**OZONE DEPLETION**

**What is Ozone Layer?**

[Ozone layer](http://en.wikipedia.org/wiki/Ozone_layer) is a deep layer in earth’s atmosphere that contain ozone which is a naturally occurring molecule containing three oxygen atoms. These ozone molecules form a gaseous layer in the Earth’s upper atmosphere called stratosphere. This lower region of stratosphere containing relatively higher concentration of ozone is called Ozonosphere. The ozonosphere is found 15-35 km (9 to 22 miles) above the surface of the earth. The average concentration of ozone in the atmosphere is around 0.6 parts per million. The thickness of the ozone layer differs as per season and geography. The highest concentrations of ozone occur at altitudes from 26 to 28 km (16 to 17 miles) in the tropics and from 12 to 20 km (7 to 12 miles) towards the poles.

The ozone layer forms a thick layer in stratosphere, encircling the earth that has large amount of ozone in it. It protects our planet i.e. Earth from the harmful radiations that comes from the sun. The ozone layer was discovered in 1913 by the French physicists Charles Fabry and Henri Buisson. The ozone layer has the capability to absorb almost 97-99% of the harmful ultraviolet radiations that sun emit and which can produce long term devastating effects on humans beings as well as plants and animals.

## Why Ozone Layer is Necessary?

An essential property of ozone molecule is its ability to block solar radiations of wavelengths less than 290 nanometers from reaching Earth’s surface. In this process, it also absorbs ultraviolet radiations that are dangerous for most living beings. UV radiation could injure or kill life on Earth. Though the absorption of UV radiations warms the stratosphere but it is important for life to flourish on planet Earth. Research scientists have anticipated disruption of susceptible terrestrial and aquatic ecosystems due to depletion of ozone layer.

Ultraviolet radiation could destroy the organic matter. Plants and plankton cannot thrive, both acts as food for land and sea animals, respectively. For humans, excessive exposure to ultraviolet radiation leads to higher risks of cancer (especially skin cancer) and cataracts. It is calculated that every 1 percent decrease in ozone layer results in a 2-5 percent increase in the occurrence of skin cancer. Other ill-effects of the reduction of protective ozone layer include – increase in the incidence of cataracts, sunburns and suppression of the immune system.

## Causes of Ozone Layer Depletion

During the last several decades, human activities have resulted in considerable reduction in the ozone layer of the atmosphere. Ozone depletion occurs when destruction of the stratospheric ozone is more than the production of the molecule. The scientists have observed reduction in stratospheric ozone since early 1970s. It is found to be more prominent in Polar Regions.

There are two regions in which the ozone layer has depleted.

* In the mid-latitude, for example, over Australia, ozone layer is thinned. This has led to an increase in the UV radiation reaching the earth. It is estimated that about 5-9% thickness of the ozone layer has decreased, increasing the risk of humans to over-exposure to UV radiation owing to outdoor lifestyle.
* In atmospheric regions over Antarctica, ozone layer is significantly thinned, especially in spring season. This has led to the formation of what is called ‘ozone hole’. Ozone holes refer to the regions of severely reduced ozone layers. Usually ozone holes form over the Poles during the onset of spring seasons. One of the largest such hole appears annually over Antarctica between September and November.

**Natural causes of depletion of ozone layer:** Ozone layer has been found to be affected by certain natural phenomena such as Sun-spots and stratospheric winds. But this has been found to cause not more than 1-2% depletion of the ozone layer and the effects are also thought to be only temporary. It is also believed that the major [volcanic eruptions](http://www.conserve-energy-future.com/HowVolcanoesForm.php) (mainly El Chichon in 1983 and and Mt. Pinatubo in 1991) has also contributed towards ozone depletion.

**Man-made causes of depletion of ozone layer:** The main cause for the depletion of ozone is determined as excessive release of chlorine and bromine from man-made compounds such as chlorofluorocarbons (CFCs). CFCs (chlorofluorocarbons), halons, CH3CCl3 (Methyl chloroform), CCl4 (Carbon tetrachloride), HCFCs (hydro-chlorofluorocarbons), hydrobromofluorocarbons and methyl bromide are found to have direct impact on the depletion of the ozone layer. These are categorized as ozone-depleting substances (ODS). Chlorofluorocarbons are released into the atmosphere due to:

* Cleaning Agents
* Coolants in refrigerators
* Packing material
* Air conditioning
* Aerosol spray cans etc.

