5

Chapter 5

Using Indicators To Track Environmental Trends In North America

This chapter presents a selected set of environmental indicators for which comparable data exist for Canada and the United States. The mandate and scope of this survey did not include developing a list of ideal indicators for North America, so the indicators below do not adhere to the many suggestions made in Chapter Four. Rather, it is a "quick and dirty" exercise using available information. As revealed in the previous chapters, reliable, up-to-date and comparable data are presently missing for a number of issues of importance to the North American region. For this reason, this chapter does not include trends or comparative data on the area and status of wetlands and coastal and marine ecosystems; nor does it include indicators on indoor air quality, on human health impacts of exposure to urban air pollution or toxic substances, or on impacts of natural disasters, among other issues for which there are gaps in data or in the existence of fully developed indicators. An attempt was made to use a consistent time period, so most of the indicators show trends between 1990 and 2000. They generally show data for each country, as well as for the two countries together, representing North America. In most cases, the data derive from the OECD. The first section includes a number of indicators of drivers of environmental change. For the most part, comparative indicators show each country's rank within the OECD or the world.

The chapter provides examples of how indicators can show trends clearly and how they can be used to compare progress with other regions and nations. To make the messages clear to decision-makers and the interested public, each indicator is accompanied by explanatory text and happy, neutral, or sad faces (see legend, below). These symbols are subjective interpretations of the trends as environmental threats or opportunities and render them visually striking. Although incomplete, the indicator set gives an idea of the status of some of North America's environmental assets and where the picture looks unsustainable, the sad faces provide warning signs and a wake-up call to prompt action.

Legend for Chapter 5

Positive trend, moving towards qualitative objectives or quantified targets

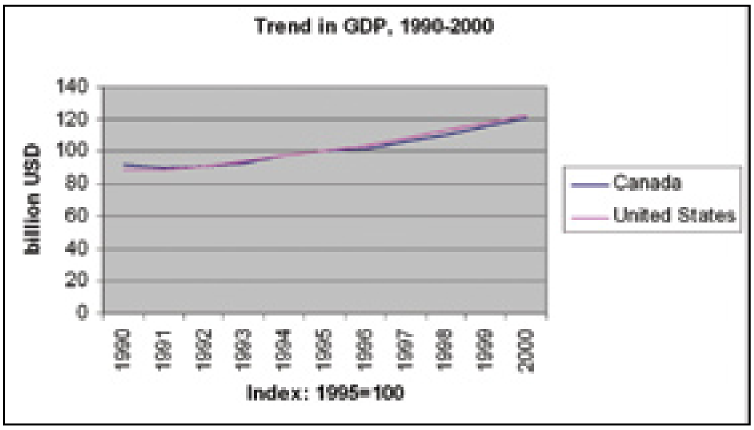
Some positive development, but either insufficient to reach qualitative objectives or quantified targets, or mixed trends within the indicators

Unfavourable trend

The Economy

GDP

Figure 32: Trend in GDP, 1990–2000



Source: Compiled by author from OECD 2002b, 9.

Economy up

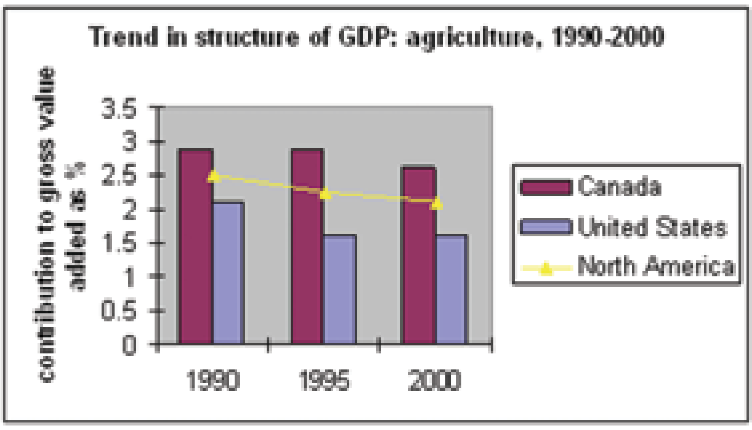
Good or bad? a source of debate

This indicator shows the changes in volume of gross domestic product (GDP) between 1990 and 2000 (Figure 32). Data are expressed as indices (1995=100) calculated from the value of GDP at constant prices.

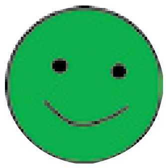
Gross domestic product measures the output of goods and services but ignores the environmental costs of economic activity. Thus, a positive interpretation of this upward trend is a false assumption because externalities—costs associated with pollution, waste disposal, and the extraction and decline in natural resources, as well as the value of ecosystem goods and services taken as "free"—are not accounted for in the calculations of GDP. In fact, in the short term, cleaning up pollution and extracting resources contributes to economic growth. On the other hand, a strong economy is also one that can finance environmentally-friendly technologies. Efforts are under way to develop an indicator that gauges progress in a more balanced way.

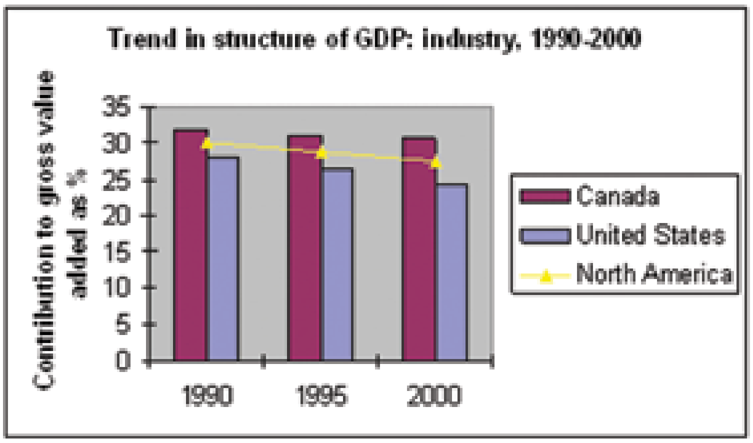
Structure of GDP

Figure 33: Trends in the structure of GDP: agriculture, industry, services, 1990–2000

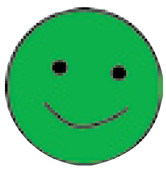


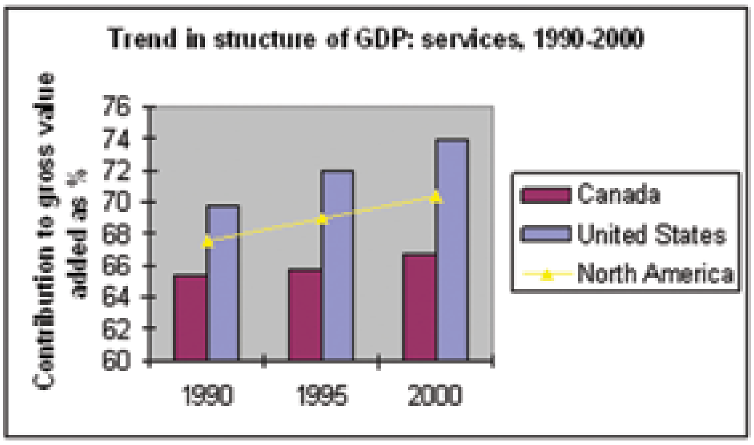
Value of agriculture down





Value of industry down





Value of services up

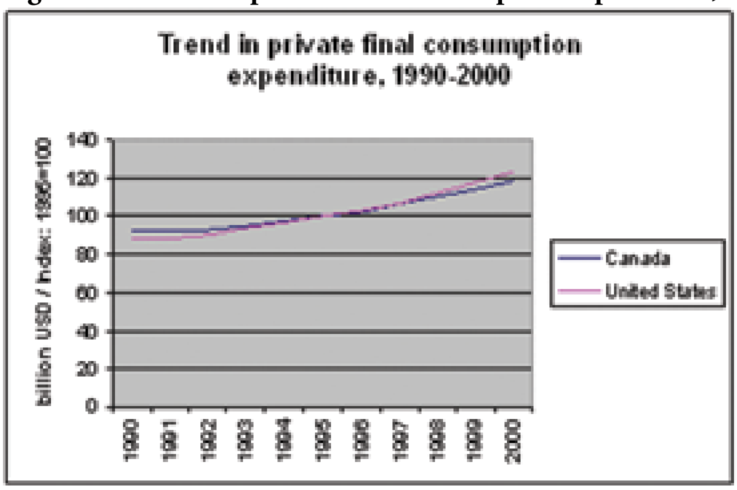
Note: Data for agriculture include hunting, forestry, and fishing. Industry data include energy and construction. Data on services exclude financial intermediation services indirectly measured. Source: Compiled by author from OECD 2002b, 10.

These indicators show the structure of GDP for three sectors of the economy, and changes since 1990 (Figure 33). Data represent the value added by each economic sector as its contribution to GDP. They are expressed as a percentage of gross value added.

The shift away from an economy based on industry and agriculture to one in which the service sector plays a greater role has implications for energy consumption since the service sector is less energy-intensive. This has contributed to a decline in North America's share of world energy consumption (EIA 1999). In addition to its heavy use of energy, agricultural and industrial activities as presently practiced also damage the environment in other ways, including through air, soil, and water pollution. The 'happy' face next to the downward trend in the value of agriculture is not meant to imply that agriculture is a 'negative' activity: a graph showing a growing trend towards the value of sustainable agriculture in the structure of GDP would be deemed a positive trend since it would indicate increased support for practices that build soils, reduce the use of agrochemicals, preserve rural landscapes, and improve livelihoods in the sustainable/organic farming sector.

Private consumption

Figure 34: Trend in private final consumption expenditure, 1990–2000



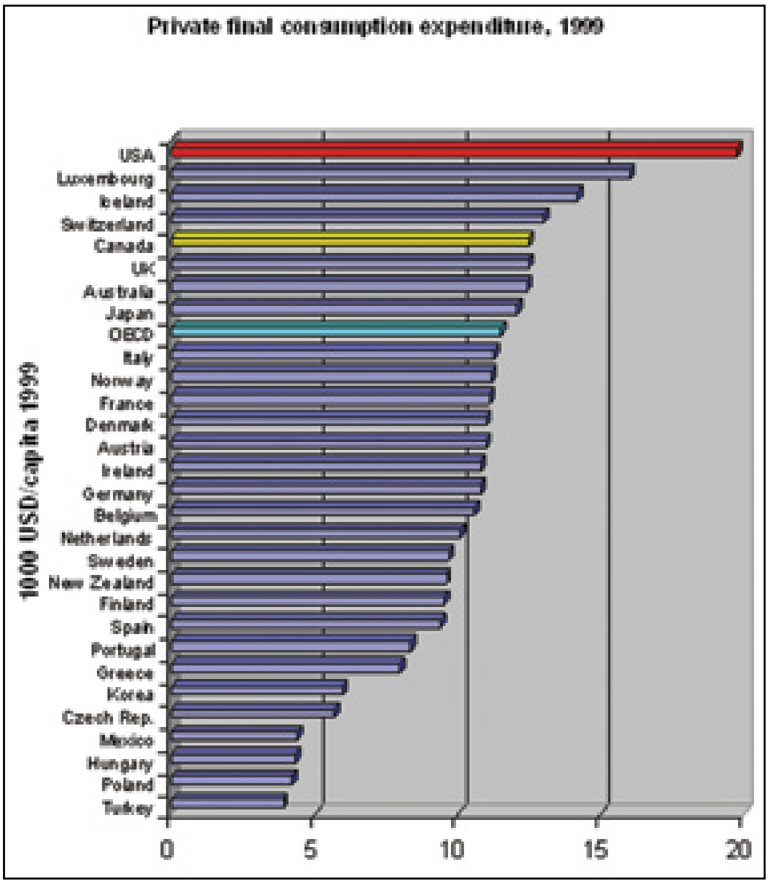
Private consumption up

Source: Compiled by author from OECD 2002b, 11.

