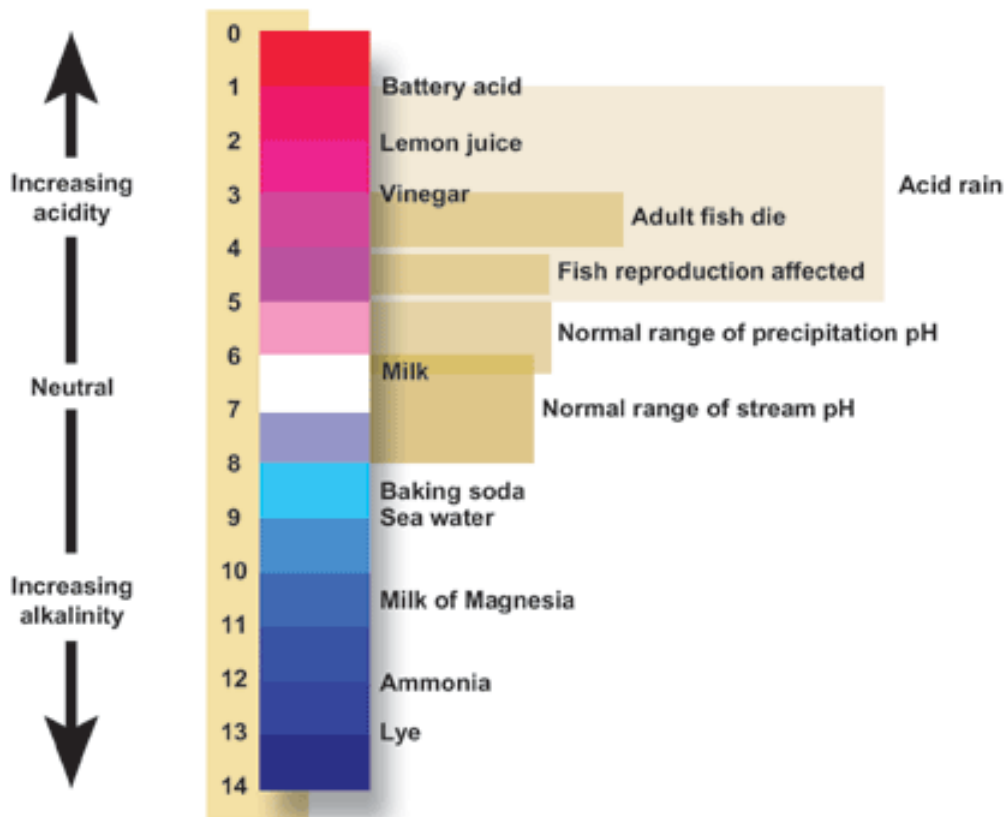


# Acid Rain



## Introduction

Acid rain refers to rainwater that, having been contaminated with chemicals introduced into the atmosphere through industrial and automobile emissions, has had its acidity increased beyond that of clean rainwater. Acidity is measured on a pH scale. For example, vinegar, an acid, has a pH of 3, and lemon juice, another acid, has a pH of 2. It is generally accepted that rain with a pH less than 5.3 is acidic.



Emissions of sulphur and nitrogen oxides from a variety of sources enter the atmosphere everyday. While in the atmosphere, these compounds combine with atmospheric water to form acids. The most common acids formed in this manner are sulphuric acid and nitric acid. When mixed with rain, these acids fall as wet deposition (acid rain). In the absence of rain, the particulate matter slowly settles to the ground as dry deposition. Together, wet and dry deposition of acidic substances is known as acid precipitation.

## The Long-Range Transport of Airborne Pollutants

On a daily basis, human activities -- industrial, agricultural and residential -- cause vast quantities of natural and synthetic chemicals to be emitted into the atmosphere.

