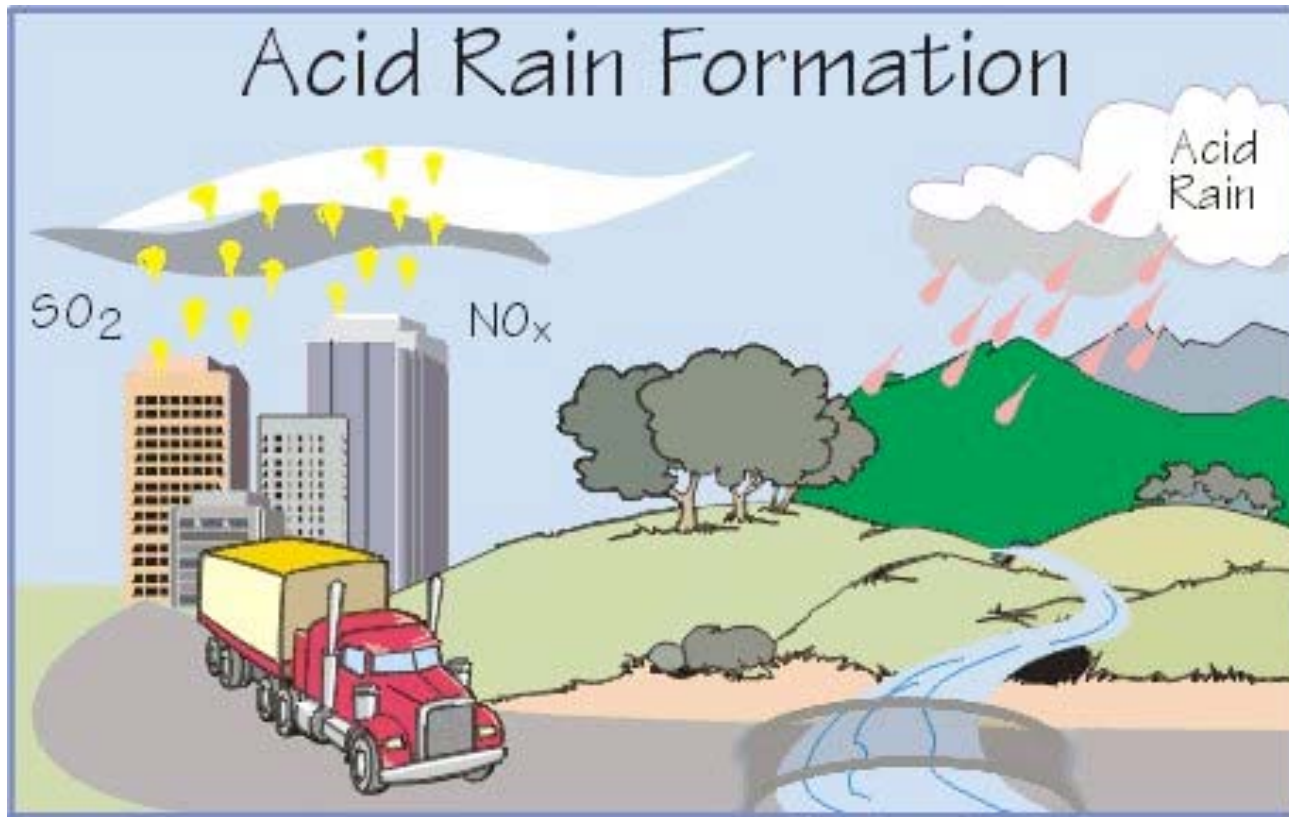
