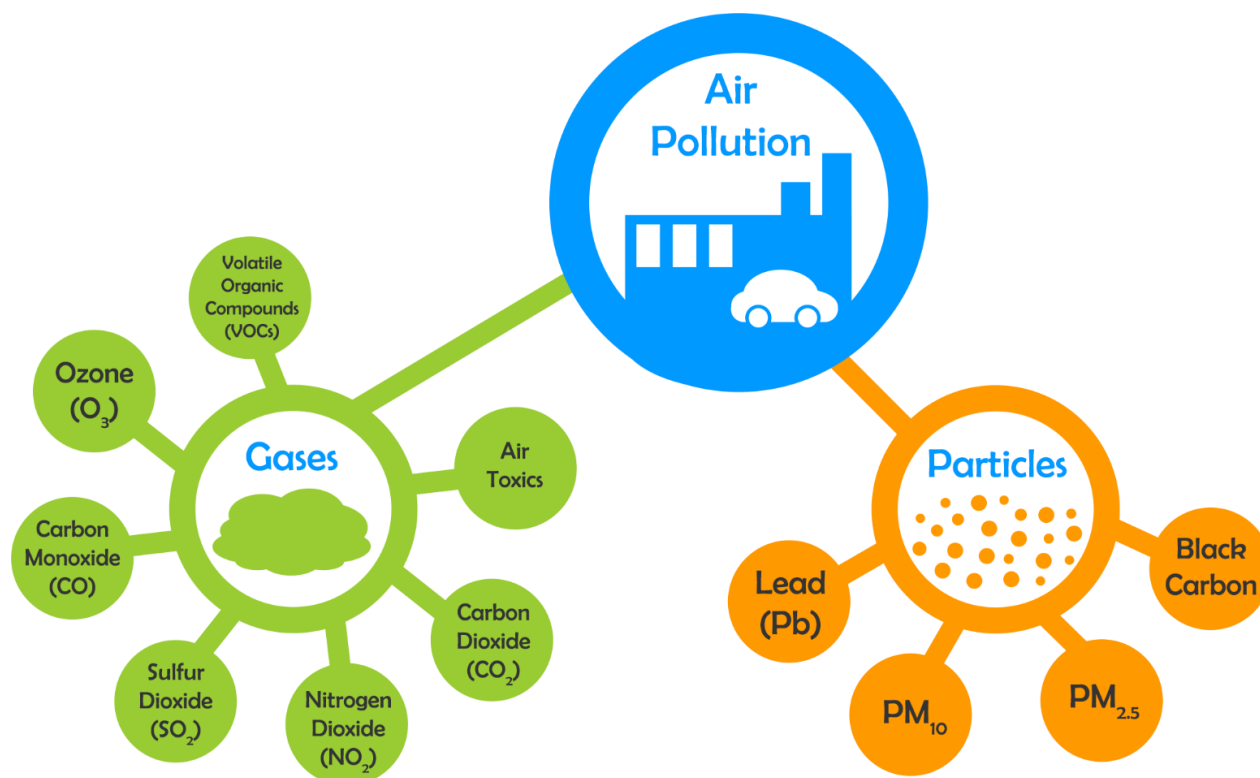
Background levels: Background air quality concentrations that are naturally occurring - Clean air.



Air pollution being created by the burning of waste material

Common air pollutants in South Africa

There are numerous sources of air pollutants and can be either natural or man-made. The most common air pollutants in the country are shown in Table 1.1.



Common air pollutants (*Torrance air, 2020*)

Table 1.1: Pollutants of concern in South Africa

| Criteria pollutants | Possible future pollutants | |
|---|--|--------------------------------------|
| | National pollutants | Local pollutants |
| Sulphur dioxide (SO ₂) Nitrogen dioxide (NO ₂) Ozone (O ₃) Carbon monoxide Particulate Matter (PM ₁₀ & PM _{2.5}) Benzene (VOC's) | Mercury Dioxons Furans POPs Other VOCs | Chrome Fluoride Manganese (Mn) |

Sulphur Dioxide

Sulphur dioxide (SO₂): SO₂ is a colourless, non-flammable toxic gas with a strong smell, similar to a just-struck match. SO₂ is made of sulphur and oxygen. It dissolves in water to form an acid and reacts with other gasses in the air to form sulphates.



Sources

Most sulphur dioxide air pollution comes from the burning of coal and oil in power plants. It is also emitted by trains, large ships, and some diesel equipment that burns high sulphur fuel, and by volcanic eruptions.

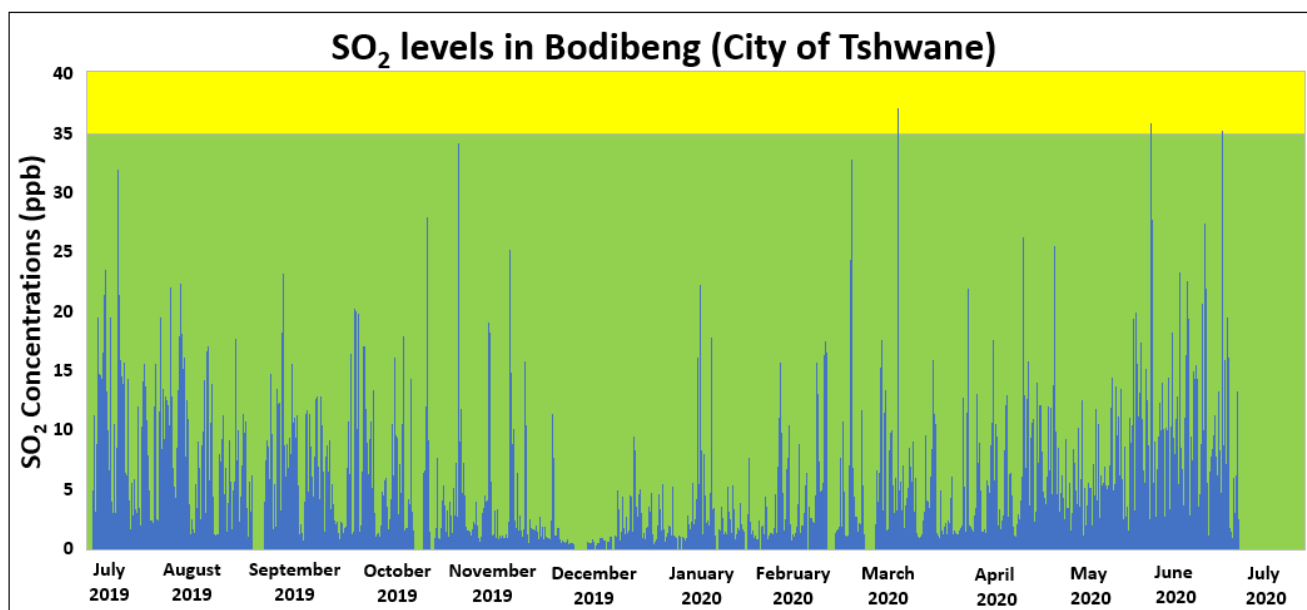
Health Effects

Short term effects

- Burning of the nose, throat, and lungs
- Difficulty breathing
- Harm to the respiratory system

Long term effect

- Changes in lung function
- Decreased fertility in women and men
- Loss of smell
- Headache and dizziness
- Nausea and vomiting
- Bronchitis and shortness of breath



SO₂ concentration levels at 1hr averaging for the Bodibeng area of the City of Tshwane

The graph demonstrates the average concentration levels of Sulphur dioxide within a rural area of the City of Tshwane. The values that we are seeing are most likely due to household activities and local mobile sources. There are no industrial sources near to this monitoring location hence the low levels of SO₂ being measured.

| SO ₂ concentration Values (ppb) | Levels of Health Concern | Cautionary Statement |
|--|--------------------------------|--|
| 0 - 35 | Good | None |
| 36 - 75 | Moderate | None |
| 76 - 186 | Unhealthy for Sensitive Groups | People with asthma should consider reducing exertion outdoors. |
| 187 - 303 | Unhealthy | Children, asthmatics and people with heart or lung disease should reduce outdoor exertion. |
| 304 - 604 | Very Unhealthy | Children, asthmatics and people with heart or lung disease should avoid outdoor exertion. Everyone else should reduce exertion outdoors. |
| < 605 | Hazardous | Children, asthmatics and people with heart or lung disease should avoid outdoor exertion. Everyone else should avoid exertion outdoors. |

This table is based on a 1hr average AQI index in correlation with the above 1hr average SO₂ concentration graph.

Nitrogen Oxides



Nitrogen Oxides (NO_x): The two most common and hazardous oxides of nitrogen are nitric oxide (NO) and nitrogen dioxide (NO₂). Nitrous oxide, commonly called laughing gas, is a greenhouse gas that contributes to global warming. NO₂ is an orange to reddish brown gas.

Sources

Nitrogen oxide pollution is emitted from vehicle exhaust, and the burning of coal, oil, diesel fuel, and natural gas, especially from electric power plants. They are also emitted by cigarettes, gas stoves, kerosene heaters, wood burning, and silos that contain silage.



