The Muskoka Watershed

REPORT CARD

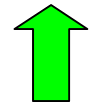
Background Report #6

Our Air – Acid Deposition

Muskoka
WATERSHED COUNCIL

July 2004

OUR AIR – ACID DEPOSITION

Indicator	Are we Happy?	Trend
Reduction in acid rain that will allow full recovery of our lakes and forests.		

Why is acid deposition a concern?

<u>Our Water</u>

In aquatic systems, acid deposition lowers the lake pH. This is especially true in lakes on the Canadian Shield, because they lack the basic compounds that buffer acidification. One of the most obvious effects of aquatic acidification is the decline in fish numbers. In the 1970s scientists discovered that acidified lakes also contained higher concentrations of toxic heavy metals like aluminum and cadmium. The source of the increase in aluminum and cadmium in the soil and bedrock surrounding the water body. Normally, these chemicals are found locked in clay particles, minerals and rocks. However, the acidification of terrestrial soils and bedrock can cause these metals to become soluble. Once soluble, these toxic metals are easily leached by infiltrating water into aquatic systems. Increases in mercury are a result of industrial emissions outside the watershed.

<u>Our Land</u>

The severity of the impact of acid deposition on vegetation is greatly dependent on the type of soil in which plants grow. Similar to surface water acidification, soils on the Canadian Shield do not have enough natural buffering capacity to withstand long-term elevated acid deposition and therefore, are not able to neutralize acid inputs over the long-term. Increasing acidity results in the leaching of several important plant nutrients, including calcium, potassium, and magnesium. Reduction in the availability of these nutrients causes a decline in plant growth rates. Reductions in soil pH can also cause germination of seeds and the growth of young seedlings to be inhibited.

Many important soil organisms cannot survive in soils below a pH of about 6.0. The death of these organisms can inhibit decomposition and nutrient cycling. High concentrations of nitric acid can increase the availability of nitrogen and reduce the availability of other nutrients necessary for plant growth. As a result, the plants become over-fertilized by nitrogen (a condition known as nitrogen saturation)[1].

Acid deposition can cause direct damage to the foliage of plants especially when the precipitation is in the form of fog, which is up to ten times more acidic than rainfall. Dry deposition of sulphur dioxide and nitrogen oxides has been found to affect the ability of leaves to retain water during dry periods.

[1] http://royal.okanagan.bc.ca/mpidwirn/atmosphereandclimate/a

Acidic deposition can leach nutrients from plant tissues weakening their structure. The combination of these effects can lead to plants that have reduced growth rates, flowering ability and yields. It also makes plants more vulnerable to diseases, insects, droughts and frosts.

Our Air

Increased concentrations of sulphur dioxide and nitrogen oxides have been correlated to increased hospital admissions for respiratory illness. Research on children from communities that receive a high amount of acidic pollution show increased frequencies of chest colds, allergies and coughs.

Our Communities

Acid deposition can influence human health when toxic metals, such as mercury, are released into the environment through the acidification of soils or industrial emissions. The toxic metals can then end up in the drinking water, crops, and fish and be ingested by humans through consumption. If ingested in great quantities, these metals can have toxic effects on human health.

Acid deposition also influences the economic livelihood of some people. Some lakes and streams have seen a decline in fish levels as a result of acidification. The reduced fish numbers will influence industries that rely on sport fishing.

Forestry is also affected by the damage caused to vegetation. In some areas of Muskoka, dieback of trees has occurred. As calcium is leached out of soils, plant growth will become impaired.

Finally, acid deposition affects buildings and other features of human construction. Buildings and head stones that are constructed from limestone are easily attacked by acids, as are structures that are constructed of iron or steel. Paint on cars can react with acid deposition, causing fading.

Current state

Initiated in 1985, the Eastern Canada Acid Rain Program committed Canada to cap sulphur dioxide emissions in the seven provinces from Manitoba eastward at 2.3 million tonnes by 1994, a 40% reduction from 1980 levels. By 1994, all seven provinces had achieved or exceeded their targets. In 1998, the provinces, territories and the federal government signed *The Canada-Wide Acid Rain Strategy for Post-2000*, committing them to further actions to deal with acid rain. Progress under both the Eastern Canada Acid Rain Program and the Post-2000 Strategy, including data on emissions, is reported in the respective annual reports of these two programs. In 1999, the most recent year for which data are available, emissions in eastern Canada totalled just 1.61 million tonnes - 30% below the 2.3-million tonne cap and a 58% reduction from 1980 levels.