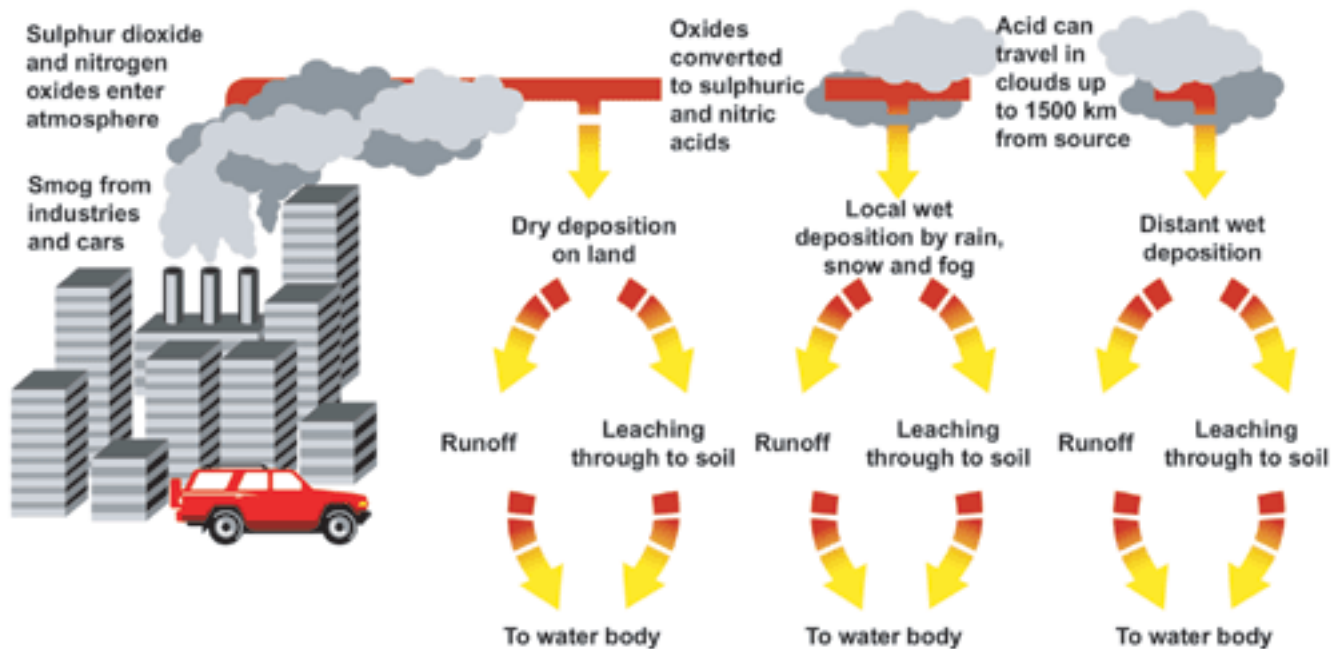
Once released, the substances are dispersed throughout the globe by air currents that know no boundaries -- provincial or international. This phenomenon is known as the *long-range transboundary air pollution (LRTAP)*.

Over time, these emissions expose human beings, wildlife and resources to diverse quantities and mixtures of air pollutants. The resulting harm is difficult to evaluate, since it occurs over varying time frames and over vast areas having differing degrees of sensitivity. The reversibility of the damage is not yet well understood.

Some of the chemicals in the atmosphere are rendered harmless through exposure to sunlight, but others are extremely persistent, surviving and circulating around the earth for as long as months or years. They reach our water systems through dry or wet deposition.

*Acid rain*, one of the most publicized LRTAP phenomena, originated with emissions from coal-fired generators, non-ferrous metal smelters, petroleum refineries, iron and steel mills, pulp and paper mills, and from motor vehicle exhaust. The released sulphur dioxide and nitrogen oxides are converted to sulphuric and nitric acids in the atmosphere. These acids return to earth through wet sulphate and/or nitrate deposition (including rain, snow and fog).

## Acid rain



In Canada, the major sources of sulphur dioxide emissions are non-ferrous metal smelters, followed by coal-fired generators. Motor vehicles and, to a lesser extent, coal-fired generators, are the major sources of nitrogen oxides. About half the wet sulphate deposition in eastern Canada is estimated to come from the United States, while about ten percent of the deposition in the northeastern United States comes from Canada.

The damage caused by acid rain deposition occurs in environments that cannot tolerate acidification. Many species of fish, insects, aquatic plants and bacteria develop reproduction difficulties. Some even die. The decline in the population of any of these aquatic organisms affects the food chain. Dwindling populations of insects and small aquatic plants and animals are especially serious because the entire food chain is

affected.

## How Acid Rain Affects Water Quality

The effects of acid deposition on water quality, although complicated and variable, have been well documented. Impacts from these acidic compounds in the atmosphere can occur directly, by deposition on the water surface, or indirectly, by contact with one or more components of the terrestrial ecosystem before reaching any aquatic system. The interactions of acid deposition with the terrestrial ecosystem, including vegetation, soil, and bedrock, result in chemical alterations of the waters draining these watersheds, eventually altering conditions in the lakes downstream.

The extent of chemical alteration resulting from acidic deposition depends largely on the type and quantity of the soils and the nature of the bedrock material in the watershed, as well as on the amount and duration of the precipitation. Watersheds with soils and bedrock containing substantial quantities of carbonate-containing materials, such as limestone and calcite, are less affected by acidic deposition because of the high acid-neutralizing capacity derived from the dissolution of this carbonate material. Thousands of lakes in Canada, however, lie on the Precambrian Shield. This vast expanse of bedrock possesses few limestone-type materials and, consequently, has only a limited ability to neutralize acidic deposition. Consequently, lakes and rivers in these areas generally show acidification effects, including decreasing pH levels and increasing concentrations of sulphate and certain metals such as aluminum and manganese.

The map below shows the potential of soils and bedrock to reduce the acidity of acid rain. Red shaded areas, almost half of Canada's area, are most sensitive to the effects of acid rain.