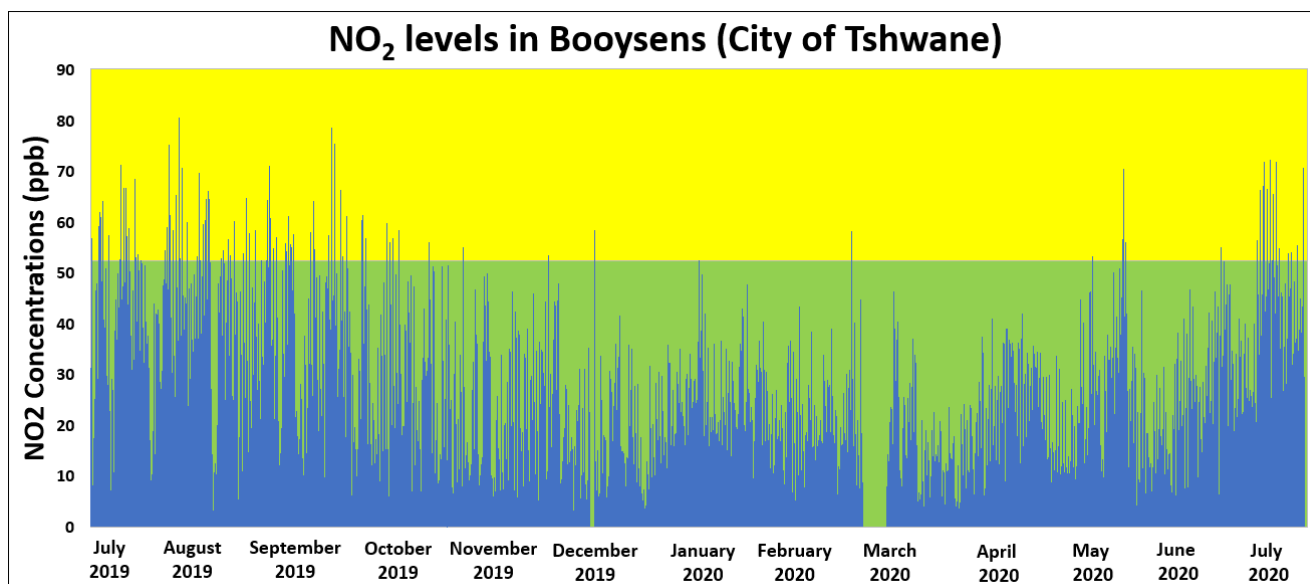
Health Effects

Short term effects

- Irritation of the respiratory system, eyes, and skin
- Aggravation of respiratory diseases, particularly asthma
- Coughing and choking
- Nausea
- Headache
- Abdominal pain
- Difficulty breathing

Long term effect

- Asthma
- Respiratory infections
- Death
- Genetic mutations
- Harm to a developing fetus
- Decreased female fertility
- Spasms
- Swelling of the throat
- Rapid pulse
- Dilated heart



NO₂ concentration levels at 1hr averaging for the Booyens area of the City of Tshwane

The graph demonstrates the average concentration levels of Nitrous Oxides within a residential area of the City of Tshwane. The values that we are seeing are most likely due to local mobile sources. There are no industrial sources near to this monitoring location hence the low levels of NO₂ being measured.

| NO ₂ concentration Values (ppb) | Levels of Health Concern | Cautionary Statement |
|--|--------------------------------|--|
| 0 - 53 | Good | None |
| 54 - 100 | Moderate | None |
| 101 - 360 | Unhealthy for Sensitive Groups | People with asthma should consider reducing exertion outdoors. |
| 361 -649 | Unhealthy | Children, asthmatics and people with heart or lung disease should reduce outdoor exertion. |
| 650 - 1249 | Very Unhealthy | Children, asthmatics and people with heart or lung disease should avoid outdoor exertion. Everyone else should reduce exertion outdoors. |
| < 1250 | Hazardous | Children, asthmatics and people with heart or lung disease should avoid outdoor exertion. Everyone else should avoid exertion outdoors. |

This table is based on a 1hr average AQI index in correlation with the above 1hr average NO₂ concentration graph.

Carbon Monoxide

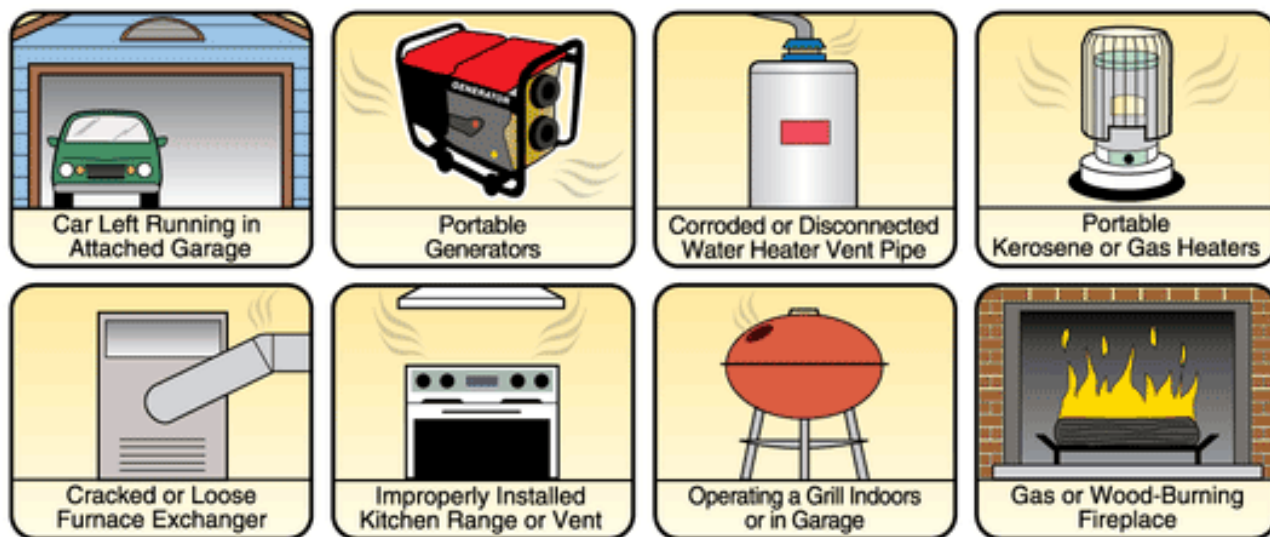


Colorless
Odorless
Tasteless

Carbon Monoxide (CO): CO is a colourless, odourless and highly poisonous gas. CO is a product of incomplete combustion and is most dangerous in enclosed spaces such as poorly ventilated rooms.

Sources

CO sources include fossil fuel combustion, industrial processes and natural sources such as forest fires. The most common sources of CO come from vehicle exhausts, cigarette smoke, smoke from burning charcoal or wood, and fumes from leaking gas appliances.



When using any type of gas or wood make sure the room is well ventilated

Carbon Monoxide

Health Effects

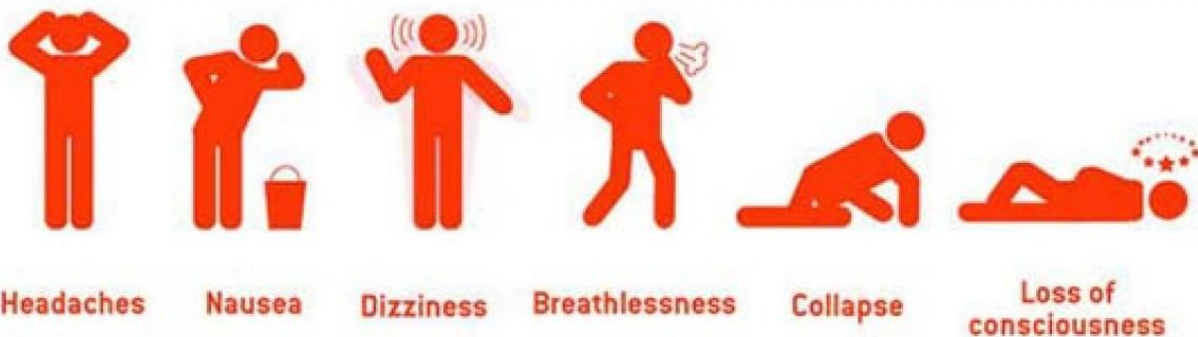
Short term effects

- Headache
- Nausea and vomiting
- Blurred vision
- Confusion
- Dizziness
- Chest pain
- Weakness
- Difficulty breathing
- Damage to the heart and brain
- Unconsciousness

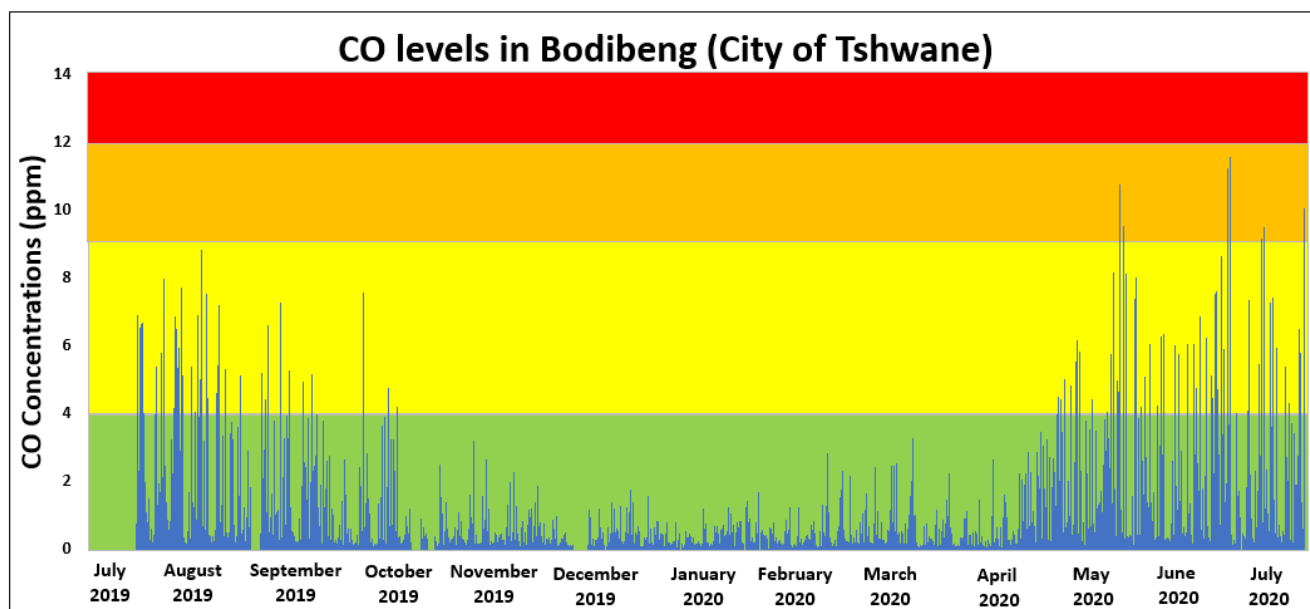
Long term effect

- Miscarriage
- Damage to a developing fetus
- Seizures
- Coma
- Heart failure

Signs of carbon monoxide poisoning



Health Effects of breathing in Carbon Monoxide (CO).