This indicator shows the changes in volume of private final consumption expenditure between 1990 and 2000 (Figure 34). Data are expressed as indices (1995=100) calculated from the value of private final consumption expenditure at constant prices.

The indicator shows the trend in consumption by households and the private nonprofit organizations that serve them in Canada and the United States. Increased consumption in North America mirrors increases in GDP; both are associated with greater use of materials and energy, the production of waste, and emissions of pollutants into the environment.

Figure 35: Private final consumption expenditure, 1999



Source: Adapted from OECD 2001, 77.

Canada and the United States are among top 5 countries with highest personal consumption

This indicator shows the per capita consumption by households and the private nonprofit organizations that serve them for each of the member countries of the OECD in 1999, in thousands of US dollars (Figure 35).

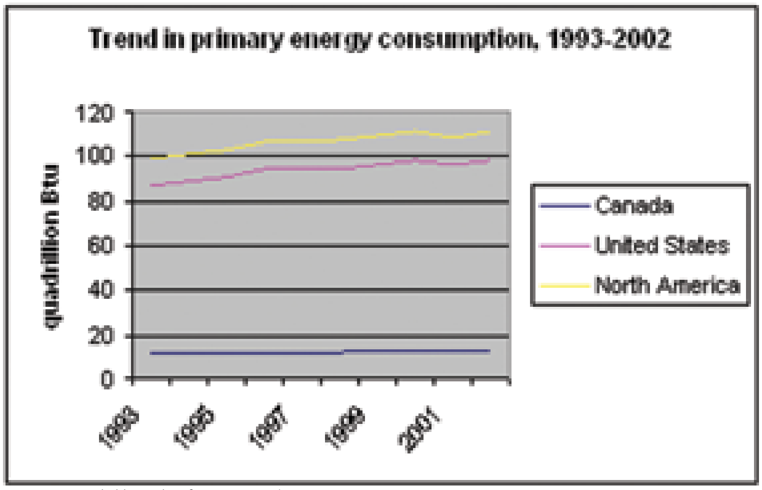
This comparative indicator reveals that private consumption in Canada and the United States is higher than in almost all other developed countries.

Cultures that promote consumption contribute to greater environmental pressures by helping to increase the demand for and use of energy resources, including: fuel for private cars; water; manufactured goods; and packaging. It also implies increases in greenhouse gas emissions and the production of waste.

Energy use

Primary energy consumption

Figure 36: Trend in primary energy consumption, 1993–2002



Source: Compiled by author from EIA 2004a.

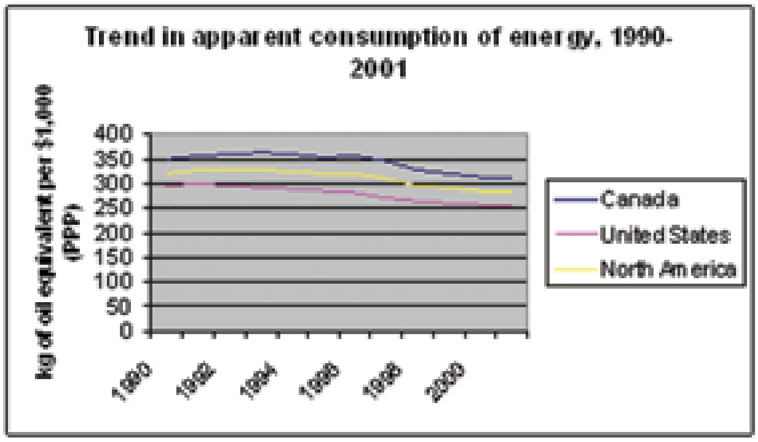
Energy consumption up

This indicator shows the upward trend in the consumption of primary energy between 1993 and 2002 (Figure 36). Primary energy refers to petroleum, natural gas, coal, and electric power, and other (hydro, nuclear, geothermal, solar, wind, and wood and waste). Total energy consumption is the amount of primary energy used on average by each person. Consumption equals: indigenous production plus imports minus exports plus stock changes minus energy delivered to international marine bunkers (WRI 2004).

North America has seen a rise in energy consumption over the past decade. Between 1992 and 2002, overall energy consumption rose by 14.6 quadrillion British Thermal Units (Btu). In 2002, Canada and the United States used 13.07 and 98.03 quadrillion Btu of energy respectively (EIA 2004a). The consumption of energy puts a variety of pressures on the natural environment and human health. The exploration for, and extraction of fossil fuels and the construction of hydroelectric dams damages, alters, or destroys wildlife and human habitat and other valuable natural resources and landscapes, while burning fuels results in air pollution and associated respiratory problems in exposed populations, the emission of greenhouse gases that contribute to climate change, and polluting emissions that help form smog and acid rain. Canada and the United States rank as two of the world's highest consumers of primary energy.

Energy intensity (apparent consumption)

Figure 37: Trend in apparent consumption of energy, 1990–2001



Intensity of energy use down slightly

Source: Compiled by author from UN 2004 http://milleniumindicators.un.org/unsd/mi/mi_series_results.asp?rowId=648.

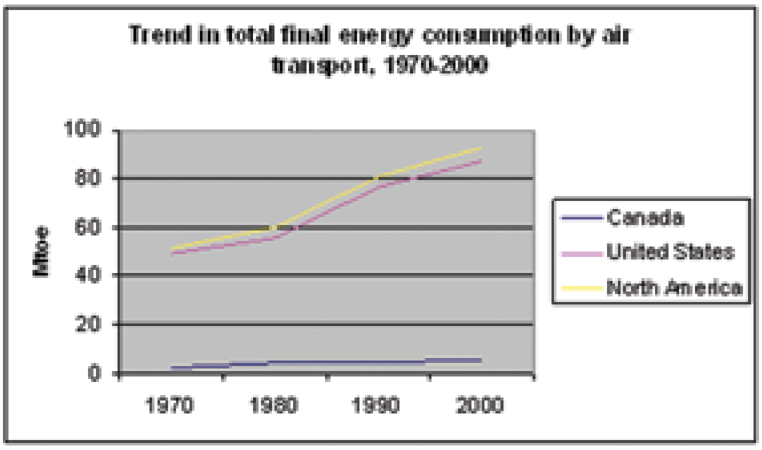
This indicator shows the intensity of energy use (Figure 37). This means the total amount of energy consumed per dollar of gross domestic product. Total primary energy domestic supply (sometimes referred to as energy use) is calculated by the International Energy Agency (IEA) as: production of fuels plus inputs from other sources plus imports minus exports minus international marine bunkers plus stock changes. "Purchasing power parities" (PPP) refers to the number of currency units required to buy goods equivalent to what can be bought with one US dollar (UN 2004).

North America's energy/GDP ratio has continued a slow decline that began in 1970. This reflects a shift to less resource-intensive patterns of production and a dematerialization of GDP as the service and information-based sectors increase in importance to the economy. Canada and the United States are among the most energy-intensive countries in the industrialized world, however. In 2002, Canada's energy intensity (per GDP) was 16,452 Btu per $1995 in purchasing power parity (PPP), well above that of the United States, which was 11,047 Btu/$1995. In 1999, Canada was 33 per cent less energy efficient than the United States (Boyd 2001). Although declining somewhat, Canada's energy intensity remains high due to its energy-intensive industries (EIA 2004b) and to increased population and economic growth (Boyd 2001). One reason for the slow decline in the Untied States is that newer homes are about 18 per cent larger than the existing housing stock and so require more energy for heating, cooling, and lighting (EIA 2003).

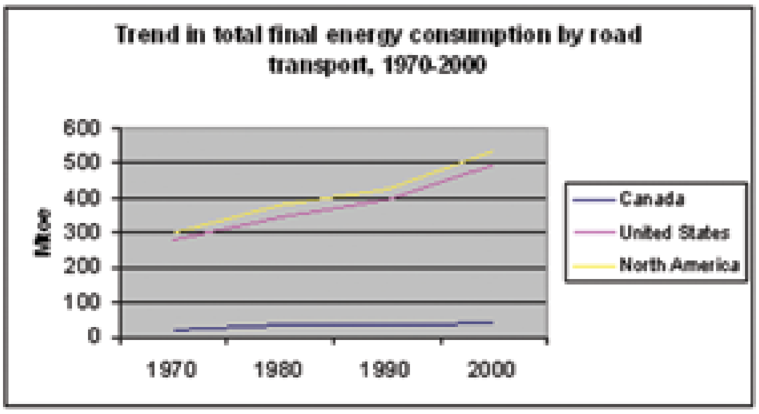
Transportation

Energy consumption by transportation

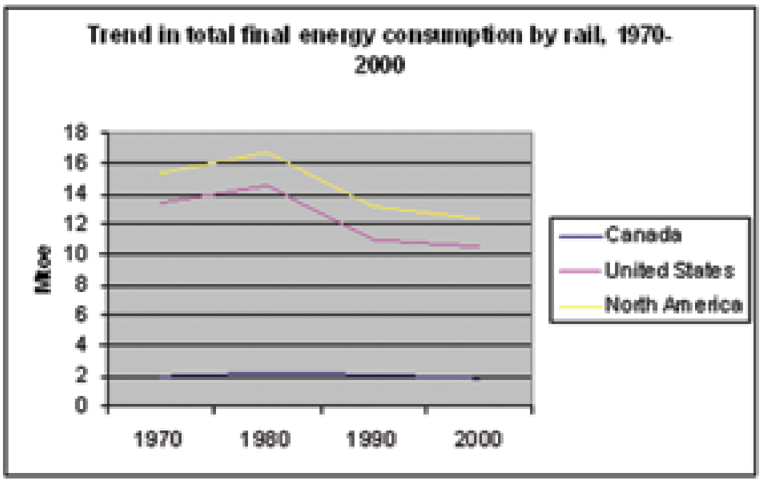
Figure 38: Trends in energy consumption by transportation sector: air, road, rail, and total, 1970–2000



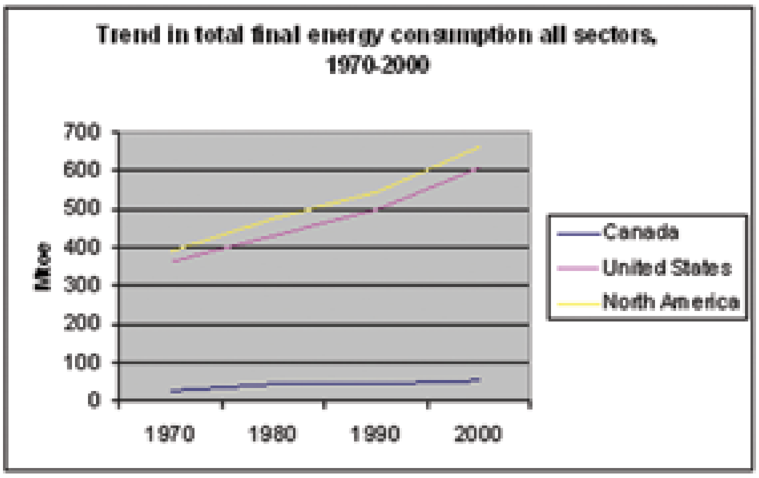
Energy consumption by air transport up



Energy consumption by road transport up



Energy consumption by rail transport down



In total, energy consumption by all transport sectors together is up

Source : Compiled by author from OECD 2002b, 21.