The problem with the Ozone-Depleting Substances (ODS) is that they are not washed back in the form of rain on the earth and in-fact remain in the atmosphere for quite a long time. With so much stability, they are transported into the stratosphere. The emission of ODS account for roughly 90% of total depletion of ozone layer in stratosphere. These gases are carried to the stratosphere layer of atmosphere where ultraviolet radiations from the sun break them to release chlorine (from CFCs) and bromine (from methyl bromide and halons). The chlorine and bromine free radicals react with ozone molecule and destroy their molecular structure, thus depleting the ozone layer. One chlorine atom can break more than 1, 00,000 molecules of ozone. Bromine atom is believed to be 40 times more destructive than chlorine molecules.

## Main Ozone Depleting Substances (OCD)

* Chlorofluorocarbons: Account for more than 80% of ozone depletion. Used in freezers, air cooling component, dry-cleaning agents, hospital sterilants.
* Methyl Chloroform: Used for vapour degreasing, some aerosols, cold cleaning, adhesives and chemical processing.
* Hydrochlorofluorocarbons: Substitutes for CFC’s but still play a vital role in ozone depletion.
* Halons
* Carbon Tetrachloride: Mainly used in fire extinguishers

# ACID RAIN

# What is Acid Rain?

"Acid rain" is a broad term referring to a mixture of wet and dry deposition (deposited material) from the atmosphere containing higher than normal amounts of nitric and sulfuric acids. The precursors, or chemical forerunners, of acid rain formation result from both natural sources, such as volcanoes and decaying vegetation, and man-made sources, primarily emissions of [sulfur dioxide (SO2)](http://www3.epa.gov/acidrain/glossary.html#GlossS) and [nitrogen oxides (NOx)](http://www3.epa.gov/acidrain/glossary.html#GlossN) resulting from fossil fuel combustion. In the United States, roughly 2/3 of all SO2 and 1/4 of all NOx come from electric power generation that relies on burning fossil fuels, like coal.  Acid rain occurs when these gases react in the atmosphere with water, oxygen, and other chemicals to form various acidic compounds. The result is a mild solution of sulfuric acid and nitric acid. When sulfur dioxide and nitrogen oxides are released from power plants and other sources, prevailing winds blow these compounds across state and national borders, sometimes over hundreds of miles.

### Wet Deposition

[Wet deposition](http://www3.epa.gov/acidrain/glossary.html#GlossW) refers to acidic rain, fog, and snow. If the acid chemicals in the air are blown into areas where the weather is wet, the acids can fall to the ground in the form of rain, snow, fog, or mist. As this acidic water flows over and through the ground, it affects a variety of plants and animals. The strength of the effects depends on several factors, including how acidic the water is; the chemistry and [buffering capacity](http://www3.epa.gov/acidrain/glossary.html#bufferingcapacity) of the soils involved; and the types of fish, trees, and other living things that rely on the water.

### Dry Deposition

In areas where the weather is dry, the acid chemicals may become incorporated into dust or smoke and fall to the ground through [dry deposition](http://www3.epa.gov/acidrain/glossary.html#GlossD), sticking to the ground, buildings, homes, cars, and trees. Dry deposited gases and particles can be washed from these surfaces by rainstorms, leading to increased runoff. This runoff water makes the resulting mixture more acidic. About half of the acidity in the atmosphere falls back to earth through dry deposition.

**Effects of Acid Rain**

Acid rain causes acidification of lakes and streams and contributes to the damage of trees at high elevations (for example, red spruce trees above 2,000 feet) and many sensitive forest soils. In addition, acid rain accelerates the decay of building materials and paints, including irreplaceable buildings, statues, and sculptures that are part of our nation's cultural heritage. Prior to falling to the earth, sulfur dioxide (SO2) and nitrogen oxide (NOx) gases and their particulate matter derivatives—sulfates and nitrates—contribute to visibility degradation and harm public health.