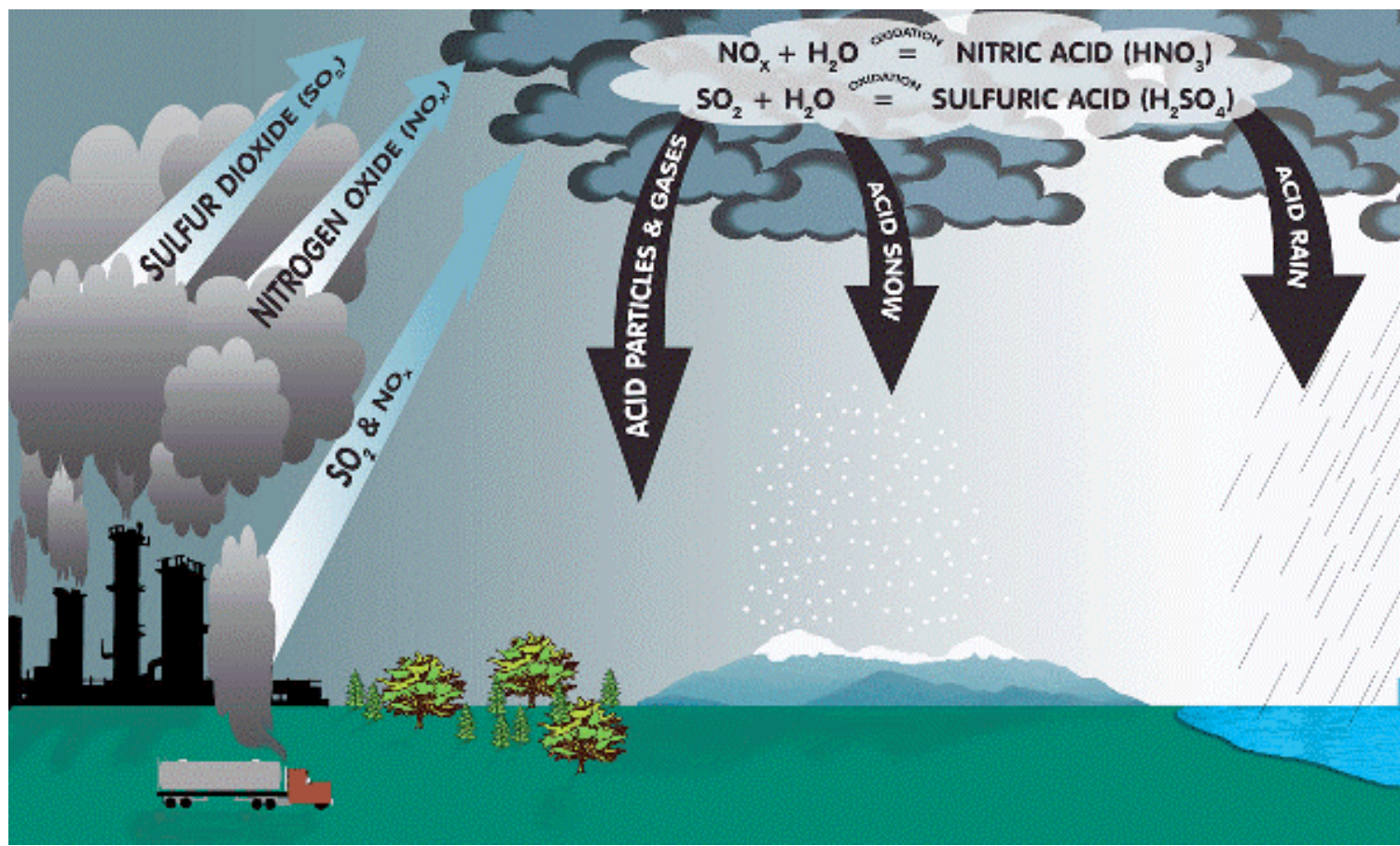