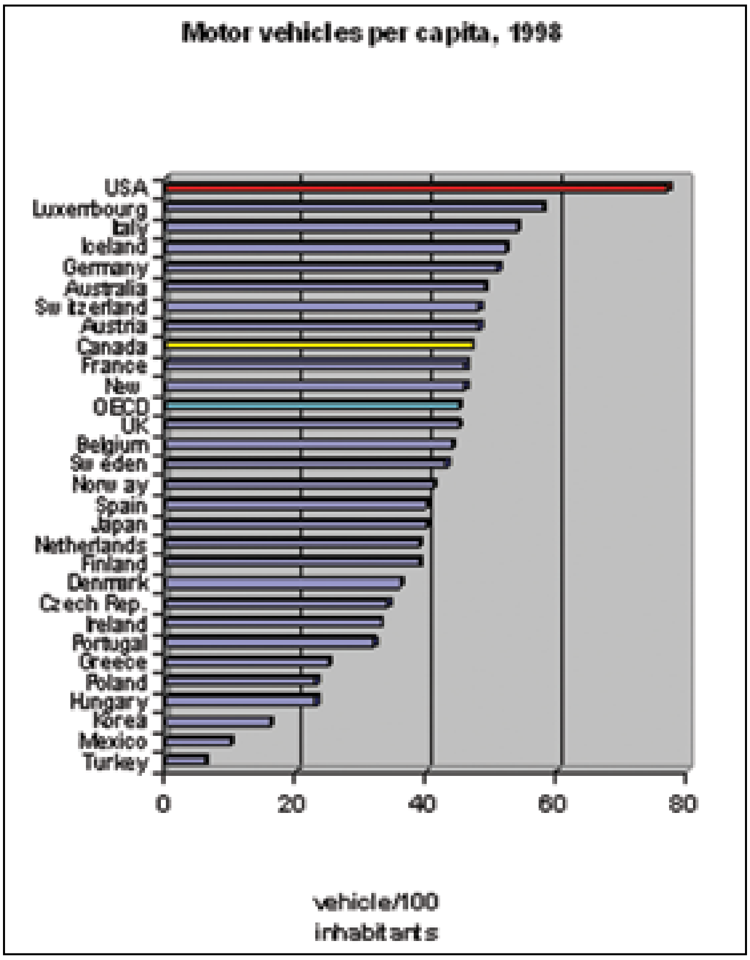
These indicators show trends between 1970 and 2000 in total final energy consumption by air, road, and rail and by the transport sector as a whole, measured in millions of tonnes of oil equivalent (Figure 38).

The total amount of energy consumed by the North American transport sector has risen significantly over the past decade—from 273 to 332 million tonnes of oil equivalent. The decline in energy used by rail was more than offset by rises in energy use for air and road transport. The transportation sector is responsible for about 33 per cent of energy use in North America. In both the United States and Canada, a recent shift towards the use of larger and less fuel-efficient vehicles such as sports utility vehicles (SUVs), reversed a previous trend towards fuel efficiency improvements. For example, energy efficiency in Canada's passenger transportation sector decreased 1.1 per cent between 1990 and 2002 (EIA 2004b). Energy use by the transport sector, especially road fuel consumption, is a major contributor to local and regional air pollution and to emissions that contribute to climate change. In fact, motor vehicles represent the single largest human-made source of air pollution in the United States (OECD 2002b).

Motor vehicles

Comparative indicator

Figure 39: Motor vehicles per capita, 1998



Source : Adapted from OECD 2001, 87.

Canada and the United States among top nations with most passenger vehicles per person

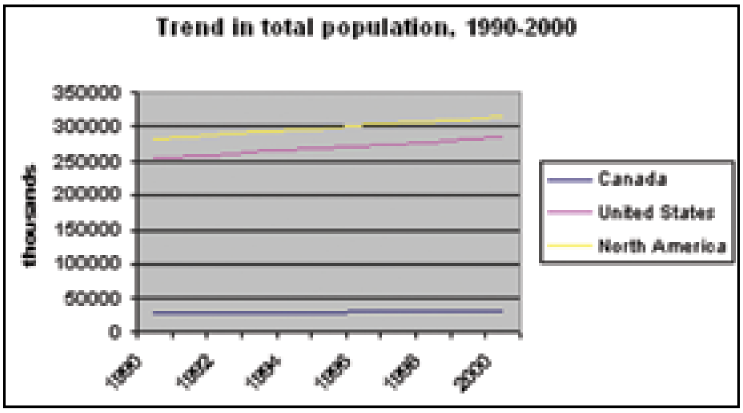
This comparative indicator shows the number of vehicles (passenger cars, goods vehicles, buses and coaches) per 100 inhabitants in OECD countries (Figure 39).

The United States and Canada are among the top nine OECD countries in passenger vehicle ownership per person. In the United States, there are three vehicles for every four people, compared to Western Europe and Japan, where there is typically one for every two people (Brown 2001). The environmental impacts of motor vehicles and the infrastructure that serves them include the expropriation of land for roads and highways, the use of materials and energy, polluting emissions, and greenhouse gases. The implications for human health and quality of life include risks of respiratory illness from air pollution, deaths and injury from accidents, and the detrimental effect of noise and traffic congestion.

Population

Total population

Figure 40: Trend in total population, 1990–2000



Source: Compiled by author from FAOSTAT 2004.

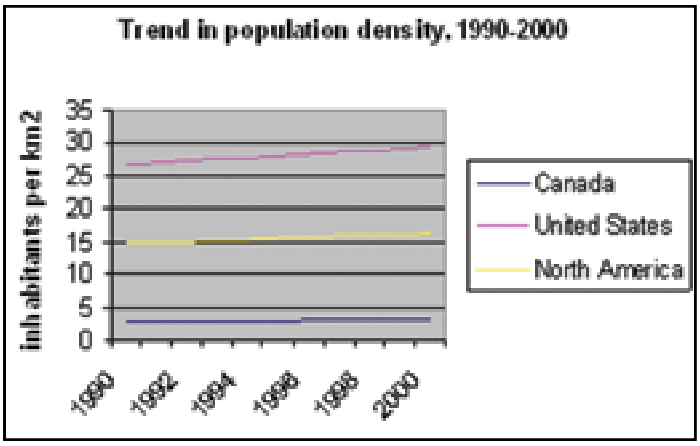
Total population up

This indicator shows the trend in total population from 1990 to 2000 (Figure 40).

The total population of North America in 2000 was 315.8 million (FAOSTAT 2004). It is presently growing at less than one per cent annually (PRB 2004). The United States is one of the three most populous countries in the world (after China and India) and is expected to still be among the top three in 2050. When combined with a pattern of high consumption and energy use, large populations are a potent driver of environmental change.

Population density

Figure 41: Trend in population density, 1990–2000



Source: Compiled by author from OECD 2002b, 7.

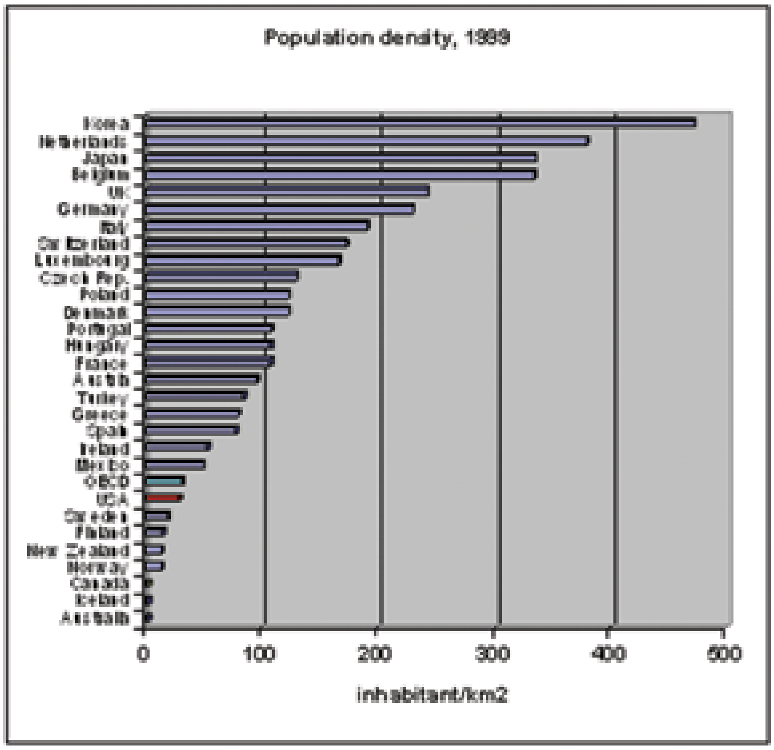
Population density up slightly

This indicator shows average population density in North America, measured by the number of inhabitants per square kilometer (Figure 41).

Average population density is increasing slightly in North America. About 79 per cent of North Americans live in relatively densely populated urban areas (Statistics Canada 2001a; US Census Bureau 2002). Changes in population densities are often used as a surrogate for urbanization (Brown and others 2004). Because the density indicator is an average measure of the number of inhabitants per square kilometer, it appears to show that Canadians are sparsely spread out across the country. This is due to Canada's relatively small population and its large land mass. In fact, most Canadians live in the southern part of the country, with 79.7 per cent living in urban areas (Statistics Canada 2001a). Densely populated areas are usually associated with high pressures on the environment, including demands for water, energy, materials, as well as waste disposal and the use of land—often productive agricultural land—for urban infrastructure. On the other hand, when planned for sustainability, dense settlement patterns have the potential to reduce environmental pressures compared to the impact of sprawling suburbs. "Smart" growth of urban areas reduces environmental impact through clustering a mixture of residential, office, retail, and outdoor recreational uses together, thereby shrinking travel distances and encouraging walking, cycling and public transit that reduces the use of fossil fuels.

Comparative indicator

Figure 42: Population density, 1999



Source: Adapted from OECD 2001, 74.

Canada and the United States among the world's least densely populated countries

This comparative indicator shows the population density (inhabitants per square kilometer) of OECD countries in 1999 (Figure 42).

Canada and the United States are among the least densely populated countries in the OECD. The settlement patterns of several much more densely populated nations, such as the Netherlands, Belgium, the United Kingdom, and Germany, are generally much "smarter" in terms of energy expenditure on transportation and the environmental impacts of water use and waste disposal associated with urban areas.

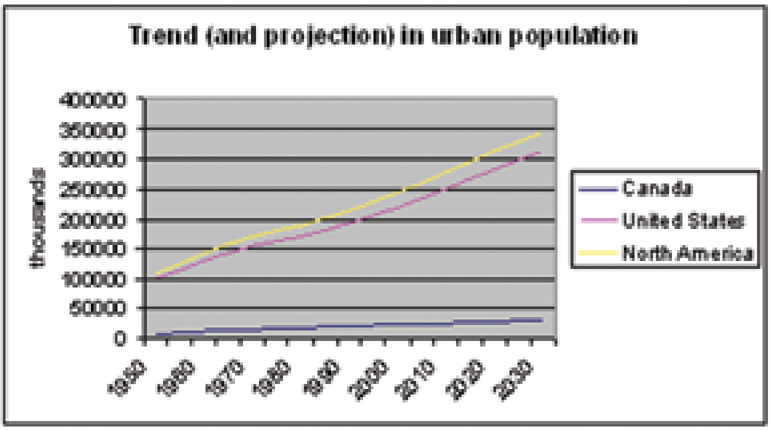
New York City USA, 2005

UNEP/MorgueFile

Urban Areas

Urban growth

Figure 43: Trend (and projection) in total urban population, 1950–2030



Population in urban areas will continue to increase

Source: Compiled by author from FAOSTAT 2004.