# Reducing Acid Rain

There are several ways to reduce acid rain—more properly called acid deposition—ranging from societal changes to individual action. It is critical that acid deposition be reduced, not only in the United States and Canada, but also throughout the world to preserve the integrity of natural habitats, as well as to reduce damage to man-made structures.

EPA has taken steps to limit the amount of NOx and SO2 emitted into the atmosphere because they are the main contributors to acid deposition (for more information, see [EPA’s Acid Rain Program](http://www.epa.gov/airmarkets/progsregs/arp/index.html)).

Additionally, individuals and society as a whole can participate in various efforts to help reduce acid deposition:

* [Understand acid deposition’s causes and effects](http://www3.epa.gov/acidrain/reducing/index.html#understand)
* [Clean up smokestacks and exhaust pipes](http://www3.epa.gov/acidrain/reducing/index.html#clean)
* [Use alternative energy sources](http://www3.epa.gov/acidrain/reducing/index.html#use)
* [Restore a damaged environment](http://www3.epa.gov/acidrain/reducing/index.html#restore)
* [Look to the future](http://www3.epa.gov/acidrain/reducing/index.html#look)
* [Take action as individuals](http://www3.epa.gov/acidrain/reducing/index.html#take)

## Understand acid deposition’s causes and effects

To understand acid deposition's causes and effects, and to track changes in the environment, scientists from EPA, state governments, and academia study acidification processes. They collect air and water samples and measure them for various characteristics such as pH and chemical composition, and research the effects of acid deposition on human-made materials such as marble and bronze. Finally, scientists work to understand the effects of sulfur dioxide (SO2) and nitrogen oxides (NOx)—the pollutants that cause acid deposition and contribute to particulate matter —on human health. See the [acid rain effects section](http://www3.epa.gov/acidrain/effects/index.html) for more information.

To solve the acid rain problem, people need to understand how acid rain damages the environment. They also need to understand what changes could be made to the air pollution sources that cause the problem. The answers to these questions help leaders make better decisions about how to control air pollution and therefore, how to reduce—or even eliminate—acid rain. Because there are many solutions to the acid rain problem, leaders have a choice of which options or combinations of options are the best. The next section describes some of the steps that can be taken to tackle the acid deposition problem.

**GREENHOUSE EFFECT AND GLOBAL WARMING**

The greenhouse effect is a natural process that warms the Earth’s surface. When the Sun’s energy reaches the Earth’s atmosphere, some of it is reflected back to space and the rest is absorbed and re-radiated by greenhouse gases.

Greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide, ozone and some artificial chemicals such as chlorofluorocarbons (CFCs).

The absorbed energy warms the atmosphere and the surface of the Earth. This process maintains the Earth’s temperature at around 33 degrees Celsius warmer than it would otherwise be, allowing life on Earth to exist.

## Enhanced greenhouse effect

The problem we now face is that human activities – particularly burning fossil fuels (coal, oil and natural gas), agriculture and land clearing – are increasing the concentrations of greenhouse gases. This is the enhanced greenhouse effect, which is contributing to warming of the Earth.

### Greenhouse effect

**Step 1:** Solar radiation reaches the Earth's atmosphere - some of this is reflected back into space.

**Step 2:** The rest of the sun's energy is absorbed by thte land and the oceans, heating the Earth.

**Step 3:** Heat radiates from Earth towards space.

**Step 4:** Some of this heat is trapped by greenhouse gases in the atmosphere, keeping the Earth warm enough to sustain life.

**Step 5:** Human activities such as burning fossil fuels, agriculture and land clearing are increasing the amount of greenhouse gases released into the atmosphere.

**Step 6:** This is trapping extra heat, and causing the Earth's temperature to rise.

**Greenhouse Gas Induced Global Warming**

Since the industrial revolution got into full swing in the 19th century we have been burning ever increasing amounts of fossil fuels (coal, oil, gasoline, natural gas) in electric generating plants, manufacturing plants, trains, automobiles, airplanes, etc. Burning releases CO2 into the atmosphere (much the same as respiration does). These fossil fuels may have formed tens or hundreds of millions of years ago from the buried and preserved remains of plant and animal matter whose carbon originated via photosynthesis.