Our Water

Even with these major emission control programs, the level of acidic deposition remaining is still unlikely to promote widespread recovery of aquatic ecosystems. A study of 285 lakes in the Muskoka River catchment was undertaken to evaluate the need for further reductions in emissions. As a result of the past decline in deposition, the number of lakes that exceed the level defined as a sustainable exposure to acid deposition has dropped substantially; however, further reductions in sulphur and nitrogen emissions are required to bring all lakes to a sustainable level. Even with full implementation of SO_2 abatement programs in Canada (achieved in 1994) and the United States (legislated for 2010), critical loads will be exceeded in a large proportion (46.6%) of the study lakes.

Our Land

Acid deposition has caused severe depletion of nutrients in forest soils in parts of Ontario, such as Muskoka, along with Quebec, the Atlantic Provinces, and the northeastern United States. While this may be reversible, it will take many years – in some areas hundreds of years – for soil nutrients to be replenished to former levels through natural processes such as weathering, even if acid rain were eliminated completely. For now, forests in affected areas-where acid rain exceeds the critical loads-are using the pool of minerals accumulated during pre-industrial times, although some monitoring sites are already deficient and visual damage has appeared. The loss of nutrients in forest soils may threaten the long-term sustainability of forests in areas with sensitive soils.

Our Air

Figure 1 illustrates an estimate of the historic sulphate deposition for the period 1850 – 1997. Although sulphate levels are being reduced, levels are still elevated above pre-European settlement era.