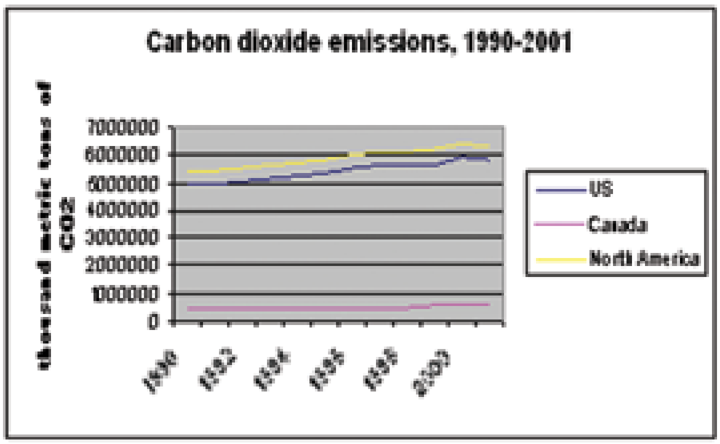
This indicator shows the historical trend in the number of people living in urban areas from 1950, projecting the trend from 2000 until 2030 (Figure 43). The urban/rural population is obtained by systematically applying the proportion of urban population ratio to the total population. The urban population estimates are based on the varying national definitions of urban areas.

The indicator reflects total population growth in urban areas, showing that the number of people living in cities and towns in North America will continue to grow. In 2000, more than 80 per cent of the US population lived in urban areas and the urban population was growing by more than 2 million people per year (USDA n.d.). If accompanied by urban planning that avoids the pitfalls of suburban sprawl and focuses on "smart" growth and the sustainable use of energy and resources, this trend could have positive impacts on the environment. However, the past decade has seen a decrease in household size and a trend toward population growth in suburbs and smaller towns and centres outside large cities (Brown and others 2004). One of the impacts of such growth is the conversion of rural land. In 2000, rural areas in the United States were being lost to urban uses at a rate faster than about 12 million km^2 (3 million acres) per year (USDA n.d.).

Climate Change

CO_2 and greenhouse gas emissions

Figure 44: Trend in total CO_2 emissions, 1990–2001



CO_2 emissions up slightly

Note: Original source of data: UNFCCC online database. "United States" includes territories. Source: Compiled by author from UN 2004.

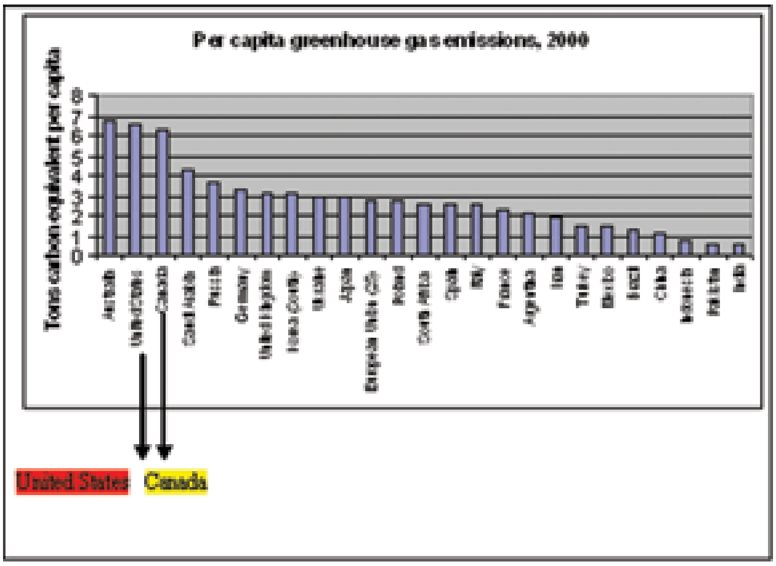
This indicator shows CO_2 emissions in North America from 1990 to 2001 (Figure 44). The data are in thousands of metric tonnes of carbon dioxide (not carbon).

Carbon dioxide emissions in Canada and the United States continued to increase during the 1990s. Canadian greenhouse gas emissions grew by more than 13.5 per cent between 1990 and 1999 (Boyd 2001). Emissions of CO_2 from fossil fuel combustion (which contribute 80 per cent of global warming potential) in the United States grew by 17 per cent from 1990 to 2001 (US EPA 2003). By 2002, the US was responsible for emitting 1.65 thousand million tonnes of carbon (Marland and others 2003) and was the world's largest producer of CO_2 from fossil fuel combustion, accounting for 24 per cent of the world total (EIA 2004b). US emissions have declined somewhat in recent years due to a slower economy, but with stagnating hydroelectric and nuclear energy generation, a stronger economy, and the continued increase in the sale of SUVs, emissions will likely grow again (EIA 2003).

There is a strong correlation among the trends in GDP, population, energy use, and CO_2 emissions, suggesting the significance of the first two of these as drivers of energy use and the associated emissions from the burning of fossil fuels. There is a general consensus among scientists that greenhouse gas emissions from human activity are contributing to global climate change.

Comparative indicator

Figure 45: Per capita greenhouse gas emissions, 2000



Source: Adapted from Baumert and Pershing 2004.

Per capita emissions of greenhouse gases in Canada and the United States are among the highest in the world

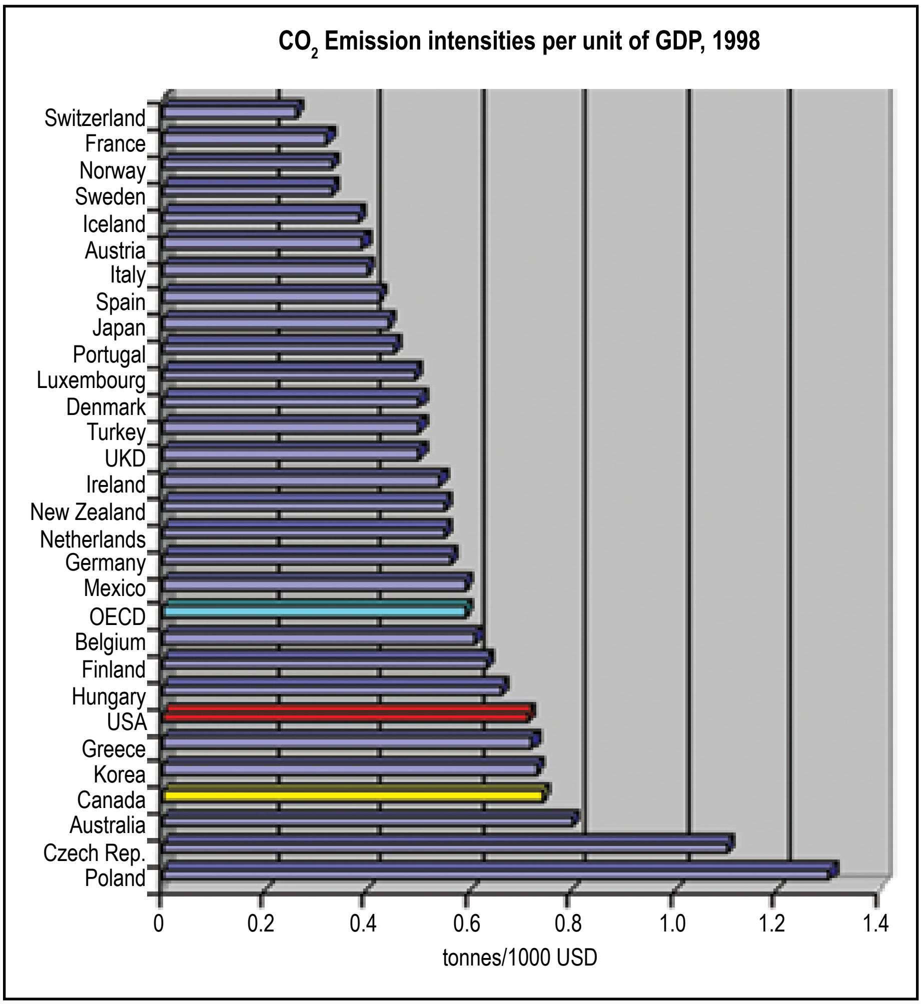
This indicator shows the top 25 greenhouse gas–emitting countries in the world, in absolute terms (Figure 45). Emissions include CO_2 from fossil fuels and cement, and non-CO_2 gasses.

Per capita greenhouse gas emissions (GHG) in North America have been consistently high and well above those for any other region (Marland and others 2003). In 2000, Canadians each produced an average of 18.7 thousand metric tonnes of carbon dioxide. The per capita yearly rate in the United States was 20.6 (UN 2004). In the United States, emissions per person increased about 3.4 per cent between 1990 and 1997 (US EPA 2000b). With greater hydroelectricity and nuclear generation (that do not emit GHGs), Canada's per capita emissions are slightly lower than those of the United States.

Carbon intensity

Comparative indicator

Figure 46: CO_2 emissions per unit GDP, 1998



Source: OECD 2001, 15.

Canada and the United States are among the 7 nations with the highest carbon intensities

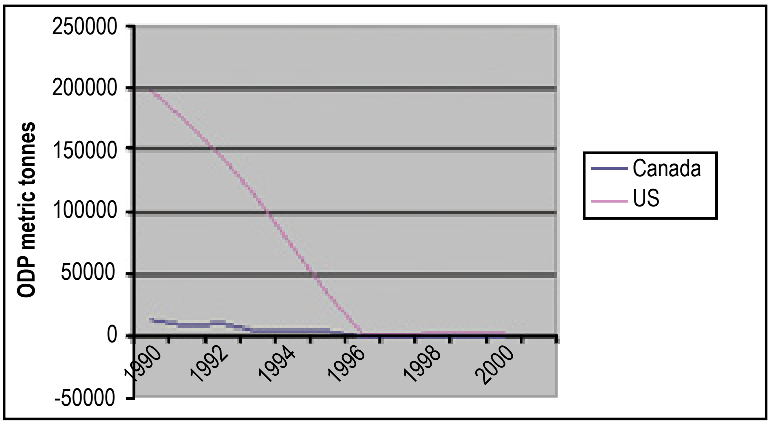
This comparative intensity indicator shows per capita CO_2 emissions (gross direct emissions) from energy use (fossil fuel combustion) among the OECD countries in 1998 (Figure 46), measured in tonnes of CO_2 relative to GDP (1 000 US dollars). GDP data refer to 1991 prices and purchasing power parities (PPPs). Since national inventories do not provide a complete and consistent picture of all greenhouse gas emissions, energy-related CO_2 emissions represent overall trends in direct GHG emissions (OECD 2001).

Carbon intensity and energy intensity are closely related. Canada and the United States have among the world's highest carbon and energy intensities. Increased consumption of fossil fuels for electricity generation, increased energy consumption in the transportation sector, and growth in fossil fuel production (largely for export) have influenced Canada's high carbon intensity relative to other nations. The high reliance on carbon-intensive coal for energy generation contributes to the high carbon-intensity rating of the United States (EIA 2003).