Acid Rain



What causes acid rain?

- Acid rain is caused by the burning of fossil fuels.
- Burning oil, gas and coal in power stations releases Sulphur Dioxide (SO_2) into the atmosphere. Burning oil and gas in motor vehicles puts nitrogen oxides (NO_x) into the atmosphere.
- These gases mix with water droplets in the atmosphere creating weak solutions of nitric and sulphuric acids. When precipitation occurs these solutions fall as acid rain.

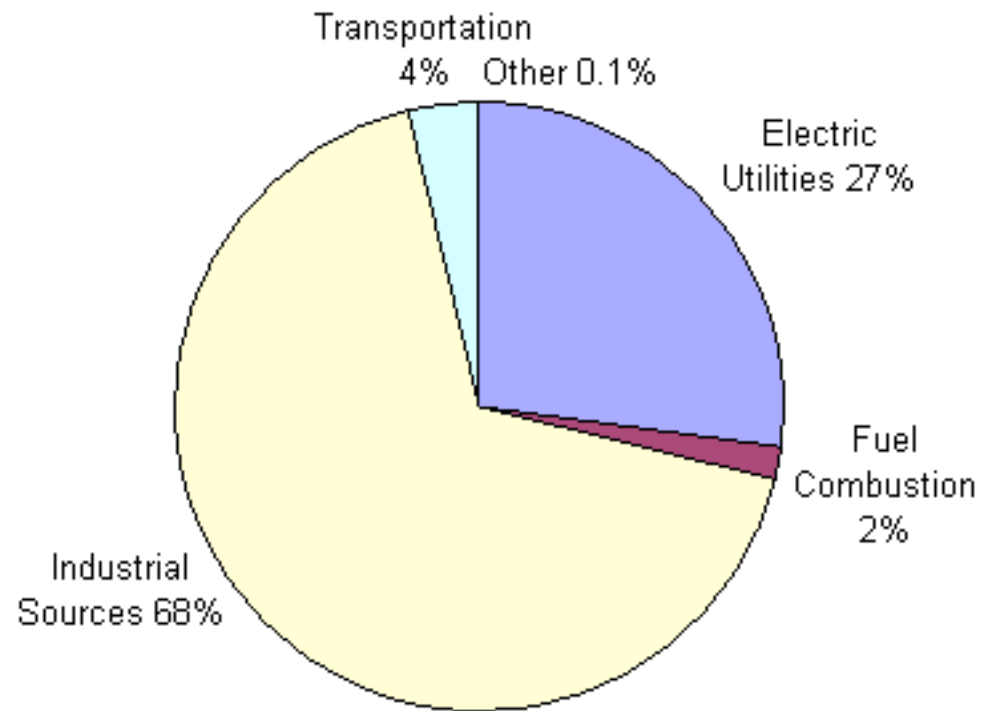


SO₂

- Sulphur dioxide (SO₂) is generally a byproduct of industrial processes and burning of fossil fuels.
- Ore smelting, coal-fired power generators and natural gas processing are the main contributors. In 2000, for instance, U.S. SO₂ emissions were measured at 14.8 million tonnes - more than six times greater than Canada's 2.4 million tonnes.
- But the sources of SO₂ emissions from the two countries are different. In Canada, 68% of emissions come from industrial sources and 27% comes from electric utilities (2000). In the U.S., 67% of emissions are from electric utilities (2002).