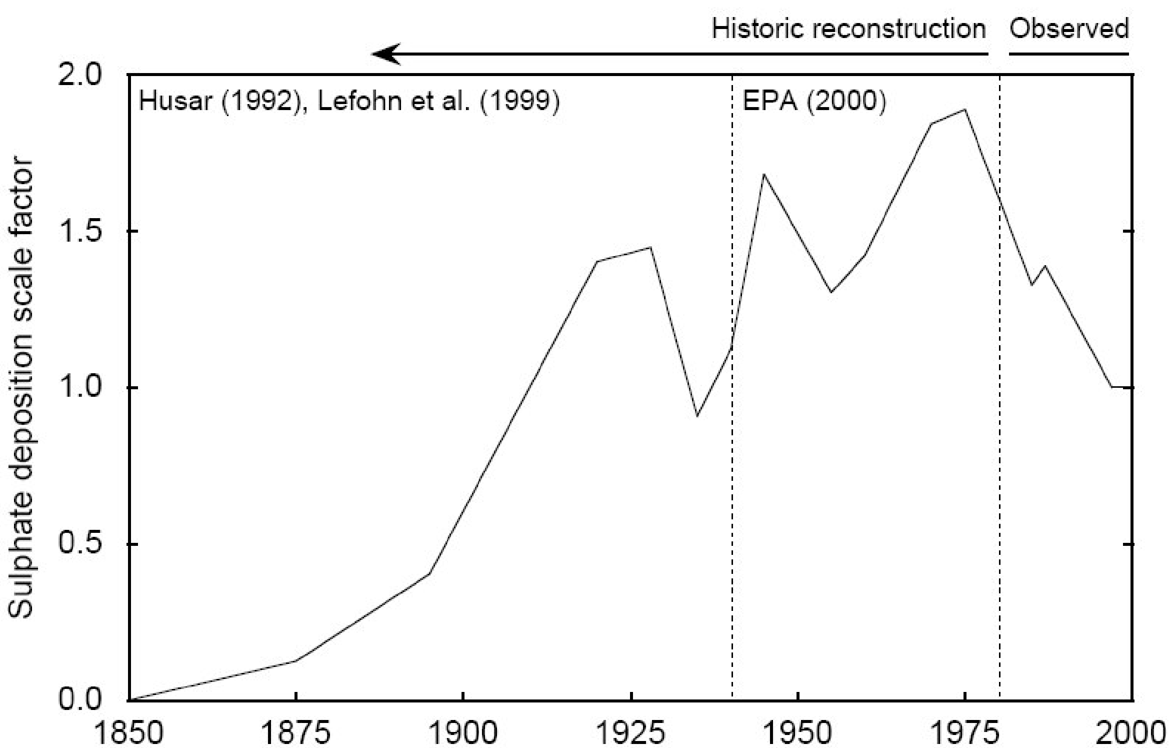


FIGURE 1: Estimate of Historic Sulphate Deposition

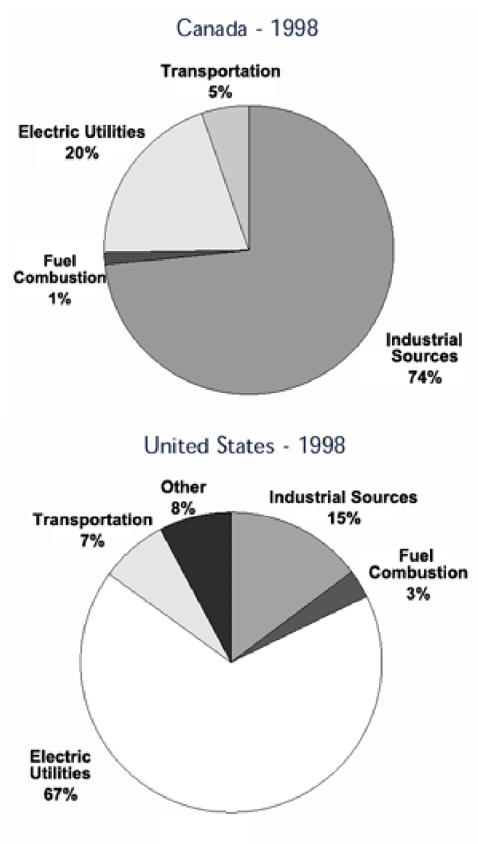
Reducing nitrogen oxides is also becoming important, especially as it relates to air quality. If nitrate deposition continues at current levels, its contribution to acidification will eventually erode the benefits gained from the reductions in sulphur dioxide. Because nitrogen oxides also contribute to ground-level ozone, the main ingredient in smog, reducing these emissions will also help to improve air quality.

What are the stresses?

Sulphur Dioxide: Sulphur dioxide (SO_2) 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 1998, for instance, U.S. SO_2 emissions were measured at 17.7 million tonnes – more than six times greater than Canada's 2.7 million total tonnes. But the sources of SO_2 emissions from the two countries are quite different. While 74% of Canada's emissions come directly from industrial sources, 67% of the U.S. emissions are from electric utilities.

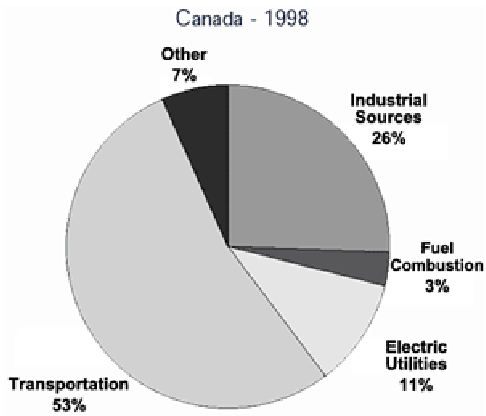
Canada cannot win the fight against acid rain on its own. Only reducing acidic emissions in both Canada and the U.S. will stop acid rain. More than half of the acid deposition in eastern Canada originates from emissions in the United States. Areas such as Muskoka receive about three-quarters of their acid deposition from the United States. In 1995, the estimated trans-boundary flow of sulphur dioxide from the United States to Canada was between 3.5 and 4.2 millions of tonnes per year.

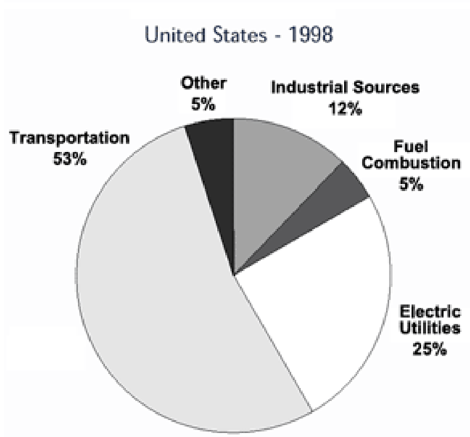
SO_2 Emissions from Canada and the United States in 1998



Nitrogen Oxides: The main source of NO_X emissions is the combustion of fuels in motor vehicles, residential and commercial furnaces, industrial and electrical-utility boilers and engines, and other equipment. In 1998, Canada's largest contributor of NO_X was the transportation sector, which accounted for approximately 53% of all emissions. Overall, NO_X emissions amounted to 2.1 million tonnes in 1998. By comparison, U.S. NO_X emissions for 1998 amounted to 23.7 million tonnes – 11 times more than Canada's.