Ozone Layer

CFC consumption

Figure 47: Trend in ozone-depleting CFC consumption, 1990–2000



Ozone-depleting CFC consumption rapidly down to zero

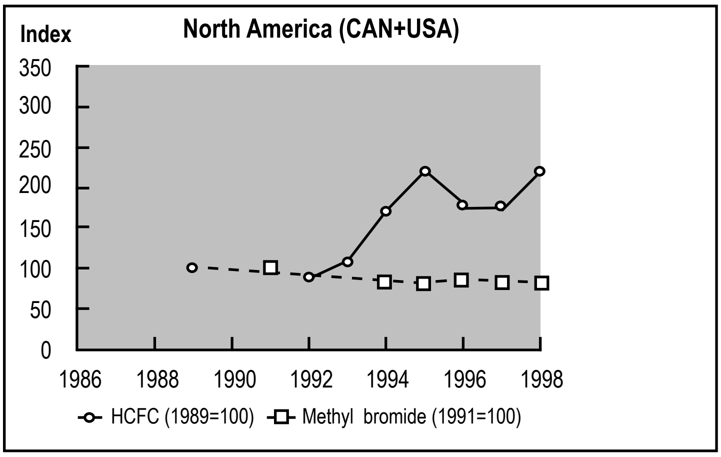
Source: Compiled by author from UN 2004.

This indicator shows the trend between 1990 and 2000 in consumption of chlorofluorocarbons (CFCs), the synthetic compounds formerly used as refrigerants and aerosol propellants that are known to harm the ozone layer of the atmosphere (Figure 47). Consumption is defined as: production plus imports minus exports of controlled substances (UN 2004). Basic data are weighted with the ozone-depleting potentials (ODP) of the individual substances (OECD 2001).

As a result of the Montreal Protocol, Canada and the United States rapidly decreased their consumption of CFCs and reached targets earlier than called for. As of 1996, there has been no production or consumption of these substances except for certain essential uses, although there are still releases to the atmosphere from previous production or consumption (OECD 2001).

HCFC and methyl bromide consumption

Figure 48: Trends in consumption of HCFCs and methyl bromide, 1988–1998



HCFCs still up and methyl bromide still in use

Source: Modified from OECD 2001, 113.

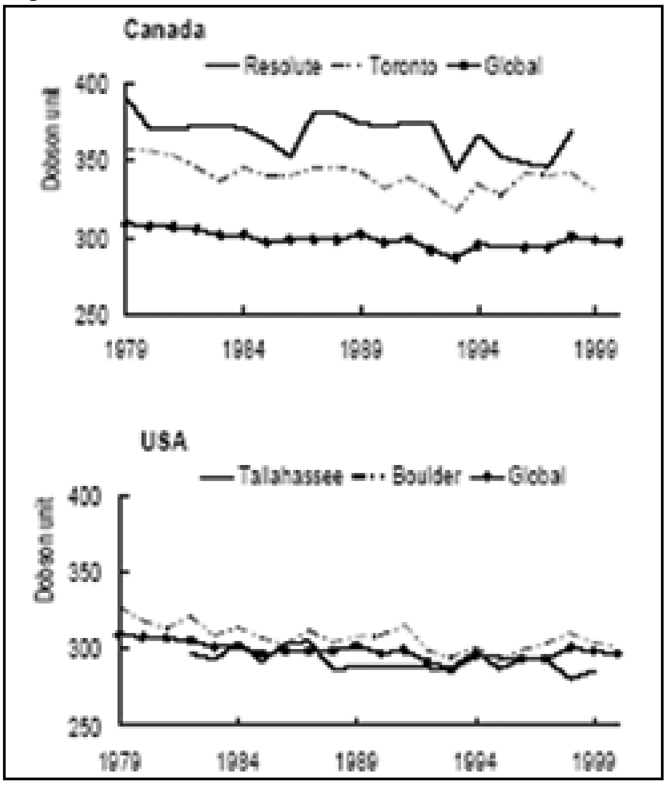
This indicator shows apparent consumption (used as a proxy for actual emissions) of hydrochlorofluorocarbons (HCFCs) and methyl bromide (Figure 48). Dotted lines refer to data not available. The year 1989, representing 100, is the index for HCFCs and 1991 is the methyl bromide index.

This indicator shows that North America, like other industrialized countries, continues to use HCFCs. Although they have only 2 to 5 per cent of the ozone-depleting potential of CFCs, concentrations of HCFCs are still increasing in the atmosphere. It will take another 20 years before use of HCFCs is phased out under current international agreements and the molecules will remain in the stratosphere for a long time after that (OECD 2001).

Under the Montreal Protocol, Canada and the United States agreed to reduce methyl bromide by 25 per cent by 1999 (compared to 1991 levels), 50 per cent by 2001, 70 per cent by 2003 and 100 per cent by 1 January 2005. In March 2004, the two countries were among 11 nations to receive critical-use exemptions that will allow this substance to continue to be used in small quantities until 2005 (UNEP 2004b).

Total column ozone

Figure 49: Trend in total column ozone over selected cities, 1979–1999



Source: OECD 2001, 23.

Ozone column thickness over Canada and the United States down slightly

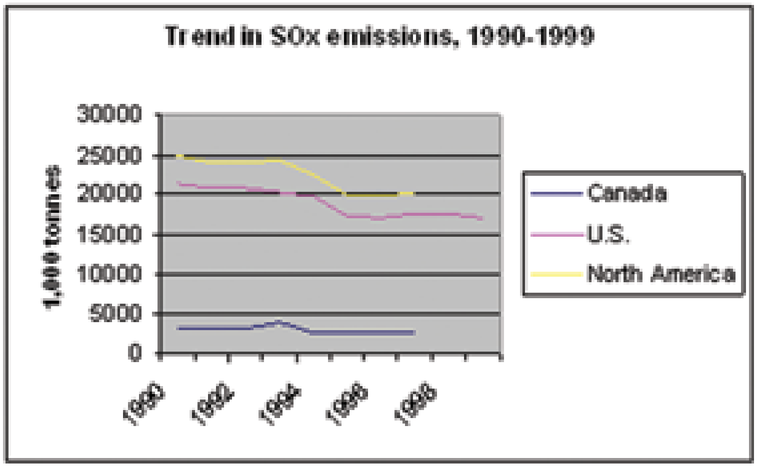
These indicators show trends in the thickness of total column ozone over selected cities in Canada and the United States, in Dobson units (Figure 49). Total column ozone refers to tropospheric plus stratospheric ozone. Dobson units are used to estimate the ozone layer's thickness. One hundred Dobson units represent a thickness of 1 mm of ozone at 0 degrees Celsius at sea-level pressure. Data are annual averages of daily values (OECD 2001).

Between 1997 and 2001, the average amounts of total column ozone in the Northern Hemisphere mid-latitudes (35°N–60°N) were three per cent below the pre-1980 values (NOAA 2002). Thinning of the ozone layer allows increased amounts of ultraviolet radiation to reach the earth. This contributes to the increase in the incidence of skin cancers in North America. It may also cause stress on some marine phytoplankton and affect productivity. Although the ozone layer is recovering, its full restoration will take decades because of the continued use of ozone-depleting products produced prior to the Montreal Protocol ban (US EPA 2003) and due to recent exemptions.

Air Quality

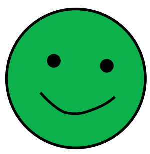
SO_x emissions

Figure 50: Trend in total emissions of SO_x, 1990–1999



Note: Data refer to man-made emissions only; SO_2 only.
Source: Compiled by author from OECD 2002b, 9.

SO_x emissions down

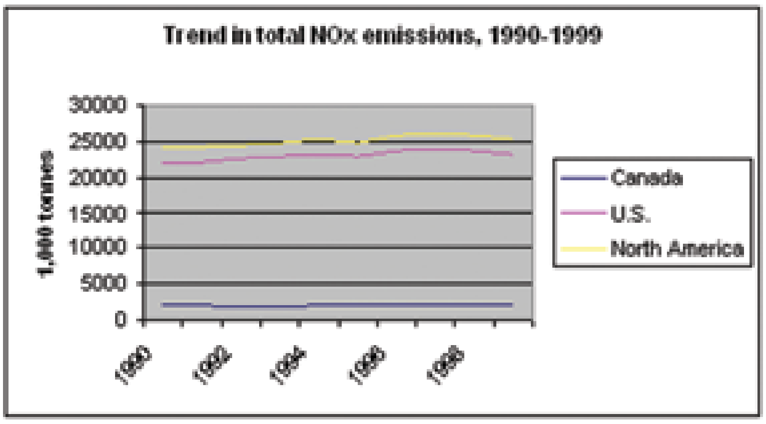


This indicator shows the amount of sulfur oxides (given as quantities of sulfur dioxide) emitted between 1990 and 1999 as a result of human activity (Figure 50).

Sulfur dioxide emissions decreased significantly over the last ten years in both countries, generally due to efforts to attain both regulatory and voluntary targets to reduce acid rain. As a result, sulfate levels in lakes in eastern North America have declined appreciatively (OECD 2004a). Acid rain can harm aquatic ecosystems and change species composition, as well as impair forests and crops. Electric utilities are the major source of total North American SO_2 emissions. In the United States, well over 90 per cent of these emissions come from coal combustion. In Canada, non-ferrous mining and smelting contributes the majority of SO_2 releases (EC 2002a). The emission of SO_2 and the resulting acid rain are linked to energy consumption, and to fossil fuel use in particular. Canada and the United States have seen a significant decoupling of SO_x emissions from GDP recently (OECD 2001).