Photosynthesis and respiration in plants, animals, fungi, bacteria, etc. exchange carbon between the CO2 in the atmosphere and carbon compounds in organisms. But humans are now putting this natural carbon cycle out of balance. Because of the emission of CO2 long-stored in fossil fuels the percentage of CO2 in the atmosphere has increased from about 289 parts per million before the industrial revolution to over 360 parts per million and rising. Sometime during the 21st century the concentration of CO2 will be twice what it was before the industrial revolution.

With higher CO2 concentrations come expectations of a stronger greenhouse effect and therefore warmer global temperatures. This was originally proposed by a chemist named Arrhenius about a century ago. Global average temperatures have risen by a small, but measurable amount in the past 100 years, apparently in large part because of the higher level of atmospheric CO2. Global average temperatures are expected to be on the order of 2-5°C (3.6-9°F) higher by the time CO2 doubles the pre-industrial concentration. The temperature rise will be small in the tropics but much greater at high latitudes.

**Consequences of Global Warming**

A whole host of consequences will result. Some are probably already occurring.

Temperature measurements of the sea surface and deep ocean indicate that the oceans are warming. Rising ocean temperature causes rising sea level from thermal expansion of the water. Rising temperature also means melting glaciers and rising sea level through addition of meltwater to the oceans. Sea level rose about 1 foot during the last century, mostly from thermal expansion of the oceans. Sea level is expected to rise closer to 3 feet during the coming century. Rising sea level will cause increasing coastal erosion, flooding, and property damage during coastal storms on top of the potential for major loss of life from storms in low-lying coastal countries like Bangladesh and island nations in the Indian and Pacific Oceans.

Warmer sea surface temperatures will result in more and stronger tropical storms (hurricanes and typhoons). Coastlines already ravaged by these storms will expect to see more strong storms than before, increasing the loss of life and damage to infrastructure.

It is much more difficult to predict how regional and local weather patterns will change but there will certainly be changes. While higher temperatures will produce more rainfall across the globe, the regional rainfall patterns will likely change. Some areas will get more, some areas will get less. The timing of wet and dry periods may change. But higher temperatures will also mean more evaporation. Higher temperatures may also mean stronger storms with damaging winds. All of these mean new risks and changing conditions for agriculture. Centuries old farming practices will have to change. Some areas may go from being marginal to becoming a breadbasket region, while other regions may go from major agricultural production to marginal.

Higher CO2 allows plants to grow faster (more CO2 enhances photosynthesis). That would sound good for agriculture. However, weed species tend to grow even better than crop plants under enhanced CO2 conditions so improved crop growth may be nullified by weed competition.

Natural ecosystems will be hard pressed to keep up with the changing climate because the rate of change will be faster than typical long-term natural climate change. Many species, especially plant species, will not be able to migrate to cooler areas fast enough to keep up with the warming of their habitats. And arctic species will have no place to go and may not be able to adapt to the new conditions.

Severe summer heat in areas not used to it can lead to deaths. Higher heat and expansion of tropical areas may lead to increased incidence of malaria.

**DESERTIFICATION**

Desertification is a process of land-degradation by which a region becomes progressively drier and drier — eventually becoming desert. Or, to put it another way — desertification is the process by which previously biologically productive land is transformed into wasteland.

There’s actually currently something of a debate over the use of the term though. As it stands, the most widely accepted definition is probably the one that’s now printed in the Princeton University Dictionary — which defines it thusly: “The process of fertile land transforming into desert typically as a result of deforestation, drought, or improper/inappropriate agriculture”

There are a number of different causes/mechanisms behind the process, such as deflation (the loss of stabilizing vegetation, and of top soil); erosion; and soil-salinity-rise (via irrigation mostly).

Some of these are, as you’ve probably noted, at least partially “natural” — but as with nearly everything in life, just because something happens “on its own” doesn’t mean that you can’t help it along. Or nudge it off a cliff, for that matter. And that’s exactly what people have a history of doing with regard to the process of desertification. Pushing it off a cliff.