NO_x Emissions from Canada and the United States in 1998





What action can be taken?

Sulphur dioxide and nitrogen oxides are the main pollutants that cause acid rain. These pollutants are emitted largely by the combustion of fossil fuels. Reducing the use of fossil fuels, including the use of electricity generated by coal- and oil-fired power plants, will help reduce acid rain-causing emissions. The following are some more specific suggestions on what you, as an individual, can do:

In the home:

- Reduce your use of electricity by reducing your hot water
    - Run the dishwasher only with a full load.
    - Run the washing machine with a full load.
    - If using an automatic dishwasher, let the dishes air dry.
    - Turn off the hot water tank when going away for extended periods of time.
    - Install additional insulation on the hot water tank and pipes.

- Reduce your use of electricity
    - Hang dry some, or all, of the laundry.
    - Buy energy-efficient appliances.
    - Avoid the use of air conditioners.
    - Turn out the lights in empty rooms and when away from home.
    - Consider installing compact fluorescent bulbs instead of high-wattage incandescent bulbs.

- Reduce your energy consumption in heating your home
    - Insulate and draft-proof your basement.
    - Weather-strip doors and windows.
    - Turn down the heat at night and when away from home.
    - If you have a forced-air furnace, change or clean its filters at least once a year.

In the yard:

- Reduce energy consumption by eliminating high maintenance
    - Consider changing to a low-maintenance landscape to reduce lawn mower use.
    - If you have a pool, keep a cover over it when you are not using it to heat by solar.

While shopping:

- Reduce the energy used to produce the products you use
    - Look for products bearing the EcoLogo symbol. They minimize the use of environmentally hazardous substances and maximize energy efficiency and the use of recycled materials.
    - Buy locally produced or grown items from local stores and businesses. They don't require the transportation energy of imported products.

Transportation:

- Reduce transportation emissions
    - Walk, ride your bike or take a bus to work.
    - Share a ride with a friend or co-worker.
    - Have your engine tuned at least once every six months.
    - Check your car tire pressure regularly.
    - Use alternative fuels, such as ethanol, propane or natural gas.
    - Avoid unnecessary idling.
    - In the winter, warm your car's engine with a block heater for two to three hours prior to driving, rather than plugging in the battery overnight.
    - Reduce the number of trips you make in your car.

- Drive at moderate speeds.
- Take the train or bus on long trips.

The Big Picture:

- Lobby senior levels of government for stronger emission controls.
  - Lobby the Provincial government for better transit funding for both large urban area and inter-municipal travel.
  - Lobby the Federal government for stronger emission control legislation aimed at ensuring ecosystem recovery.
  - Lobby the Federal government to negotiate with the United States for stronger Clean Air Legislation.

Sulphur deposition has decreased since 1980; however, we are beginning to understand the need to reduce the nitrogen oxides as well. Canada has met and exceeded the sulphur reduction targets set for 1994 and, in fact in 1999, emissions were 58% lower than 1980 levels. The Americans are also on track to meet their 2010 emissions targets. However, studies indicate that further reductions in both sulphur and nitrogen oxides will be required to see a recovery of land and water ecosystems, and improvement in air quality.

References

1. http://www.ec.gc.ca/acidrain/index.html
2. http://royal.okanagan.bc.ca/mpidwirn/atmosphereandclimate/acidprecip.html#a
3. Aherne J., T. Larssen , P.J. Dillon and B.J. Cosby, Effects Of Climate Events On Elemental Fluxes From Forested Catchments In Ontario, Canada: Modelling Drought-Induced Redox Processes, Modelling the effects of climate events on forested catchment.
4. Aherne J., M. Posch , P.J. Dillon and A. Henriksen, Critical Loads Of Acidity For Surface Waters In South-Central Ontario, Canada: Regional Application Of The First-Order Acidity Balance (FAB) Model, Critical loads for surface waters in Ontario, Canada.
5. Henriksen, A. P.J. Dillon, and J. Aherne, Critical Loads of Acidity for Surface Water in South-Central Ontario, Canada: Regional Application of Steady-State Water Chemistry (SSWC) Model, in Canadian Journal of Fisheries Aquatic Science. 59: 1287-1295 (2002).
6. Watmough S.A. , J. Aherne and P.J. Dillon, Potential Impact Of Forest Harvesting On Lake Chemistry In South-Central Ontario At Current Levels Of Acid Deposition, Submitted to: Canadian Journal of Fisheries and Aquatic Sciences (November 2002).