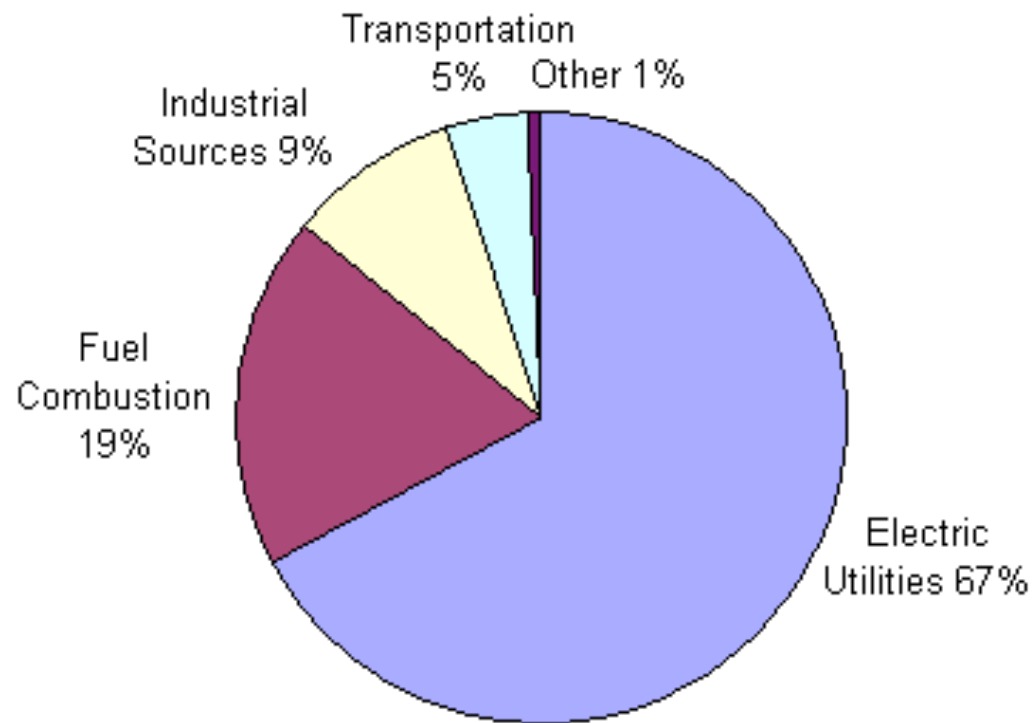
SO₂

Canada - 2000 SO₂



SO₂

United States - 2002 SO₂

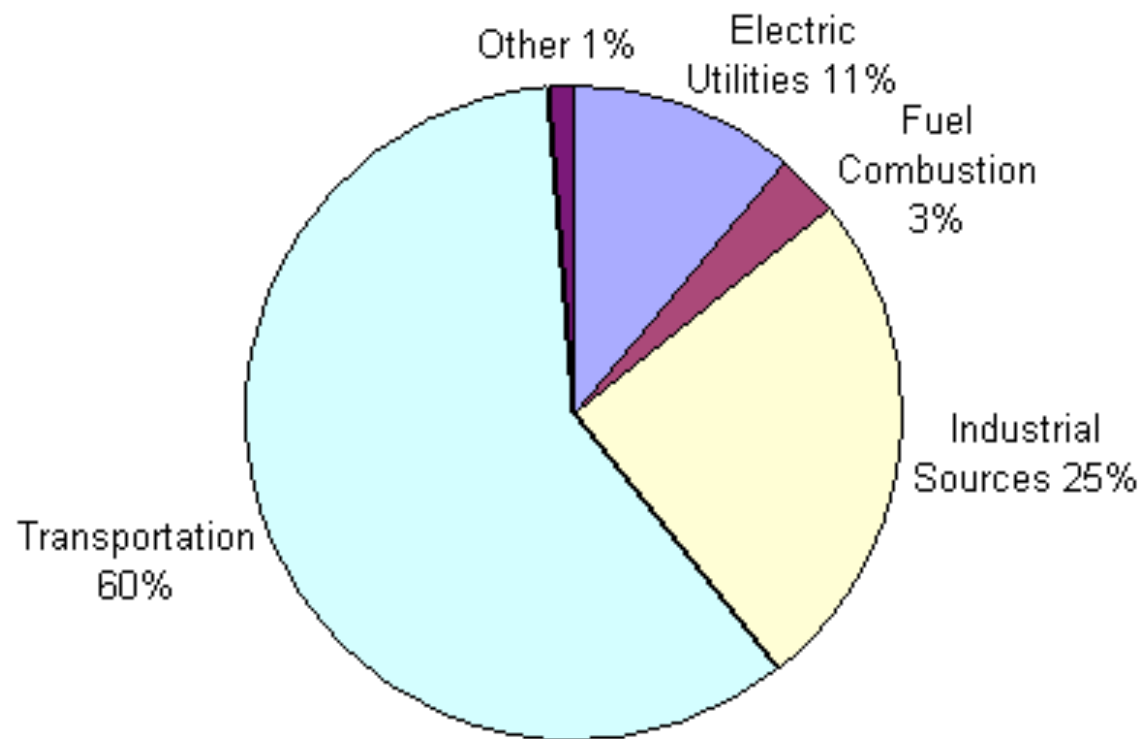


NOx

- The main source of NOx emissions is the combustion of fuels in motor vehicles, residential and commercial furnaces, industrial and electrical-utility boilers and engines, and other equipment.
- In 2000, Canada's largest contributor of NOx was the transportation sector, which accounted for approximately 60% of all emissions. Overall, NOx emissions amounted to 2.5 million tonnes in 2000. By comparison, U.S. NOx emissions for 2000 amounted to 21 million tonnes - 8 times more than Canada's emissions.