NO_x emissions

Figure 51: Trend in total emissions of NO_x, 1990–2000



NO_x emissions up slightly

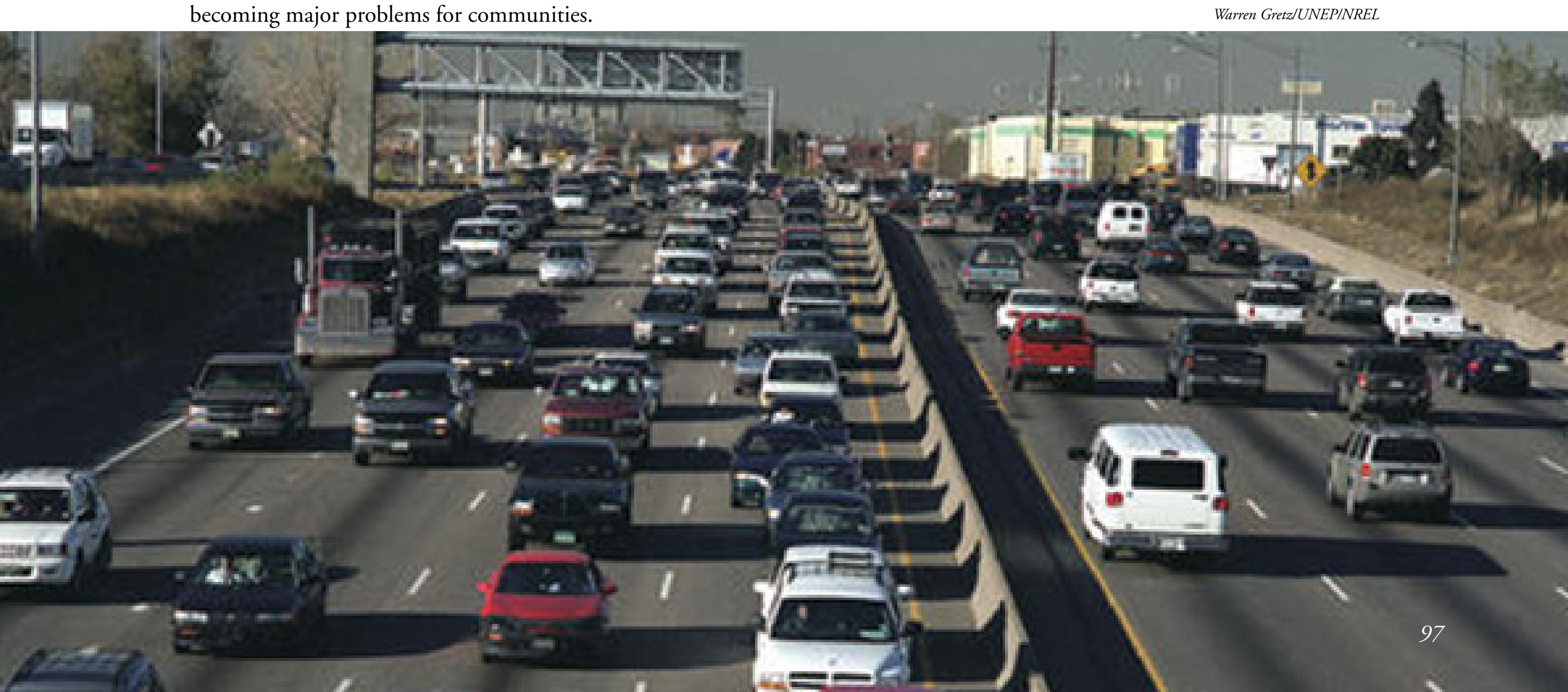
Note: Data refer to man-made emissions only.
Source: Compiled by author from OECD 2002b, 16.

This indicator shows the amount of nitrogen oxides (given as quantities of nitrogen dioxide) emitted between 1990 and 1999 as a result of human activity (Figure 51).

Emissions of NO_x have not declined as much as those of SO_x during this ten-year period. Fossil fuel combustion by motor vehicles, residential and commercial furnaces, industrial and electric utility boilers and engines, and other equipment are the principal sources of NO_x emissions that result from human activity (EC 2002a). Gains made through pollution regulations and progress in technical pollution controls in North America have been offset by the steady growth in road traffic and other uses of fossil fuel that generate NO_x (OECD 2001). Compared to most OECD countries, emissions of traditional air pollutants in North America remain generally high (OECD 2004b). NO_x contributes to acid rain and to the formation of smog.

Increasing traffic, as well as the associated air pollution and fuel consumption, are becoming major problems for communities.

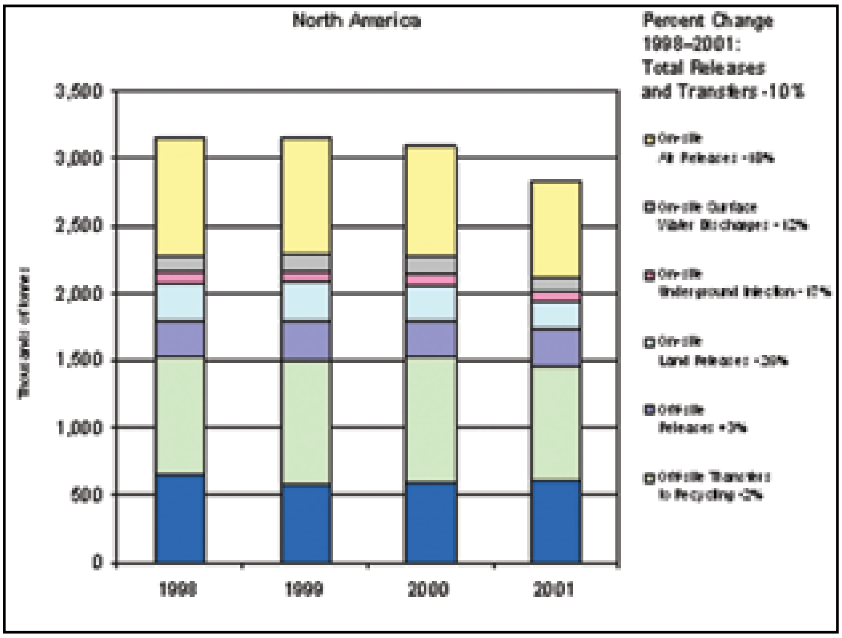
Warren Gretz/UNEP/NREL



Toxic Substances

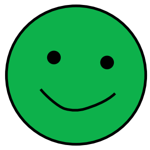
Releases and transfers

Figure 52: Change in releases and transfers of pollutants, 1998–2001



Source: Adapted from CEC 2004a, xxv.

Toxic emissions down



This indicator shows the trend in the on- and off-site release and transfer of toxic substances in Canada and the United States (Figure 52). Data include 155 chemicals common to the pollutant release inventories of each country (NPRI and TRI) from selected industrial and other sources. They represent data that have been consistently reported over the 1998–2001 period and include chemicals, as well as manufacturing facilities, electric utilities, hazardous waste management facilities, chemical wholesalers, and coal mines.

"Total releases and transfers of chemicals in North America decreased by 10 per cent from 1998 to 2001. Total releases decreased by 16 per cent, on-site releases decreased by 19 per cent, other transfers for further management decreased by 8 per cent, and transfers to recycling decreased by 2 per cent. However, off-site releases increased by 3 per cent. Compared with a decrease in total releases of 16 per cent for all matched chemicals from 1998 to 2001, releases of carcinogens decreased by 20 per cent and chemicals known to cause cancer, reproductive or development harm (California Proposition 65 chemicals) decreased by 26 per cent" (CEC 2004a, xxv).

Weldon Springs Ordnance Works. TNT contaminated water in excavation. St. Louis, MO USA.

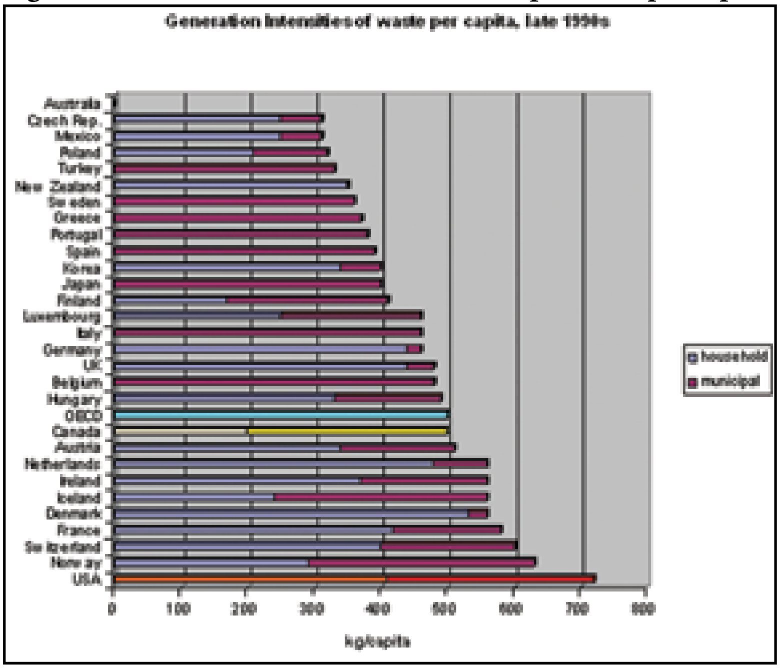
Bill Empson/UNEP/USACE

Waste

Municipal waste

Comparative indicator

Figure 53: Generation intensities of municipal waste per capita, late 1990s



Source: Adapted from OECD 2001, 37.

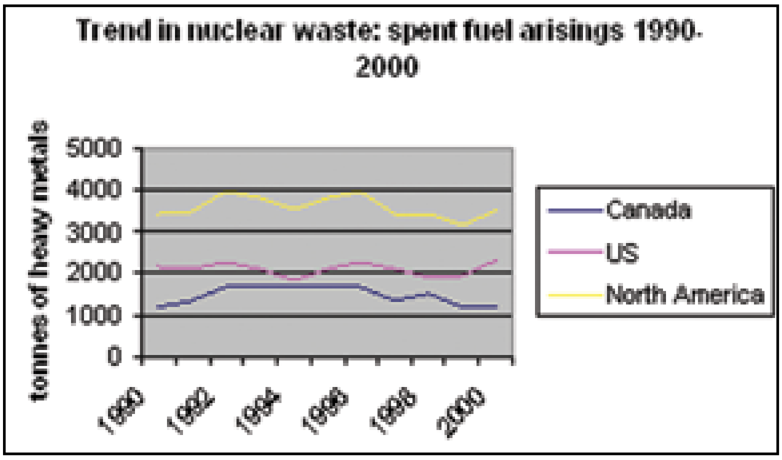
Canada and the United States among highest per capita producers of municipal waste

This indicator shows the amount of household and municipal waste generated per capita in the OECD countries in the late 1990s (Figure 53).

Canada and the United States are among the top ten per capita producers of household and municipal waste in the OECD, with the United States topping the list. The generation of waste in North America generally mirrors private final consumption expenditure and GDP. The disposal of municipal waste has various environmental impacts, including toxic air emissions from incinerators, methane emissions from landfills, and the contamination of soils and water from leaking landfills.

Nuclear waste

Figure 54: Trend in nuclear waste: spent fuel arisings, 1990–2000



Source: Compiled by author from OECD 2002b, 27.

Radioactive waste generation steady

This indicator presents annual spent fuel arisings in nuclear power plants (Figure 54). Spent fuel arisings are one part of the radioactive waste generated at various stages of the nuclear fuel cycle (uranium mining and milling, fuel enrichment, reactor operation, spent fuel reprocessing) (OECD 2002b).

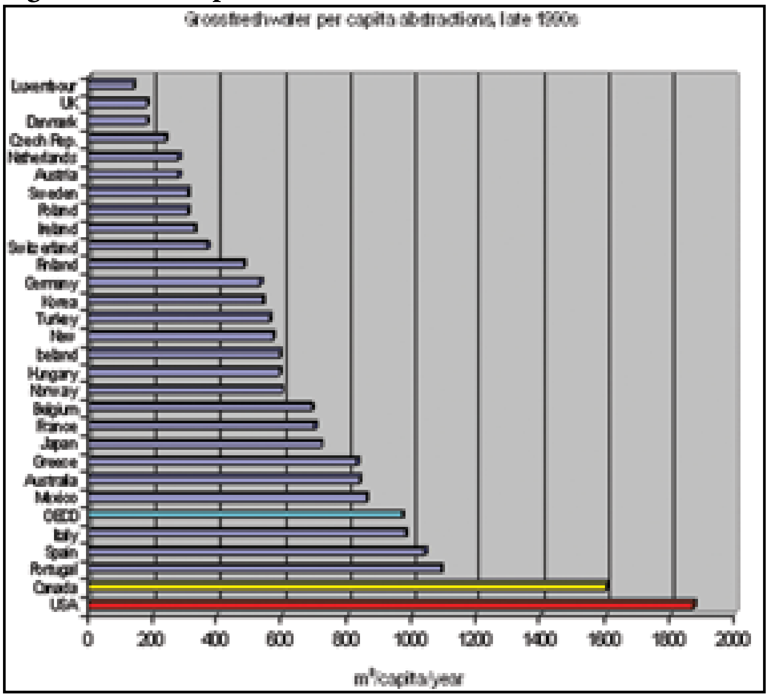
The steady generation of radioactive waste over the past decade reflects the continued use of nuclear power but the lack of growth in the number of nuclear power plants in North America. Nuclear waste is a serious threat to human health and the environment and, despite efforts to increase the efficient use of nuclear fuel and to optimize storage capacity, there are concerns about the region's capacity to store spent fuel (Fukuda and others, n.d.).