CO concentration levels at 1hr averaging for the Bodibeng area of the City of Tshwane

The graph demonstrates the average concentration levels of Carbon Monoxide within a rural area of the City of Tshwane. The values that we are seeing are most likely due to household activities and mobile sources. Higher activity is seen during the winter months demonstrating the burning of biomass and fuels for the purposes of cooking and heat.

| CO concentration Values (ppm) | Levels of Health Concern | Cautionary Statement |
|-------------------------------|--------------------------------|---|
| 0 - 4.4 | Good | None |
| 4.5 - 9.4 | Moderate | None |
| 9.5 - 12.4 | Unhealthy for Sensitive Groups | People with heart diseases, such as angina, should reduce heavy exertion and avoid sources of CO, such as heavy traffic. |
| 12.5 - 15.4 | Unhealthy | People with heart diseases, such as angina, should reduce moderate exertion and avoid sources of CO, such as heavy traffic. |
| 15.5 - 30.4 | Very Unhealthy | People with heart diseases, such as angina, should avoid exertion and sources of CO, such as heavy traffic. |
| < 30.5 | Hazardous | People with heart diseases, such as angina, should avoid exertion and sources of CO, such as heavy traffic. Everyone else should reduce heavy exertion. |

This table is based on an 8hr running average AQI index in correlation with the above 1hr average CO concentration graph.

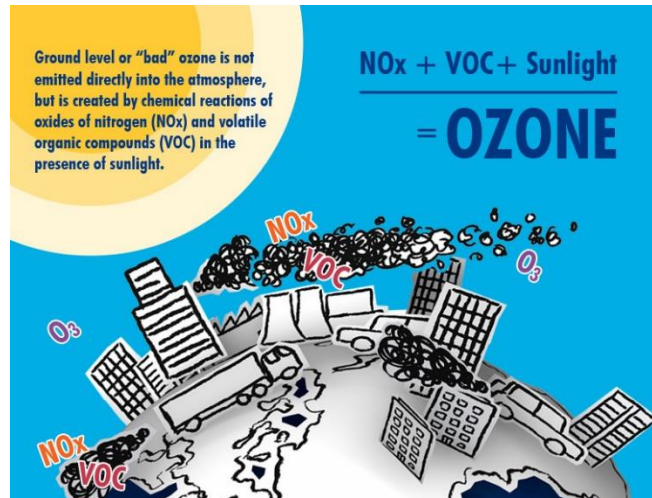
Ozone



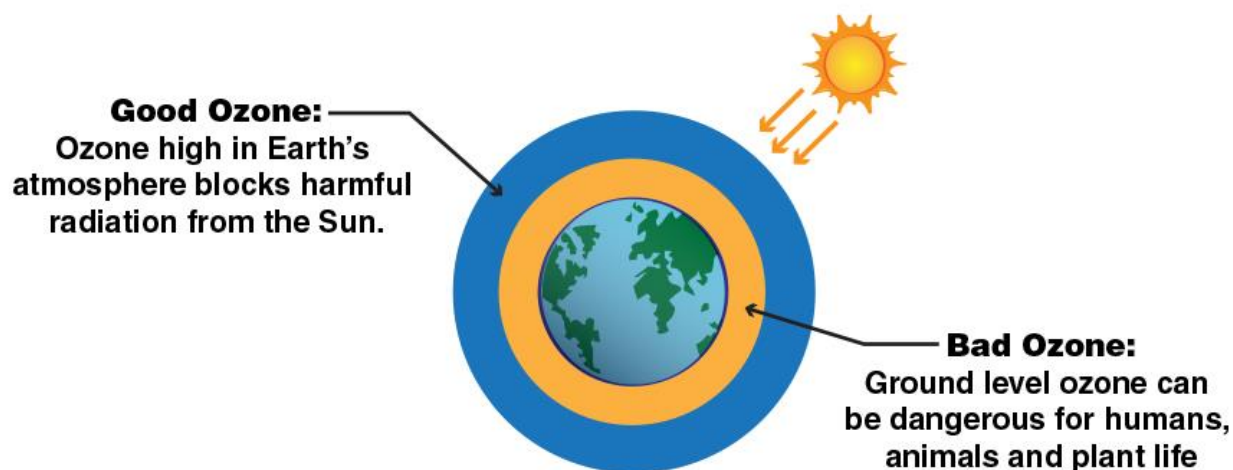
Ozone (O_3): Ozone is not emitted directly into the air but is created by chemical reactions between NO_x and VOCs in the presence of sunlight. Ozone occurs naturally and is an important chemical in the upper atmosphere where it blocks ultra-violet radiation but can have harmful effects on human health at ground-level.

Sources

Ozone on the ground level is the main component of smog. It is created when sunlight reacts with pollution from vehicles, power plants, and industrial sources. Ozone pollution is worse in the afternoon and early evening.



Ozone: Good and Bad



Good ozone and bad ozone (*SciJinks, 2020*)

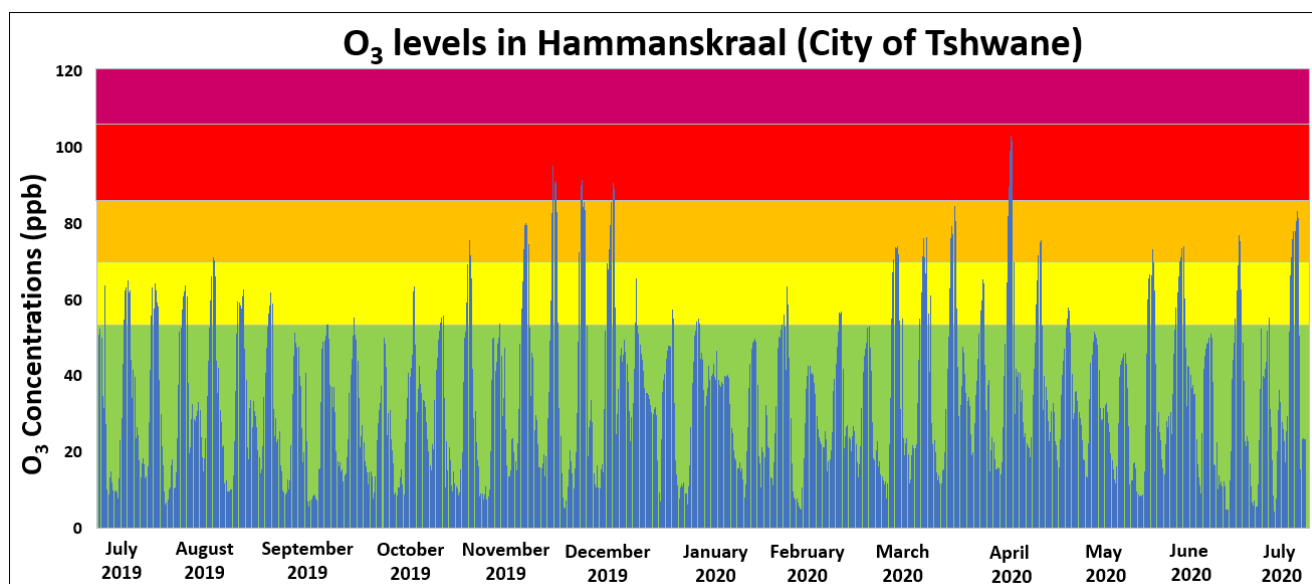
Health Effects

Short term effects

- Chest pain
- Coughing and wheezing
- Difficulty breathing
- Irritation of the lungs and throat
- Congestion

Long term effect

- Lung damage and reduced lung function
- Inflammation of airways
- Respiratory distress
- Aggravated lung diseases
- Increased asthma attacks
- Increased risk of early death from heart or lung disease



O₃ concentration levels at 1hr averaging for the Hammanskraal area of the City of Tshwane

The graph demonstrates the average concentration levels of Ozone within a rural area of the City of Tshwane. Higher activity is seen during the summer months demonstrating the effect that increased sunlight (solar radiation) has on the creation of ozone in the presence of NO_x, VOC's and particulates.

| O ₃ concentration Values (ppm) | Levels of Health Concern | Cautionary Statement |
|---|--------------------------------|---|
| 0 - 54 | Good | None |
| 55 - 70 | Moderate | Unusually sensitive people should consider reducing prolonged or heavy outdoor exertion. |
| 71 - 85 | Unhealthy for Sensitive Groups | Active children and adults, and people with lung disease, such as asthma, should reduce prolonged or heavy exertion outdoors. |
| 86 - 105 | Unhealthy | Active children and adults, and people with lung disease, such as asthma, should reduce prolonged or heavy exertion outdoors. Everyone else, especially children, should reduce prolonged or heavy exertion outdoors. |
| 106 - 200 | Very Unhealthy | Active children and adults, and people with lung disease, such as asthma, should avoid all outdoor exertion. Everyone else, especially children, should avoid prolonged or heavy exertion outdoors. |
| < 201 | Hazardous | Everyone should avoid all physical activity outdoors. |

This table is based on an 8hr average AQI index in correlation with the above 1hr average O₃ concentration graph.

Volatile Organic Compounds

Volatile Organic Compounds (VOCs): VOCs are organic compounds with a structure that makes it possible for them to evaporate under standard atmospheric conditions. VOCs can easily become vapours or gases.

Definition

Organic Compounds: These are any compounds that contain carbon that are typically found in living systems.

Sources

VOCs are released from burning fuel such as gasoline, wood, coal, or natural gas. Household sources of VOCs are created by burning of consumer products such as:

- Cigarettes
- Solvents (eg. bleach)
- Paints and thinners
- Adhesives/ Glues
- Hobby and craft supplies
- Dry cleaning fluids
- Wood preservatives
- Cleaners and disinfectants
- Moth balls
- Air fresheners
- Building materials and furnishings
- Copy machines and printers
- Pesticides



Sources of VOCs can be either natural (e.g., vegetation) or man-made (e.g., chemical industries and fossil fuel combustion). Natural sources of VOCs such as forests, grasslands and swamps are estimated to be much larger than man-made sources.