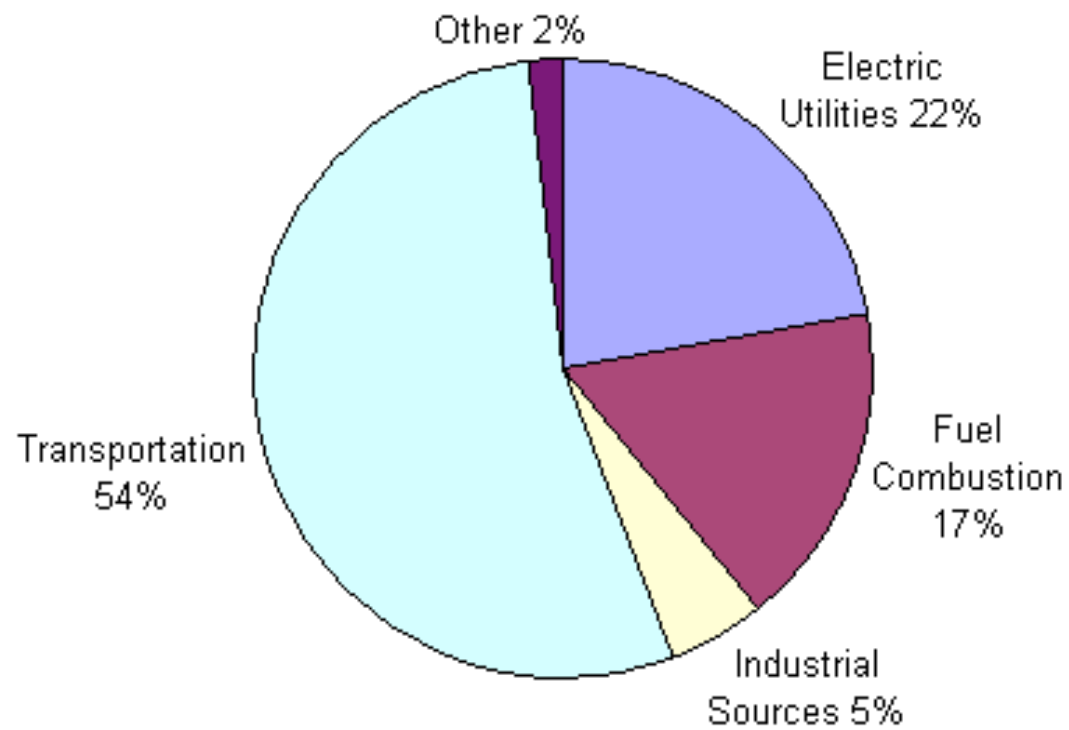
NO_x

Canada - 2000 NO_x



NO_x

United States - 2002 NO_x

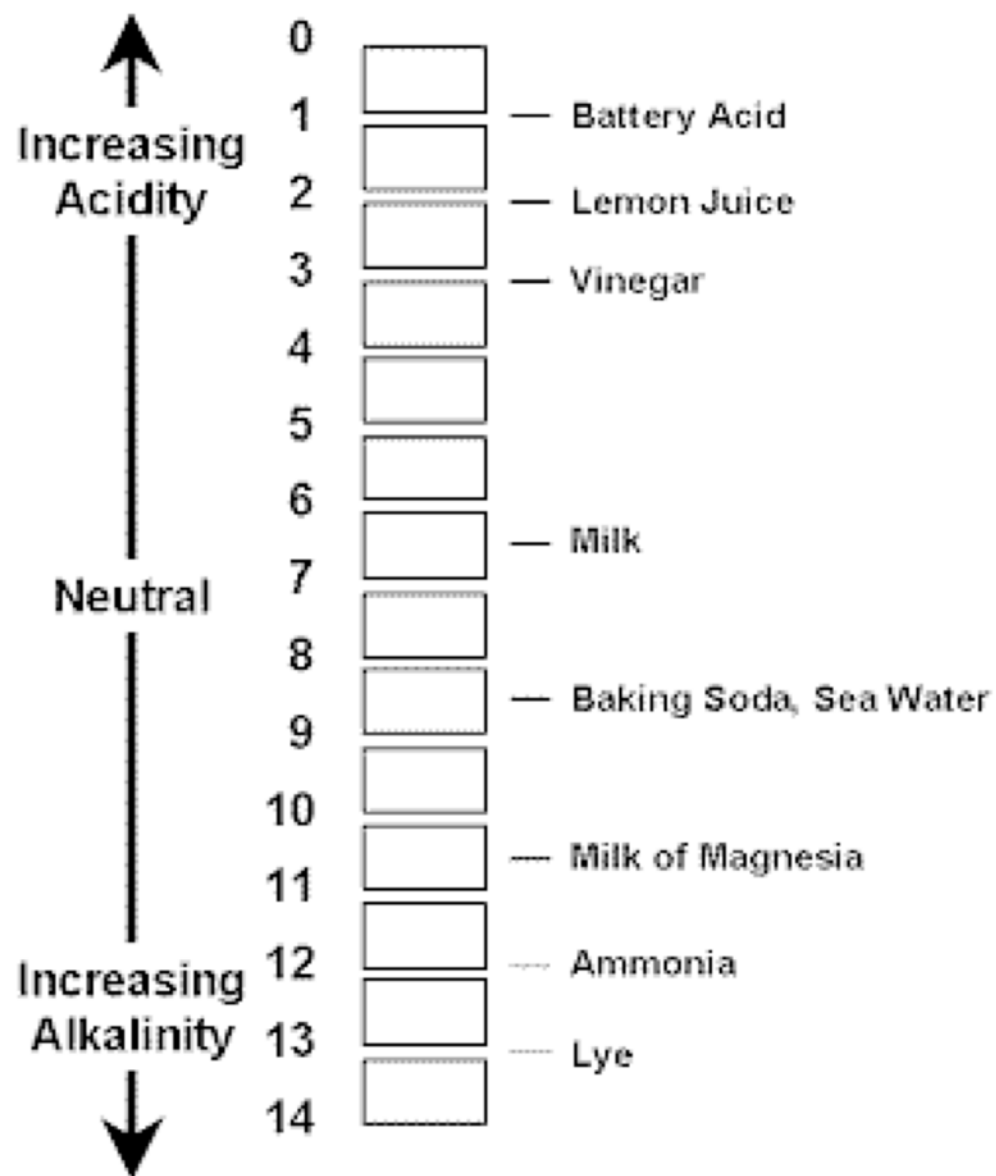


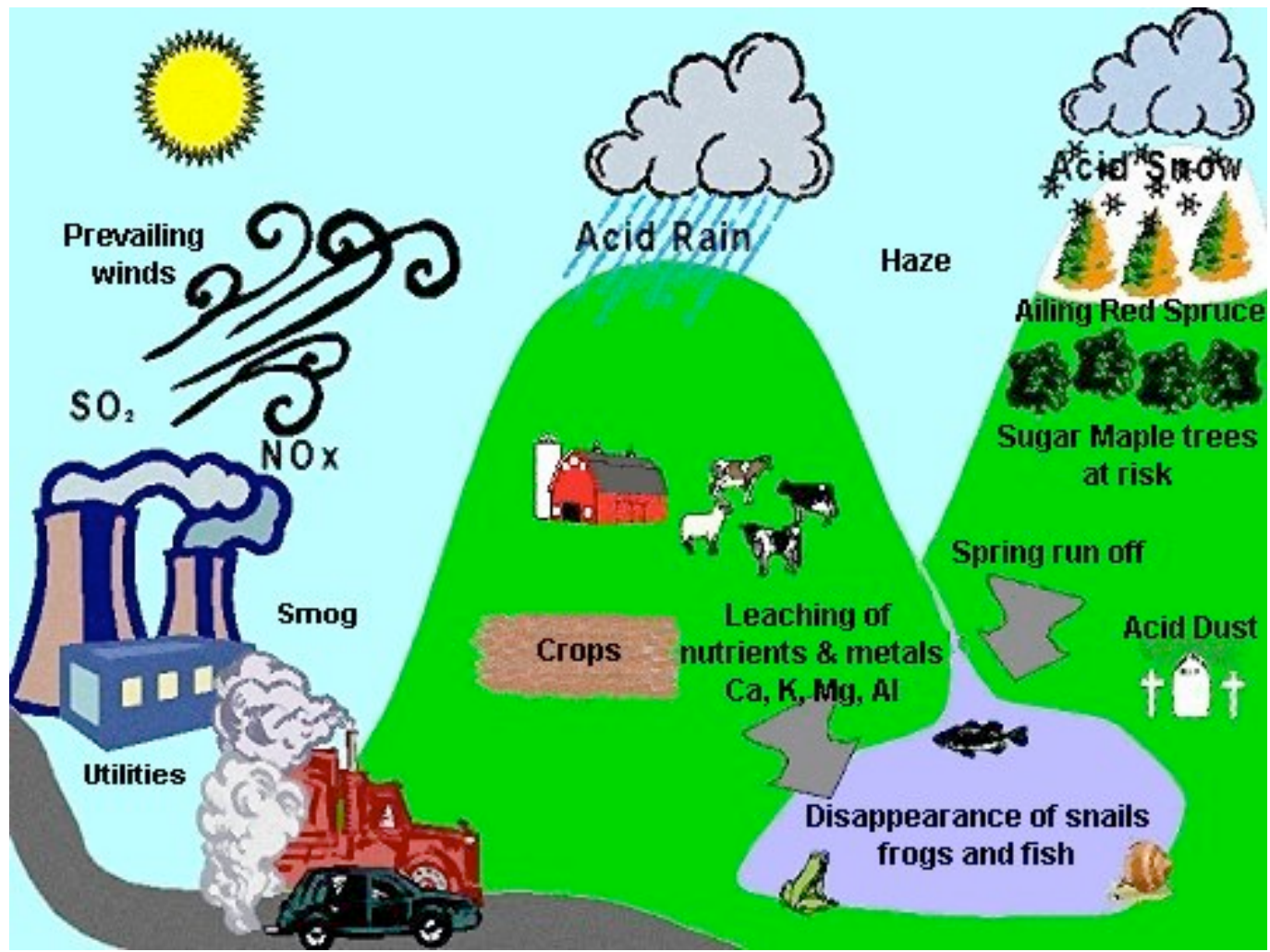




How Do We Measure Acid Rain?

- Acid rain is measured using a scale called "pH." The lower a substance's pH, the more acidic it is. Pure water has a pH of 7.0. Normal rain is slightly acidic because carbon dioxide dissolves into it, so it has a pH of about 5.5.
- As of the year 2000, the most acidic rain falling in the US has a pH of about 4.3.





What problems are caused by acid rain?