Freshwater

Use of water

Comparative indicator

Figure 55: Per capita freshwater abstractions, late 1990s



Source: Adapted from OECD 2001, 49.

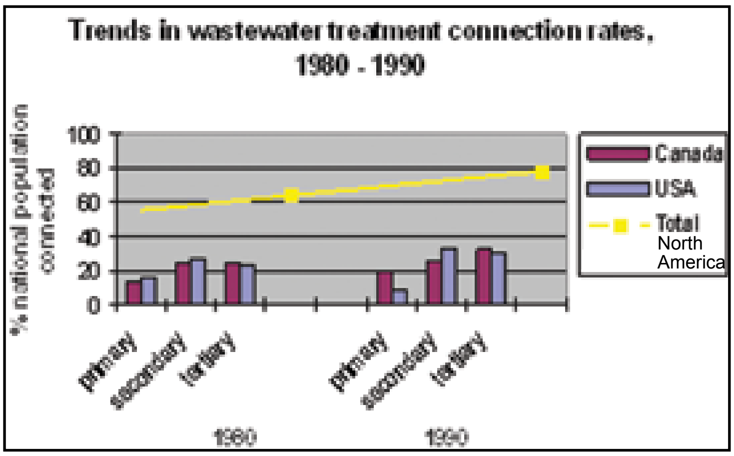
Canada and the United States are the highest per capita users of water in the world

This indicator shows the yearly amount of water used per capita in each of the OECD countries (Figure 55). Use is measured as abstractions, or total water withdrawal without deducting water that is reintroduced into the natural environment after use (OECD 2001).

The United States and Canada respectively are the two highest users of water on a per capita basis in the world. In fact, per capita water abstraction is two or three times greater than that of most OECD countries. In both countries, the electric power sector accounts for most water use (about 64 and 48 per cent of the total water abstraction in Canada and the United States respectively). Canada's high per capita use is accounted for to some degree by this reliance on hydroelectric power. This is followed by irrigation in the United States, with 34 per cent, and the manufacturing sector in Canada, which accounts for about 14 per cent of total abstractions. In Canada, agriculture accounts for only 9 per cent of abstractions (Hutson and others 2004; OECD 2004a). The pressures accounting for high water use in both countries include infrastructure development and maintenance; water-use conflicts; drought in the prairies; urban sprawl; and climate change (Gaudet 2004) as well as unrealistic water pricing. High water-use, especially for irrigation in drought-prone regions, is causing the unsustainable use of fossil water from aquifers while dams and water diversions to supply users have disrupted ecological processes and wildlife habitat.

Wastewater treatment

Figure 56: Trend in wastewater treatment connection rates, 1980–1997



Source: Compiled by author from OECD 2001, 45.

Wastewater treatment connection rates up

Wastewater treament center

Kyer Wiltshire/UNEP/City of Santa Cruz

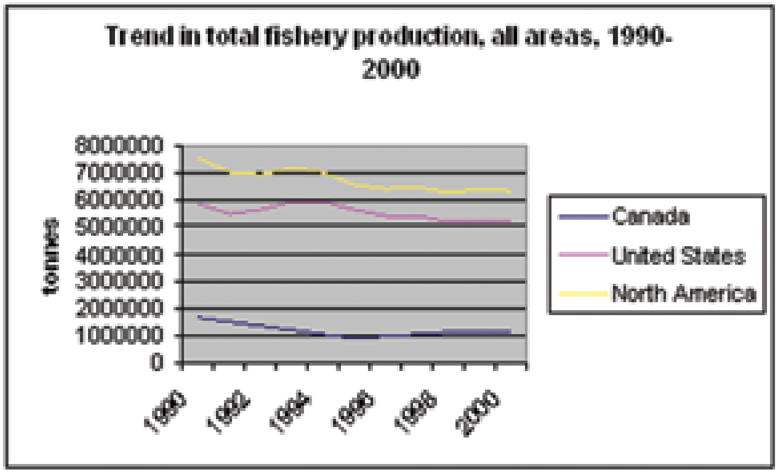
This indicator shows the percentage of the population connected to public wastewater treatment plants in the late 1990s, according to the type of treatment—primary (physical and mechanical processes), secondary (biological treatment technologies), and tertiary (advanced chemical treatment technologies)—and the total (Figure 56).

The indicator shows the steady rise in the percentage of the population served by sewage treatment. In 1996, wastewater treatment facilities provided for 73 per cent of the total US population. The indicator shows that at the same time, there was a steady increase in the proportion of facilities providing secondary and tertiary treatment. Untreated sewage and wastewater is still released into the environment, however. Newer statistics show that by 1999, 73 per cent of Canadians were served by municipal sewer systems, although about 3 per cent of Canadians were serviced by sewage collection systems that discharged untreated sewage directly into lakes, rivers, or oceans (EC 2002b) and only 33 per cent of the population was served by tertiary treatment (Boyd 2001). Numerous coastal areas and inland beaches in both Canada and the United States are frequently closed to recreational uses, fishing, and shellfish harvesting due to the pollution from such discharges or from storm water runoff that contains contaminants from inadequate sewage treatment.

Fisheries

Fish harvests

Figure 57: Trend in total fishery production, all areas, 1990–2000



Fish production down

Source: Compiled by author from FAOSTAT 2004.

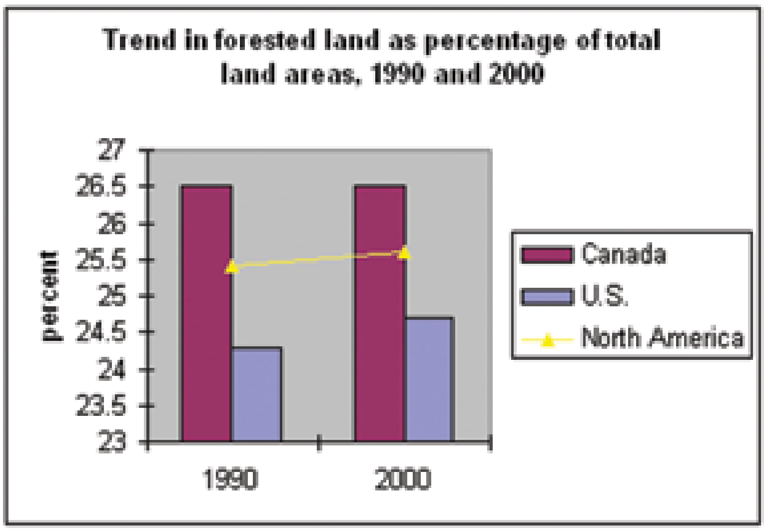
This indicator shows the tonnes of fish (species of fish in the nine divisions of the FAO International Standard Statistical Classification of Aquatic Animals and Plants) produced in all fishing areas of Canada and the United States from 1990 to 2000 (Figure 57).

There has been a downward trend in the volume of fish harvested from North American waters since 1990. Since they collapsed in the early 1990s, cod stocks in the cold waters off the Canadian Atlantic coast have not rebounded. There was a 78 per cent drop in Atlantic catches of groundfish in Canada between 1990 and 2002 and a marked decline in salmon stocks began in 1995 on the West Coast (Statistics Canada 2001b). Although US federal management of fisheries was strengthened in 1999 and overfishing of some stocks has been eliminated, of a total of 909 stocks reviewed in 2003, 76 were deemed to be overfished and 60 fish stocks thought to be fished at too high a rate, while the status of nearly 75 per cent of fish stocks managed by the federal government remained unknown (NMFS 2004). Both the United States and Canada recently adopted tougher fishing controls and are reducing the size of their fishing fleets (UNDP and others 1998).

Forests

Forest area

Figure 58: Trend in total forest area as per cent of land area, 1990 and 2000



Forested area up slightly

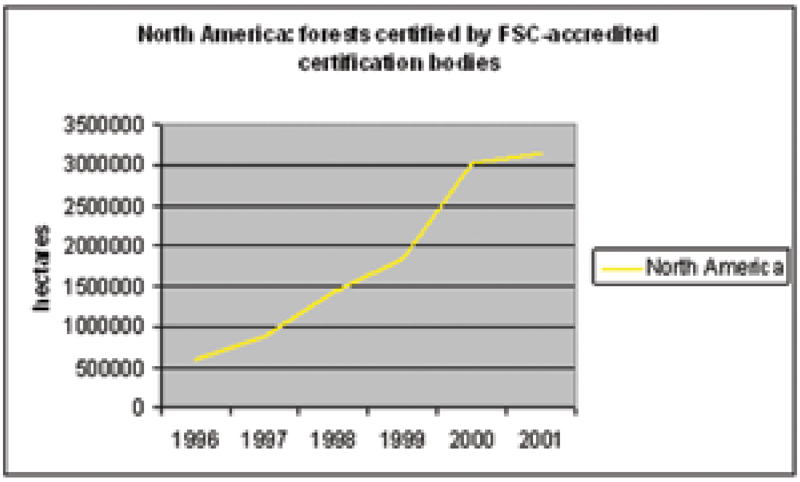
Source: Compiled by author from UN 2004 (metadata: FAO).

This indicator shows the per cent of total land area under forests in 1990 and 2000 (Figure 58). Forest includes natural forests and forest plantations. It refers to land with a tree canopy cover of more than 10 per cent and area of more than 0.5 hectares (UN 2004).

The area of forested land in North America is growing. There were substantial increases in forest areas in the United States during the decade, but these were partly offset by declining areas of other wooded land. The total area grew by about 3.9 million hectares (9.6 million acres) (FAO 2003). Canada's wooded area is assumed to have remained fairly constant over the decade, at 417.6 million hectares (1 032 million acres), of which over 70 per cent has never been harvested (OECD 2004a). North America is about 25.6 per cent forested, slightly below the global average of 30 per cent (FAO 2001b). The indicator does not reveal any information about the quality of the forests in terms of fragmentation, age of stands, insect and fire damage, and air pollution impacts, among other indicators of forest health.

Certified sustainable forests

Figure 59: Trend in FSC-certified forests, 1996–2001



Area of certified forests up

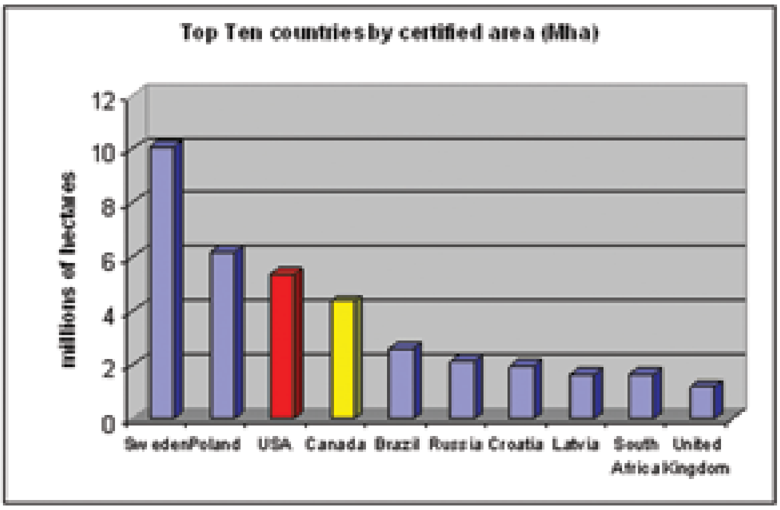
Source: Compiled by author from FSC (online data service) 2004.