Volatile Organic Compounds

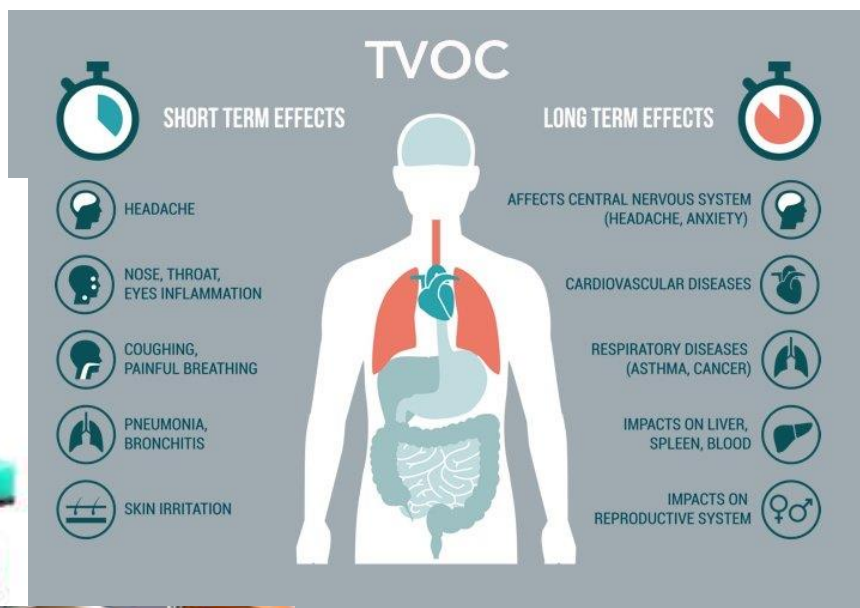
Health Effects

Short term effects

- Irritation of the eyes and respiratory tract
- Headaches
- Dizziness
- Visual disorders
- Memory problems

Long term effect

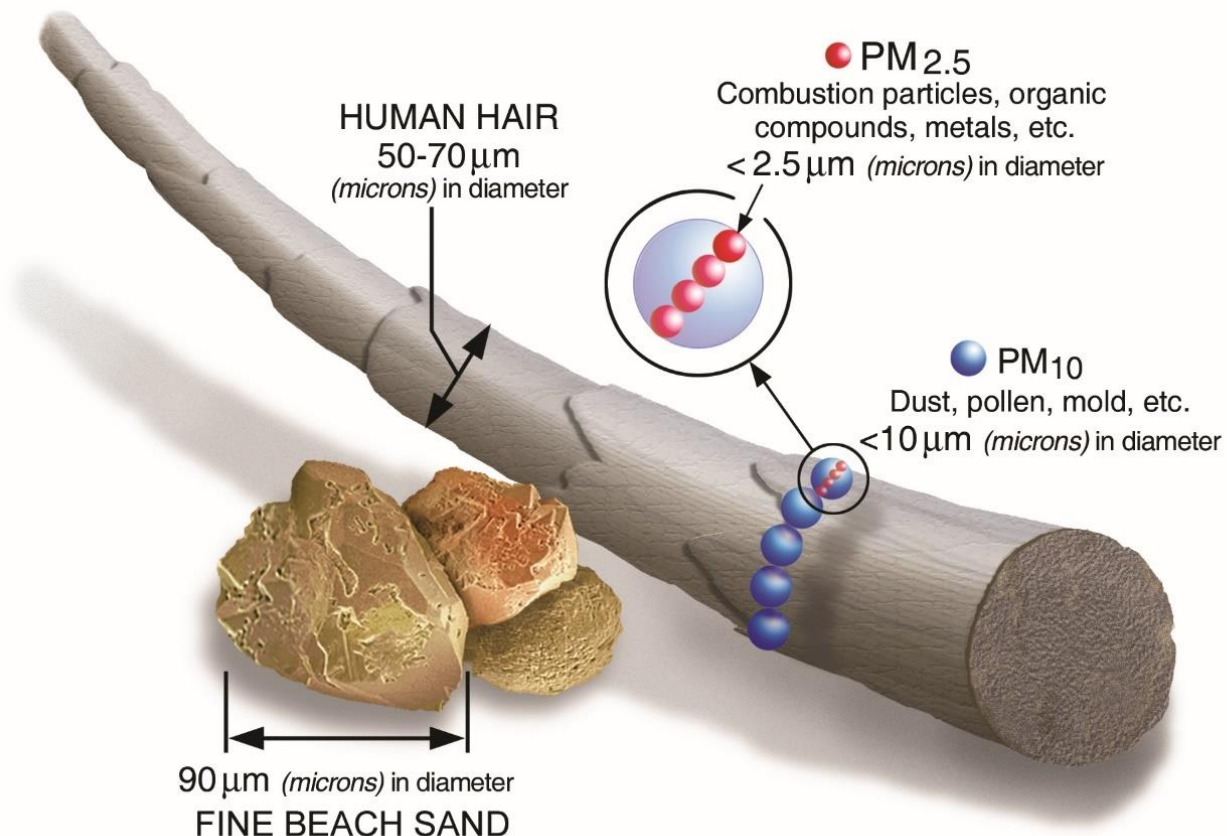
- Irritation of the eyes, nose, and throat
- Nausea
- Fatigue
- Loss of coordination
- Dizziness
- Damage to the liver, kidneys, and central nervous system
- Cancer



Particulate Matter

Particulate Matter (PM): Particulate matter is classified by particle size. The term particle indicates small size, usually less than a centimetre. When we measure PM it is classified as total suspended particulate matter (i.e., dust);

- PM₁₀ (less than 10 μm in diameter),
- PM_{2.5} (less than 2.5 μm in diameter), and
- Ultrafine particles (less than 0.1 μm in diameter).



Size comparisons for PM particles (US-EPA, 2018).

PM is referred to as "primary" if it is directly emitted into the air as solid particles and is called "secondary" if it is formed by chemical reactions of gases in the atmosphere.

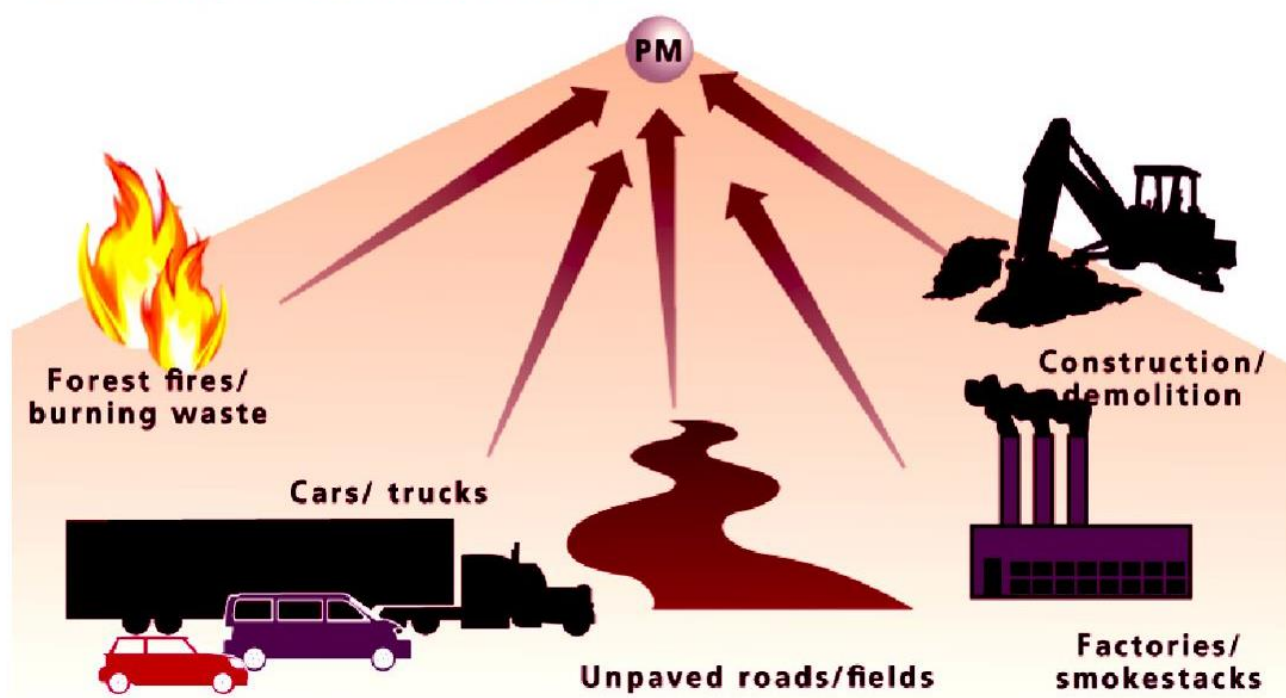
Particulate Matter

Sources

Sources of airborne particulate matter include road dust, agricultural activities, vehicle exhaust, wood burning, smoke from forest fires, and industrial activities. Secondary particulate matter is an important fraction of PM_{2.5} which can be created from NO_x, SO₂ and ammonia (NH₃).