- Acid rain increases the acidity levels of rivers, lakes and seas. This can kill aquatic life.
- Acid rain increases the acidity levels of soils. This can kill vegetation.
- Acid rain has been found to destroy the roots and leaves of forests in Germany and Scandinavia have been destroyed as the result of acid rain emissions from the UK.
- Acid rain can erode buildings and monuments (particularly if they are made from limestone).

Power Plants

- Most sulfur dioxide comes from power plants that use coal as their fuel. These plants emit 100 million tons of sulfur dioxide, 70% of that in the world.



Credit: Tennessee Valley Authority (TVA)

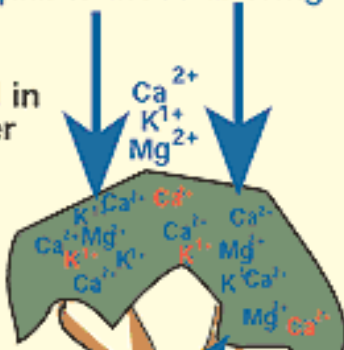
Automobiles

- Automobiles produce about half of the world's nitrogen oxide. As the number of automobiles in use increases, so does the amount of acid rain.
- Power plants that burn fossil fuels also contribute significantly to nitrogen oxide emission.

Chilean Forest:

The amount of precipitation derived elements leaving is equal to those arriving

Nutrients dissolved in precipitation enter



Tree takes up nutrients from soil, some from rock weathering, some from atmospheric sources

Blue=precipitation derived nutrients

Red=Rock derived nutrients

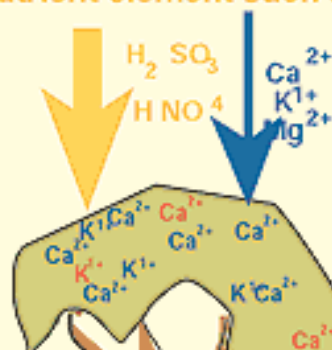


Nutrients exit to groundwater and streams



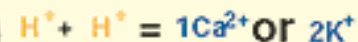
Acid impacted forest:

Every H^+ added to the soil by acid rain replaces an equivalent amount of a nutrient element such as K

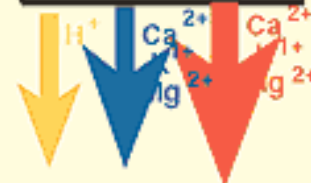
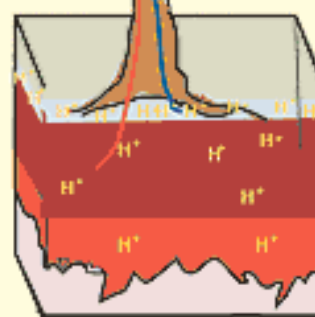


Tree leaves become yellow as nutrients become scarce in the soil

H^+ ions from acid replace the nutrient elements in the soil: for every unit of acid added to the soil, an equivalent amount of nutrient elements are removed



More nutrient elements are leached from the soil than arrive from weathering of rocks or precipitation; the forest goes into decline



Natural Causes

- Fires, volcanic eruptions, bacterial decomposition, and lightening also greatly increase the amount of nitrogen oxide on the planet. However, even the gigantic explosion of Mt. St. Helens released only about what one coal power plant emits in a year.



Solutions

- Industry can reduce acid rain creation by using coal with a low sulfur content, they can remove the sulfur from smoke their plants release, and they can limit processes known to generate high levels of acid rain.
- Environmentalists advocate the installation of sulfur cleaning scrubbers in factories, washing sulfur out of coal, and finding new methods of burning coal. Power plant operators are looking for less expensive solutions to the problem.

US vs. Canada

- Canada cannot win the fight against acid rain on its own. Only reducing acidic emissions in both Canada and the U.S. will stop acid rain.
- More than half of the acid deposition in eastern Canada originates from emissions in the United States. Areas such as southeastern Ontario and Southern Quebec receive about three-quarters of their acid deposition from the United States.

One Brick Shy

Bob Smith



"Dad, what's acid rain?"