Most especially in recent years (but throughout much of recorded human history as well), much of the desertification around the world has been driven by human activity. Agriculture, animal husbandry, and groundwater pumping/depletion, are all currently significant contributors to the process.

As you can no doubt surmise, desertification is a significant global ecological and environmental problem, one that poses a significant threat to many regions of the world in the coming decades (with regard to human habitation and activity) — and, for that matter, one that has already felled (and/or contributed to the downfall of) many a great civilization throughout history.

Though it may be tempting to think of our current civilization as being immune to such historical constants — as the role that desertification has played in the collapse of many a civilization has most certainly been, a historical constant — there’s no doubt that it will cause significant problems with regard to the foundation on which our civilization (and most others) is built. That is to say — on agriculture and the relative peace/social-stability that a steady supply of food brings.

When food/arable-land becomes a scarcity, whole peoples, cultures, and populations, uproot and go on the move. Either displacing the people living in the still productive lands, eliminating them, and/or being eliminated themselves. Unsurprisingly, such chaotic and tumultuous periods are often the times when new ethnic/racial/cultural identities emerge.

**DEFORESTATION**

**What is deforestation?**

Deforestation is when humans remove or clear large areas of forest lands and related ecosystems for non-forest use. These include clearing for farming purposes, ranching and urban use. In these cases, trees are never re-planted.

Since the industrial age, about half of world's original forests have been destroyed and millions of animals and living things have been endangered. Despite the improvements in education, information and general awareness of the importance of forests, deforestation has not reduced much, and there are still many more communities and individuals who still destroy forest lands for personal gains.

**Why do humans clear forest lands?**

Trees are cut down (deforestation) for many reasons including:

**1.** To be used, sold or exported as timber, wood or fuel (charcoal). This is called logging.   
**2.** To be used for farming purposes (grazing fields for livestock, or large scale farming activities).  
**3.** To make room for human settlement and urbanization (these include making space for shelter, industries and roads)

**4.** To make room for mining

In all the reasons above, the trees cut are usually very well developed trees that have taken many years to mature. When they are cut, they break down many more younger trees as they fall to the ground, leaving that area heavily [degraded](http://eschooltoday.com/forests/what-is-deforestation.html).

**Effects of deforestation**

Looking at the importance of forests and trees in the previous pages, you can deduce the massive effects of deforestation and tree-cutting activities. Let us see a few below:  
**1. Soil erosion destruction**

Soils (and the nutrients in them) are exposed to the sun’s heat. Soil moisture is dried up, nutrients evaporate and bacteria that help break down organic matter are affected. Eventually, rain washes down the soil surfaces and erosion takes place. Soils never get their full potential back.  
**2. Water cycle**

When forests are destroyed, the atmosphere, water bodies and the water table are all affected. Trees absorb and retain water in their roots. A large part of the water that circulates in the ecosystem of rainforests remains inside the plants. Some of this moisture is transpired into the atmosphere. When this process is broken, the atmosphere and water bodies begin to dry out. The watershed potential is compromised and less water will run through the rivers. Smaller lakes and streams that take water from these larger water bodies dry up.  
**3. Loss of biodiversity**

Many wonderful species of plants and animals have been lost, and many others remain endangered. More than 80% of the world's species remain in the Tropical Rainforest. It is estimated that about 50 to 100 species of animals are being lost each day as a result of destruction of their habitats, and that is a tragedy.

Many beautiful creatures, both plants and animals have vanished from the face of the earth.  
**4. Climate change**

Plants absorb Carbon Dioxide CO2 (a greenhouse gas) from the atmosphere and uses it to [produce food](http://www.eschooltoday.com/photosynthesis/what-is-photosynthesis.html) (carbohydrates, fats, and proteins that make up trees). In return, it gives off Oxygen. Destroying the forests mean CO2 will remain in the atmosphere and in addition, destroyed vegetation will give off more CO2 stored in them as they decompose. This will alter the climate of that region. Cool climates may get a lot hotter and hot places may get a lot cooler.