PRIMARY PARTICULATE MATTER

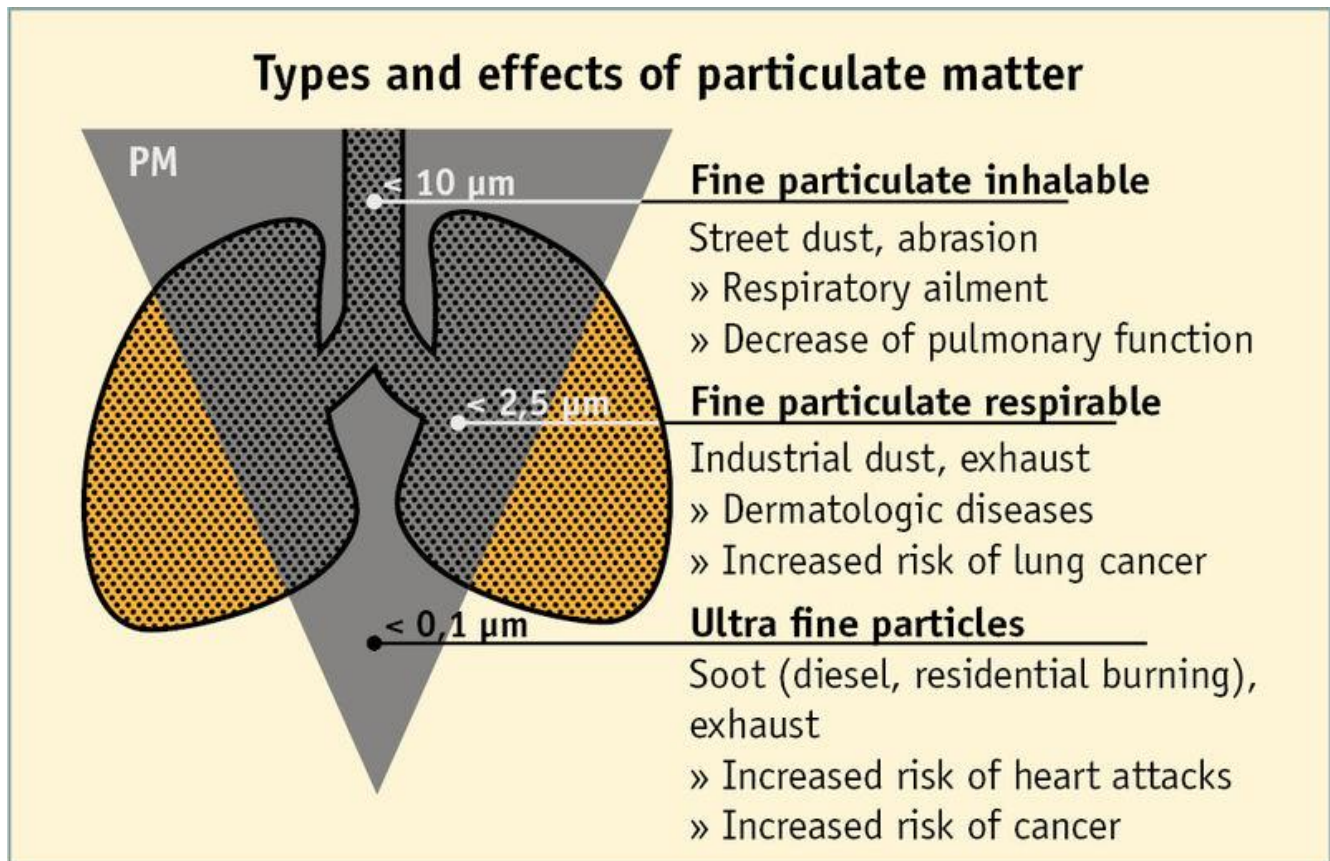
Emitted directly from a source into the atmosphere.



Primary sources of particulate matter.

Particulate Matter

Health Effects



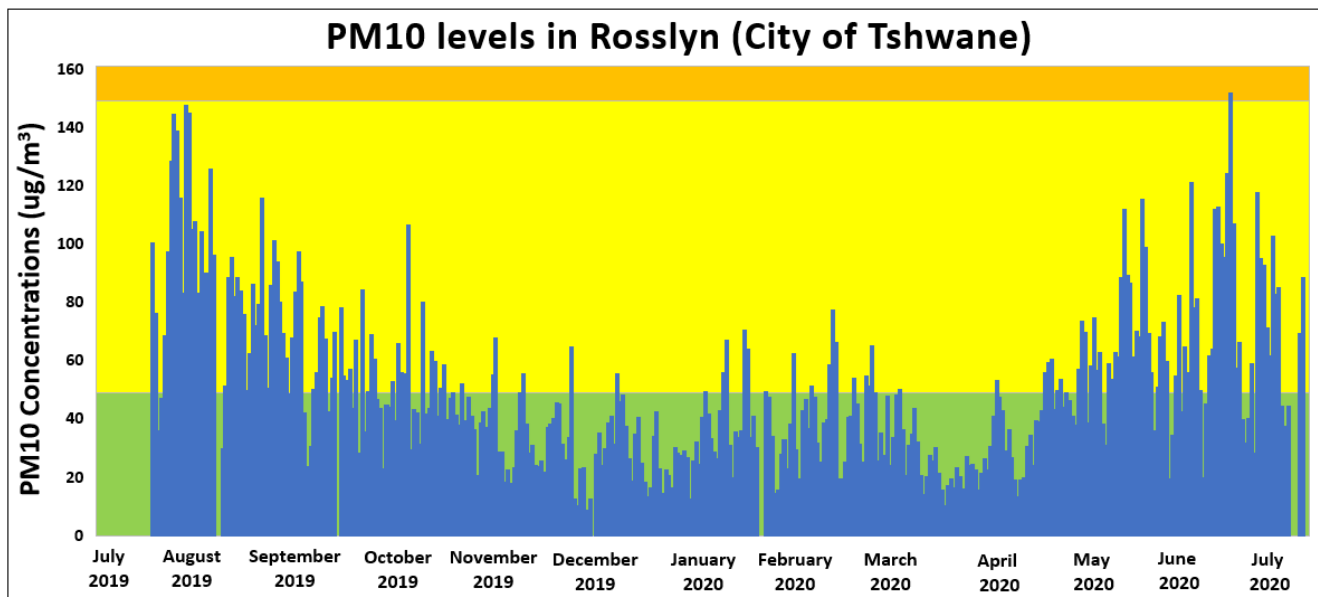
Effects of particulate matter on human health (DUH, 2020)

Exposure to small particles less than 10µm in diameter effects

- Nonfatal heart attacks
- Irregular heartbeat
- Aggravated asthma
- Decreased lung function
- Increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing
- Premature death in people with heart or lung disease

Exposure to diesel exhaust including particulate matter effects

- Cancer



PM10 concentration levels at 24hr averaging for the Rosslyn area of the City of Tshwane

The graph demonstrates the average concentration levels of Particulate Matter within a rural/industrial area of the City of Tshwane. The values that we are seeing are most likely due to household activities and mobile sources. Higher activity is seen during the winter months demonstrating the burning of biomass and fuels for the purposes of cooking and heat.

| PM10 concentration Values (ug/m ³) | Levels of Health Concern | Cautionary Statement |
|--|--------------------------------|--|
| 0 - 54 | Good | None |
| 55 - 154 | Moderate | Unusually sensitive people should consider reducing prolonged or heavy exposure. |
| 155 - 254 | Unhealthy for Sensitive Groups | People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion. |
| 255 - 354 | Unhealthy | People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion. |
| 355 - 424 | Very Unhealthy | People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion. |
| < 425 | Hazardous | People with heart or lung disease, older adults, and children should remain indoors and keep activity levels low. Everyone else should avoid all physical activities outdoors. |

This table is based on a 24hr average AQI index in correlation with the above 24hr average PM10 concentration graph.

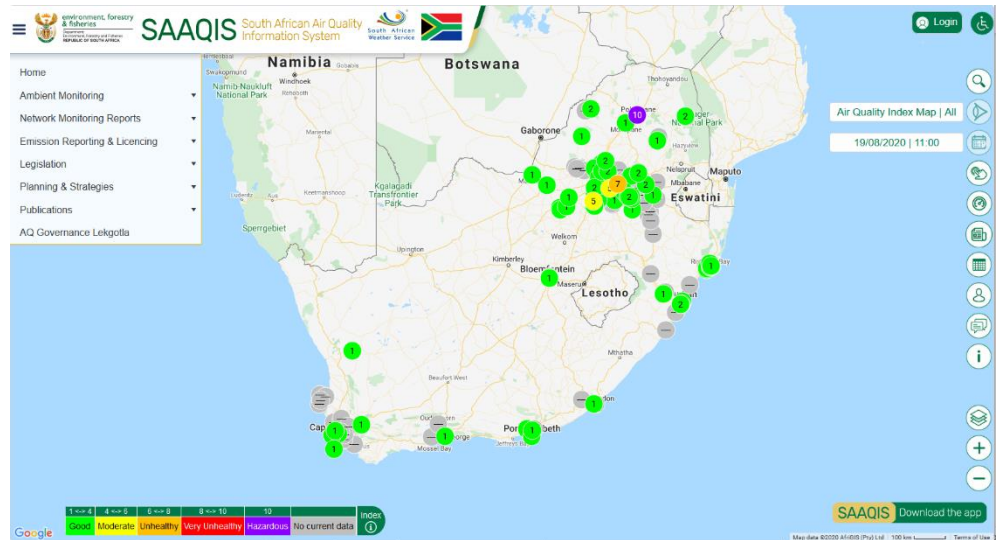
The below table represents a list of regulated air pollutants and the major sources of these pollutants.

Table 1.2: List of regulated pollutants and their associated sources.

| Pollutant | Source(s) |
|---|---|
| Particulate Matter | Fuel Combustion in Power Generation. Fuel Combustion in Road Transport Incineration Tyre and brake wear Road wear |
| Ozone | Is not emitted directly but results from reactions involving precursor gases such as volatile organic compounds and nitrogen oxides. |
| Nitrogen Oxides (NO and NO ₂) | Combustion Sources (results in NO mostly, which is subsequently oxidized to NO ₂). |
| Sulphur Dioxide (SO ₂) | Combustion of fuels containing high levels of sulphur (e.g. Heavy Fuel Oil in thermal power plants). |
| Benzo[a-]pyrene | Incomplete combustion of fuels in road transport and rubber-tyre wear. |
| Carbon monoxide | Incomplete combustion of fuels in road transport. |
| Benzene | Incomplete combustion of fuel in road transport. Handling and distribution of petrol. |
| Arsenic | Metal smelters. Coal combustion. |
| Cadmium | Non-ferrous metal production. Iron and steel production Cement production. Waste Incineration. Stationary combustion of fossil fuel. |
| Nickel | Combustion of fuel oil and coal in stationary plants. Combustion of fuel in ships. Waste Incineration. Steel manufacture. Electroplating. |
| Lead | Combustion of fossil fuel. Waste incineration. Production of non-ferrous metals. Production of iron and steel. Production of cement. |
| Mercury | Combustion of coal. |

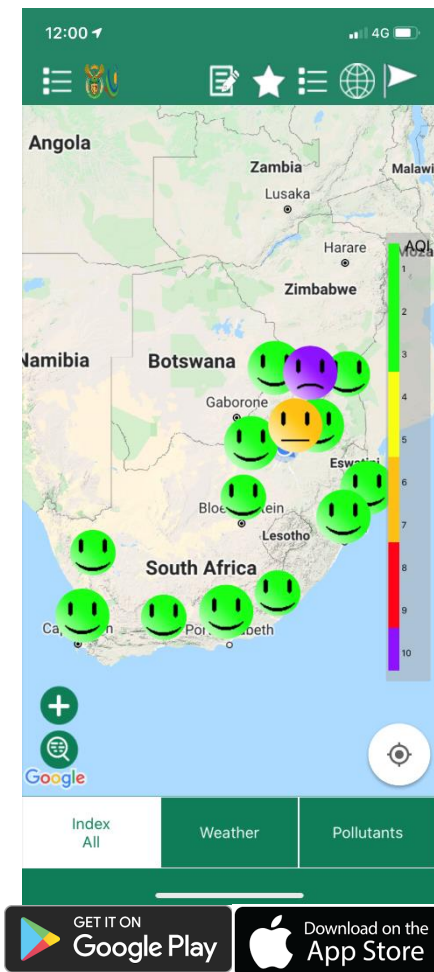
Know your air quality using SAAQIS: South African Air Quality Information System

The SAAQIS is a web based interactive air quality information system which seeks to provide air quality information to citizens.

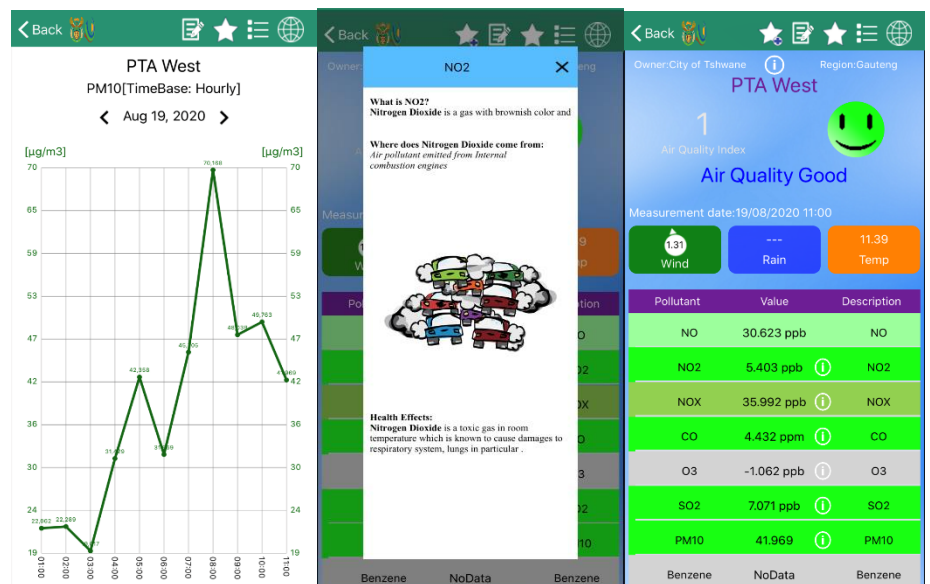


www.saaqis.environment.gov.za

With the large network of air quality monitoring stations, the SAAQIS gives you access to live air quality information via a Web based platform or straight from your smart phone with the use of an APP.



Each circle is a monitoring station showing what the air quality is in that area.

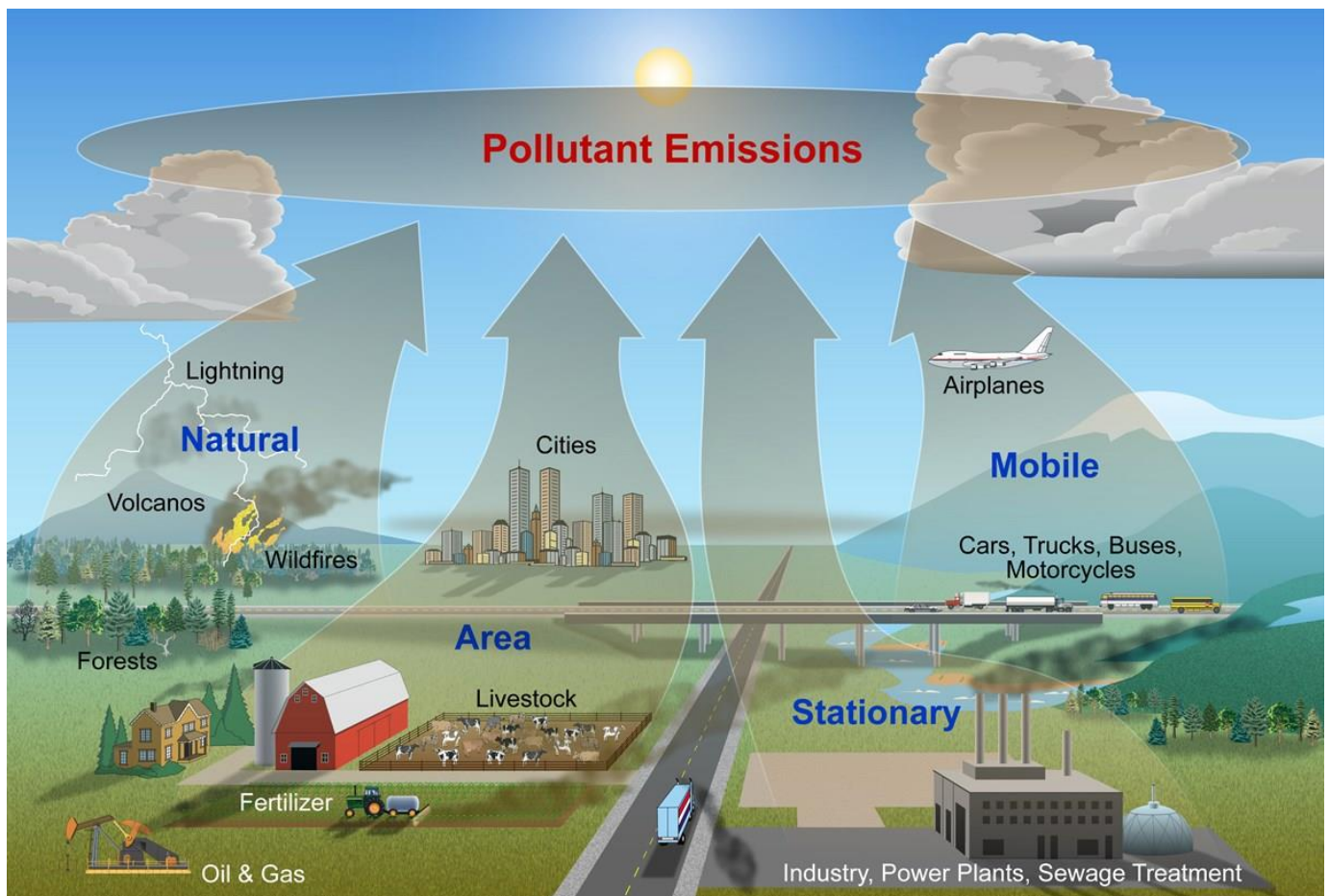


Select your area to know your air quality

Sources of air pollution

Air pollution is caused by solid and liquid particles and certain gases that are suspended in the air. These particles and gases can come from car and truck exhaust, burning of fossil fuels in factories and household, dust, pollen, volcanic eruptions and wildfires. The solid and liquid particles suspended in our air are called aerosols.

Air pollutants are produced or formed from a range of man-made and natural sources. Air pollutants can be released directly into the atmosphere (primary emissions) or can form as a result of chemical reaction involving other substances (secondary emissions). There are four main types of air pollution sources (NPS.gov 2018).



Natural, area, stationary and mobile sources of air pollution (NPS.gov, 2018)

Mobile Sources

Mobile sources of air pollution move from place to place while emitting pollutants. These sources include cars, busses, planes, trucks, and trains. The increase of privately-owned vehicles, commercial trucks and public transport has resulted in an increase in fuel consumption and the release of combustion pollutants into the atmosphere.



In urban areas **vehicle emissions** may be responsible for;

- 90 to 95 % of CO, and
- 60 to 70 % of NO_x within the atmosphere

Aircrafts, with the combustion of jet fuel also release pollutants such as; CO₂, PM, NO_x, SO₂ and VOC's

These are the sources of pollution which emits pollutants from a specific area such as agricultural areas, cities, and wood burning fireplaces.

Area Sources

In South Africa informal settlements are dependent on **domestic burning** of fuels, such as coal, paraffin and wood for cooking and heating. The burning occurs mostly under poor conditions result in high emission rates/ concentrations, which in turn affect neighbourhood air quality.



Biomass burning is a significant source of pollutant gasses and particulate matter emissions to the atmosphere.

Veld fires also adversely affect air quality due to the large concentrations of carbon monoxide, volatile organic compounds, particulate matter and other harmful chemicals present in the smoke.



Stationary Sources



A stationary source is a fixed emitter of air pollutants such as fossil fuel burning power plants, oil refineries, petrochemical plants, food processing plants, waste incineration plants and other heavy industrial sources. Stationary sources are a major consumer of energy and depends mainly on fossil fuels especially coal. Coal mining operations are a secondary impact from coal-fired power stations. The industrial sector also includes processes of producing iron and steel, cement and pulp and paper. Industrial processes produce primarily combustion particles - Particulate matter (PM10).

Definition

Primary impact: direct pollution from the burning of coal such as smoke from stacks. For example; coal-fired power station pollution effects.

Secondary impact: pollutants generated from the subsequent effects of any activity. For example; particulate matter generated during coal mining process.