**RADIOACTIVITY LEAKAGE**

**Nuclear and radiation accidents and incidents**

A nuclear and radiation accident is defined by the [International Atomic Energy Agency](https://en.wikipedia.org/wiki/International_Atomic_Energy_Agency) (IAEA) as "an event that has led to significant consequences to people, the environment or the facility." Examples include [lethal effects to individuals](https://en.wikipedia.org/wiki/Radiation_poisoning), [large radioactivity release](https://en.wikipedia.org/wiki/Ionizing_radiation) to the [environment](https://en.wikipedia.org/wiki/Natural_environment), or [reactor core melt](https://en.wikipedia.org/wiki/Nuclear_meltdown)." The prime example of a "major nuclear accident" is one in which a [reactor core](https://en.wikipedia.org/wiki/Reactor_core) is damaged and significant amounts of [radioactivity](https://en.wikipedia.org/wiki/Radioactivity) are released, such as in the [Chernobyl disaster](https://en.wikipedia.org/wiki/Chernobyl_disaster) in 1986.

The impact of nuclear accidents has been a topic of debate practically since the first [nuclear reactors](https://en.wikipedia.org/wiki/Nuclear_reactor) were constructed in 1954. It has also been a key factor in [public concern about nuclear facilities](https://en.wikipedia.org/wiki/Anti-nuclear_movement). Some technical measures to reduce the risk of accidents or to minimize the amount of radioactivity released to the environment have been adopted. Despite the use of such measures, [human error](https://en.wikipedia.org/wiki/Normal_Accidents) remains, and "there have been many accidents with varying impacts as well near misses and incidents".

Worldwide there have been 99 accidents at nuclear power plants. Fifty-seven accidents have occurred since the Chernobyl disaster, and 57% (56 out of 99) of all nuclear-related accidents have occurred in the USA. Serious [nuclear power plant](https://en.wikipedia.org/wiki/Nuclear_power_plant) accidents include the [Fukushima Daiichi nuclear disaster](https://en.wikipedia.org/wiki/Fukushima_Daiichi_nuclear_disaster) (2011), Chernobyl disaster (1986), [Three Mile Island accident](https://en.wikipedia.org/wiki/Three_Mile_Island_accident) (1979), and the [SL-1](https://en.wikipedia.org/wiki/SL-1) accident (1961).

[Nuclear-powered submarine](https://en.wikipedia.org/wiki/Nuclear-powered_submarine) core meltdown and other mishaps include the [K-19](https://en.wikipedia.org/wiki/Soviet_submarine_K-19) (1961), [K-11](https://en.wikipedia.org/wiki/Soviet_submarine_K-11) (1965), [K-27](https://en.wikipedia.org/wiki/Soviet_submarine_K-27) (1968), [K-140](https://en.wikipedia.org/wiki/Soviet_submarine_K-140) (1968), [K-429](https://en.wikipedia.org/wiki/Soviet_submarine_K-429) (1970), [K-222](https://en.wikipedia.org/wiki/Soviet_submarine_K-222) (1980), [K-314](https://en.wikipedia.org/wiki/Soviet_submarine_K-314) (1985), and [K-431](https://en.wikipedia.org/wiki/Soviet_submarine_K-431) (1985). Serious radiation accidents include the [Kyshtym disaster](https://en.wikipedia.org/wiki/Kyshtym_disaster), [Windscale fire](https://en.wikipedia.org/wiki/Windscale_fire), [radiotherapy accident in Costa Rica](https://en.wikipedia.org/wiki/Radiotherapy_accident_in_Costa_Rica), [radiotherapy accident in Zaragoza](https://en.wikipedia.org/wiki/Radiotherapy_accident_in_Zaragoza), [radiation accident in Morocco](https://en.wikipedia.org/wiki/Radiation_accident_in_Morocco), [Goiania accident](https://en.wikipedia.org/wiki/Goiania_accident), [radiation accident in Mexico City](https://en.wikipedia.org/wiki/Radiation_accident_in_Mexico_City), radiotherapy unit accident in Thailand, and the [Mayapuri radiological accident](https://en.wikipedia.org/wiki/Mayapuri_radiological_accident) in India.