Natural Sources



Some of the natural sources of air pollution are organic compounds from plants, suspended soils and dust wind-blown dust. Other natural sources are released during nature's disasters such as wildfires (forest fires) and volcanic eruptions.

- Volcanic eruptions: emit smoke, particulate matter, SO_2 , H_2S , CH_4
- Fires: emit smoke, unburnt hydrocarbons, CO , CO_2 , NO_x
- Dust and sandstorms release dust (particulate matter)
- Oceans emit corrosive salt aerosols
- Lightning produces NO_x and O_3
- Normal human respiratory produces CO_2



Naturally occurring wind-blown dust

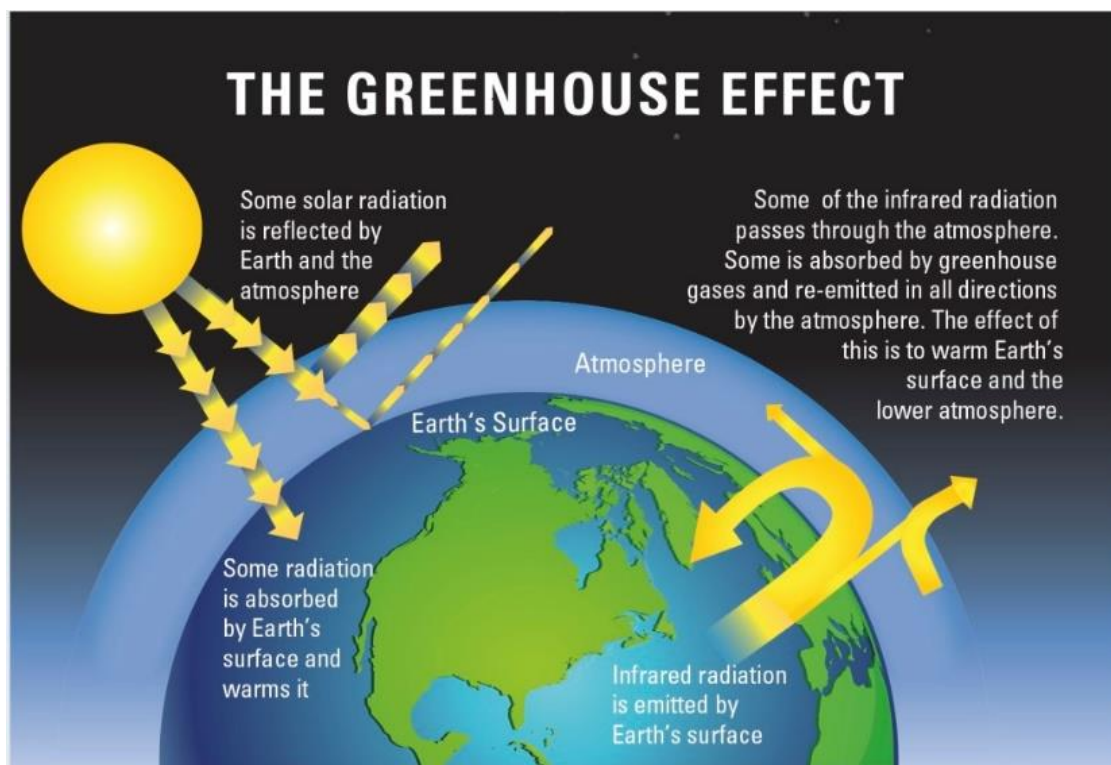
Climate Change and Environmental Effects of air pollution

The Greenhouse Effect

As the Sun heats up the Earth, some of the solar radiation is reflected/returned to space and rest is absorbed by the atmosphere. The stored heat is then returned to the atmosphere in a form of infrared radiation. Part of the infrared radiation goes back to space and another is trapped by the greenhouse gases in the atmosphere and then sent back to the Earth. The surface of the Earth heats up depending on the concentrations of the greenhouse gases.

Definition

Infrared radiation: the heat we feel from the sunlight, a fire, a radiator or a warm pavement. It is invisible to the human eye; it can be detected as a sensation of warmth of the skin.



“warming that results when the atmosphere traps heat radiating from Earth toward space”

What is Climate Change



Climate change is the change in usual weather conditions on the environment over time. This could be a change in how much rain a place usually gets in a year, or it could be a change in a place's usual temperature for a month or season. Climate

change is also a change in Earth's climate. Things that we depend upon and value – water, energy, transportation, wildlife, agriculture, ecosystems, and human health – are experiencing the effects of a changing climate.

What causes Climate Change



Burning of [fossil fuels](#) releases harmful pollutants and other greenhouse gases such as carbon dioxide, ozone, black carbon and methane, into the atmosphere causing global warming. Increased concentrations of greenhouse gases cause [global warming](#) which increasing the global temperatures.

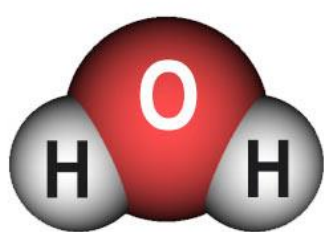
Certain gases in the atmosphere block heat from escaping. Long-lived gases that remain semi-permanently in the atmosphere and do not respond physically or chemically to changes in temperature are described as "forcing" climate change.

Definition

Fossil fuels: these may include coal, petroleum, natural gas, heavy oils. When burned, they release greenhouse gases, such as carbon dioxide, black carbon etc., which trap heat in our atmosphere.

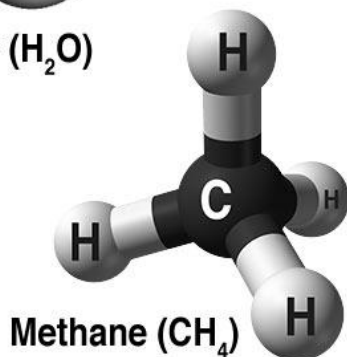
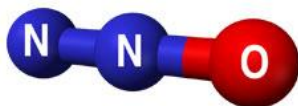
Global warming: slow heating of the Earth's surface over time, oceans and atmosphere caused by human activity, primarily the burning of fossil fuels that release harmful gases and other greenhouse gases into the atmosphere.

Gases that contribute to the greenhouse effect include:

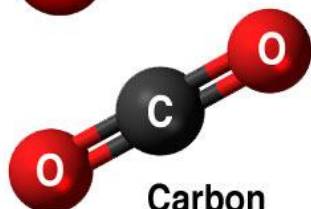


Water vapor (H_2O)

Nitrous oxide (N_2O)



Methane (CH_4)



Carbon dioxide (CO_2)

Water vapor (H_2O). The most abundant greenhouse gas, but importantly, it acts as a feedback to the climate. Water vapor increases as the Earth's atmosphere warms, but so does the possibility of clouds and precipitation.

Carbon dioxide (CO_2). A minor but very important component of the atmosphere, carbon dioxide is released through natural processes such as respiration and volcano eruptions and through human activities such as deforestation, land use changes, and burning fossil fuels.

Methane (CH_4). A hydrocarbon gas produced both through natural sources and human activities, including the decomposition of wastes in landfills, agriculture and manure management associated with domestic livestock. Methane is a far more active greenhouse gas than carbon dioxide, but much less abundant in the atmosphere.

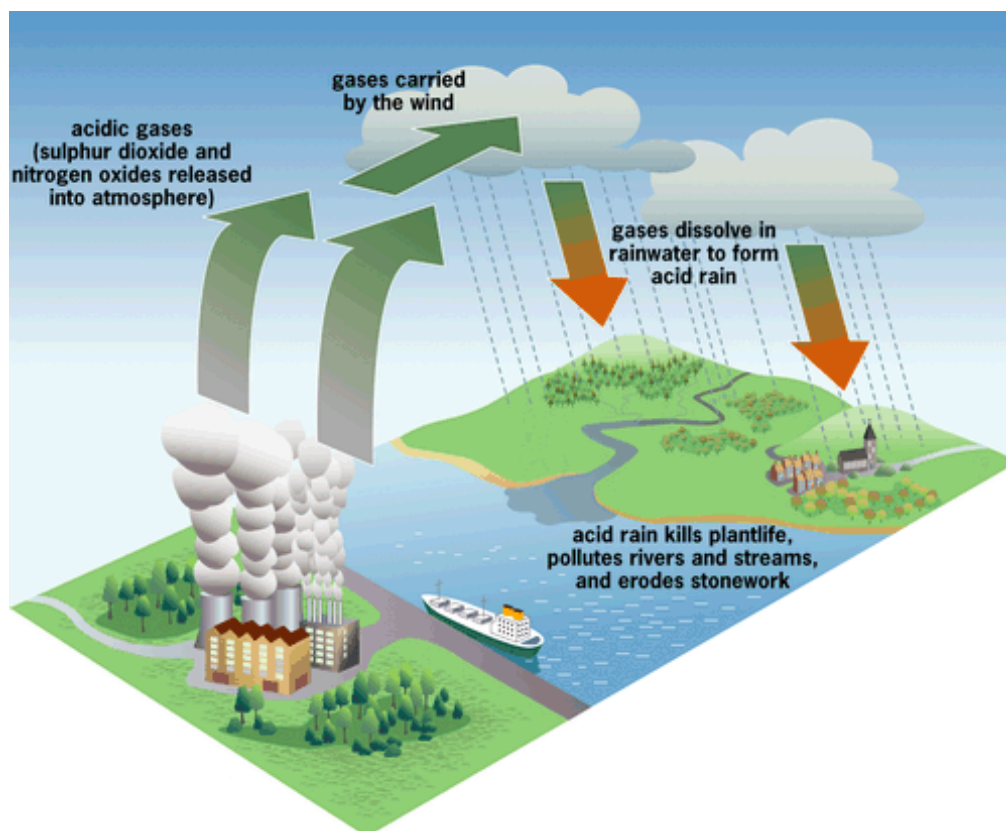
Nitrous oxide (N_2O). A powerful greenhouse gas produced by soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

Chlorofluorocarbons (CFCs). They are also greenhouse gases. Synthetic compounds entirely of industrial origin used in several applications, but now largely regulated in production and release to the atmosphere by international agreement for their ability to contribute to destruction of the ozone layer.

Impact of Common Air Pollutants on Environment

Sulphur Dioxide Effects on Environment

SO₂ affects the environment when it reacts with water in the atmosphere to form acid rain. Acid rain flows through the soil to cause damage to the plants and acidifies the groundwater (drinking water).



Formation and effects of acid (*Science online, 2014*)

Nitrogen oxides can create environmental health hazards when they react with sunlight and other chemicals to form **smog**. Nitrogen oxides and sulphur dioxide react with substances in the atmosphere to form acid rain.

Definition

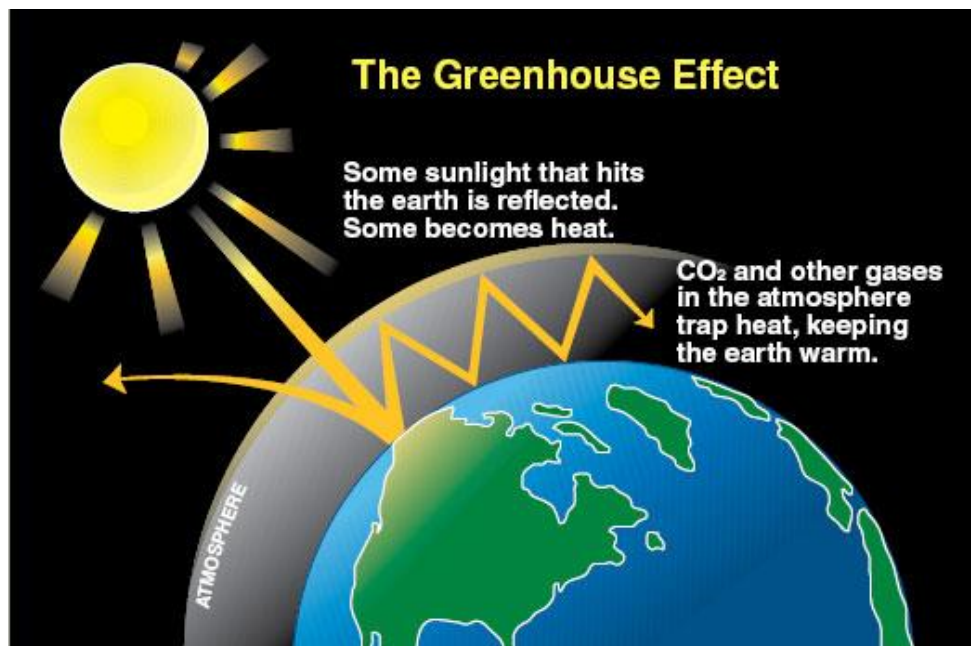
Smog: This is a kind of air pollution named for the mixture of smoke and fog in the air. Classic smog is formed by large amounts of coal burning and is formed by a mixture of smoke and sulphur dioxide.



Thick smog covering a city

Carbon Monoxide Effects on Environment

Carbon monoxide effects the amount of greenhouse gasses in the atmosphere which is linked to climate change and global warming. This results in increasing land and sea temperatures changing our ecosystem, increasing storm activities resulting in extreme weather events.



The greenhouse effect within the earth's atmosphere.

Ozone Effects on Environment

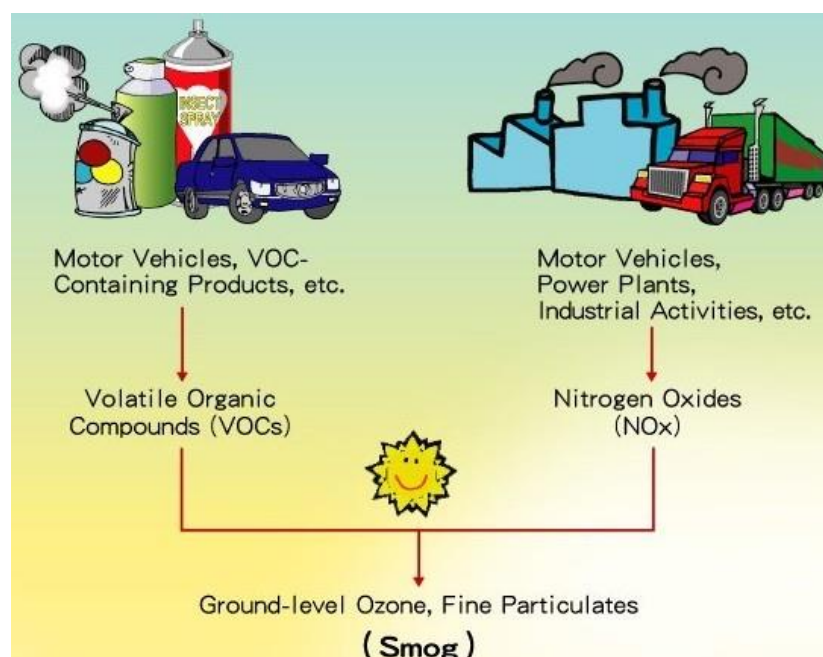
Ground level ozone has a negative effect on plants and ecosystems. Ozone prevents plants from producing and storing food making them more defenceless to diseases and parasites.



Effect of ozone on plants (*Bard, 2016*).

Volatile Organic Compounds Effects on Environment

When Volatile Organic Compounds are exposed to sunlight with NO_x and CO they react to create ground level O_3 giving us smog.

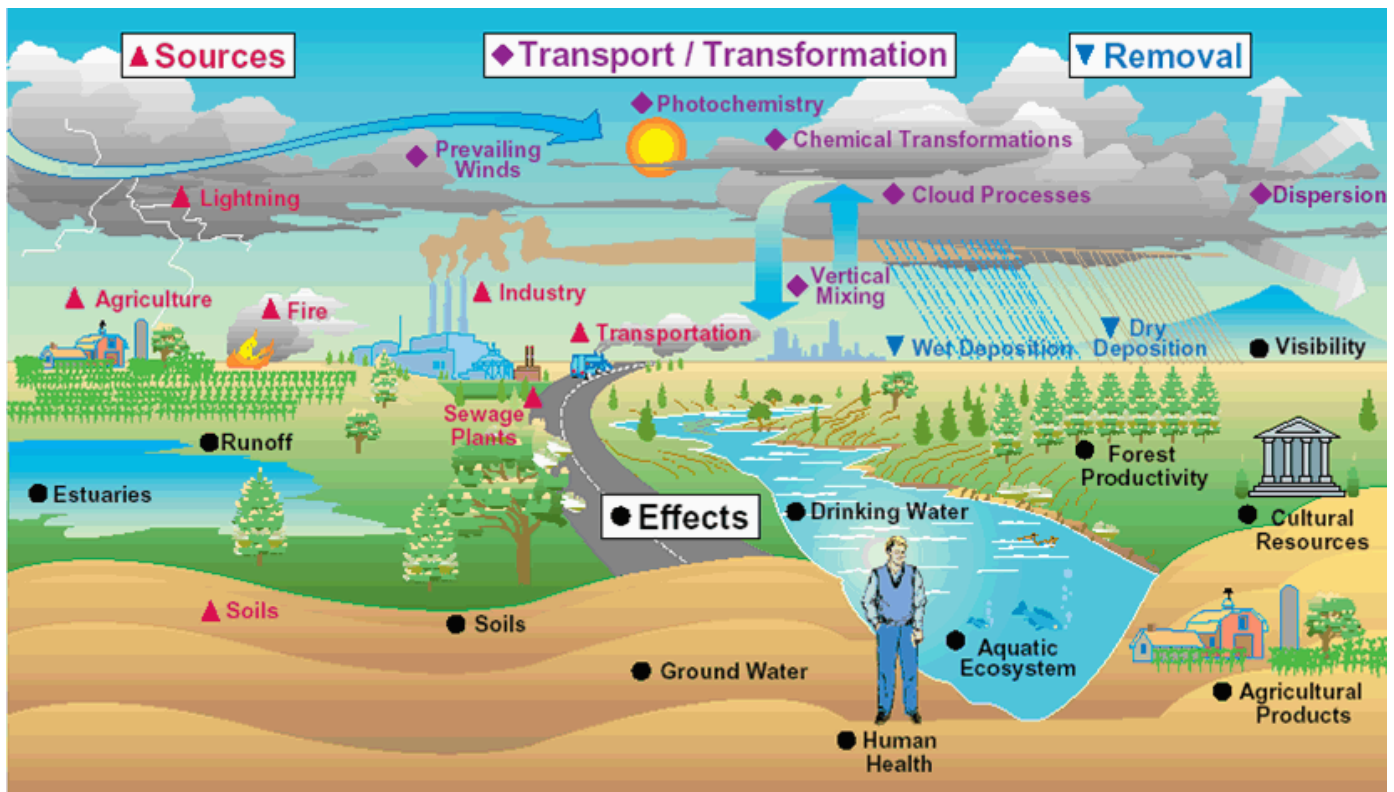


Creation of O_3 Smog due to VOC's and NO_x (*EPD, 2015*).

Particulate Matter Effects on Environment

Particles can be carried over long distances by wind and then settle on ground or water. Depending on their chemical composition, the effects of this settling may include:

- making lakes and streams acidic
- changing the nutrient balance in coastal waters and large river basins
- depleting the nutrients in soil
- damaging sensitive forests and farm crops
- affecting the diversity of ecosystems
- contributing to acid rain effects.



Sources, transport, effects and removal of particulates (*CLA, 2011*)

Video Information Material

Air pollution. What causes air pollution.

<https://youtu.be/fephtrPt6wk>

Why is air pollution a problem? How does air pollution affect the body?

<https://youtu.be/vYSAPwQwMTk>

Air pollution. Causes and effects of climate change.

<https://youtu.be/Bk8qm299N2s>

Waste dump site in Accra Ghana and the effects it is having on the people and their environment.

<https://youtu.be/jl8DGso-f4E>

Heating and cooking with wood. Effects on your health and environment.

<https://youtu.be/VvAY95TGPhA>

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