This indicator shows the number of hectares certified as sustainable by accredited Forest Stewardship Council (FSC) bodies, from 1996 to 2001 (Figure 59). FSC-endorsed certification of a forest site signifies that an independent evaluation by one of several FSC-accredited certification bodies has shown that its management meets the internationally recognized FSC Principles and Criteria of Forest Stewardship. Some of the criteria include the assurance that areas of natural wealth and endangered wildlife habitat are not being negatively affected and that forest management does not put the forest's natural heritage at risk (FSC 2004; UNEP-WCMC 2004).

Although the Forest Stewardship Council (FSC), one of three major certification programmes in North America, was only created in 1993 and forest certification is still fairly new, the amount of certified forest worldwide has grown rapidly (Segura 2004). One of the drivers of this growth has been increased public awareness of forest destruction and degradation and the demand by consumers for wood and other forest products that do not contribute to this destruction but rather help to ensure sustainable forestry (FSC 2004). In 2003 alone, Canada doubled its certified lands, largely due to the first large-scale FSC certification in the boreal forest in Northern Ontario. Canada's growth in certification was a major factor in the 31 per cent increase in certified forest areas worldwide. At 56 million hectares, Canada has twice as much total certified area as the United States. One of the reasons for the difference is that a large share of forest products in the United States comes from non-industrial, privately-owned forest lands, where certification is much harder to implement than in Canada, where the expansion of certification has been on large-scale public lands (FSC 2004; IISD 2004b).

Comparative indicator

Figure 60: Top ten countries with certified forests



United States and Canada are among the top four countries by certified forest area

Source: Adapted from UNEP-WCMC/WWF 2004.

This comparative indicator ranks the top ten countries in the world in 2004 by the area (in millions of hectares) of land certified by the Forest Stewardship Council (FSC) (Figure 60).

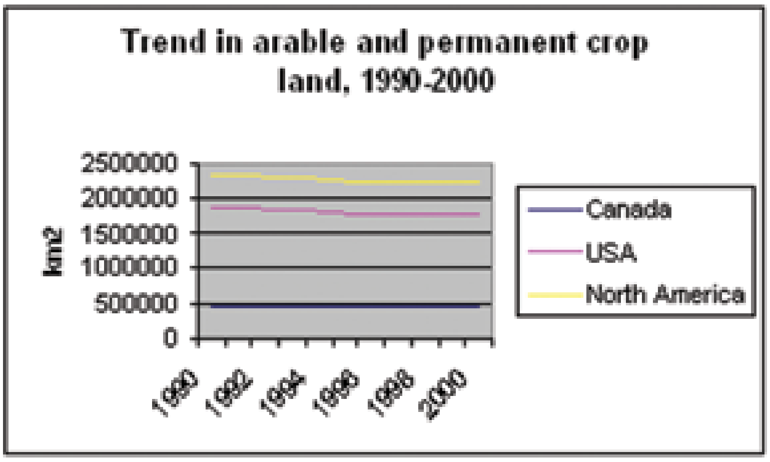
Canada and the United States are among the top four countries in the world with land certified by the Forest Stewardship Council. The FSC is one of three dominant North American forest certification programmes. The other two are the Canadian Standards Association (CSA) and the Sustainable Forestry Initiative (SFI) (IISD 2004b).

Aspens in fall color in Uncompahgre National Forest, USA. *Gene Alexander/UNEP/NRCS*

Agricultural Lands

Area of cropland

Figure 61: Trend in arable and permanent-crop land, 1990–2000



Area in cropland down slightly

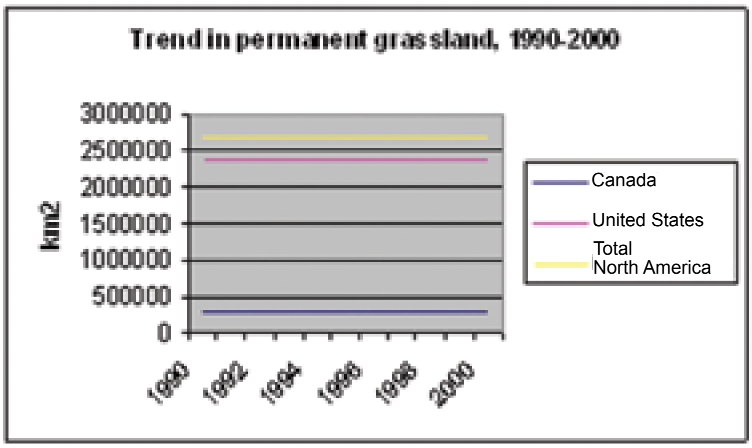
Source: Compiled by author from OECD 2002b, 7.

Arable and permanent-crop land is the sum of the areas of arable land and land under permanent crops. "Arable land" refers to all land that can be cultivated to plant seed, including meadows and land that is left fallow (at rest, without a crop) in the cycle of crop rotation. Permanent crops are those that occupy land continuously for many years, rather than are completely replanted annually. They would include, for example, orchard and other trees; vines; shrubs and perennials grown for flowers, leaves, seed, fruit; and nursery stock (with the exception of trees grown for reforesting)(OECD 2002b).

There has been a slow decline in the amount of land under rotational and permanent crops in North America since 1990 (Figure 61), continuing a trend since the 1950s. In the United States, cropland area decreased 11 per cent between 1950 and 2000, from 35 per cent of the land area to 31 per cent (Brown and others 2004). In Canada, only 4.5 per cent of the total land area is arable and permanent-crop land (OECD 2004a). The decline in total area devoted to cropland in the United States is the result of a number of processes, including the conversion of agricultural land to other uses (especially urbanization), abandonment of poor-quality land, increases in productivity in the agriculture sector, and intensification of agriculture on land still cultivated. The decline varies by region, with the cornbelt and parts of the west showing stable cropland area while regions east of the Mississippi River experienced declines. Where the dominant factor is exurban growth and the abandonment of agricultural lands (especially in the Eastern United States), environmental impacts such as changes in the functioning of ecological systems and concerns about the potential for restoration are most significant, especially given the large areas affected. The ecological state of cropland varies depending on the intensity of irrigation and the use of fertilizers, pesticides, and herbicides (Brown and others 2004).

Area of grassland

Figure 62: Trend in permanent grassland, 1990–2000



Area in permanent grassland steady

Source: Compiled by author from OECD 2002b, 8.

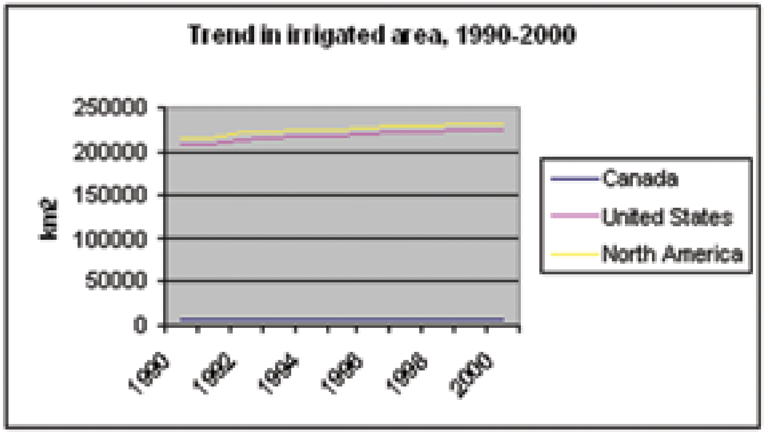
This indicator shows the 1990–2000 trend in the area (in square kilometers) of permanent grassland (Figure 62), which refers to land used for five years or more for herbaceous forage, either cultivated or growing wild.

The area devoted to grassland in North America has remained steady since 1990. This trend was preceded by a decline that started in the mid-1960s due to efforts to improve the forage quality and productivity of grazing lands that led to the need for less pasture and range to sustain grazing herds (Heimlich 2003). In the Western United States, the loss of grasslands to other uses has been offset by the conversion of land back to rangeland (Conner and others, n.d.). With about 31 per cent of the land in the contiguous United States under grassland, pasture, and range in 1997, this is the largest major land-use category in the country (Heimlich 2003). In Canada, only 2.9 per cent of the land base is permanent grassland (OECD 2004a). Native grasslands and rangelands support the livestock industry in both countries (Conner and others, n.d.).

Grasslands are important ecological areas because they store substantial amounts of carbon and cycle nutrients. While reclaiming land for pasture helps to soften the total loss of rangeland, the ecological value of reclaimed grassland is not as significant as undisturbed native grasslands. Population growth and development in the Great Plains can be a threat to the existence and health of grasslands, leading to loss, deterioration, and fragmentation—between 1990 and 2000, the population of the 22 states west of the Mississippi River increased by 17.3 per cent (Conner and others, n.d.). Grasslands are one of the world's most endangered ecosystems, and some experts consider them to be one of North America's highest conservation priorities. In the United States, the Endangered Species Act lists about 55 prairie grasslands wildlife species as either threatened or endangered (Bachand 2001).

Irrigated area

Figure 63: Trend in irrigated area, 1990–2000



Source: Compiled by author from OECD 2002b, 10.

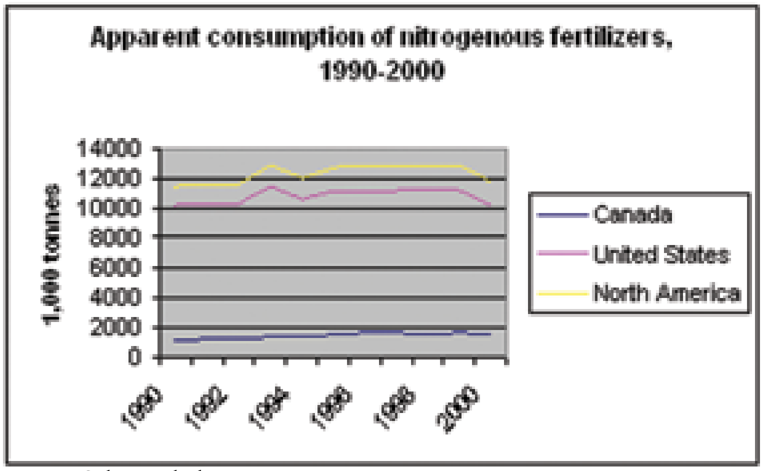
Area under irrigation up

This indicator shows the trend in the amount of land under irrigation between 1990 and 2000 (Figure 63). The data on irrigation relate to areas purposely provided with water, including land flooded by river water for crop production or pasture improvement (controlled flooding), whether this area is irrigated several times or only once during the year (OECD 2002b).

The amount of land under irrigation in North America has risen steadily since 1990. The United States, with 224 000 km^2 (55 351 605 acres) of irrigated land in 2002, has significantly more land under irrigation than does Canada, with only 7 200 km^2 (1 779 159 acres). Irrigation, the largest use of water in the United States, represents about 80 per cent of the nation's water consumption and as much as 90 per cent of freshwater consumption in the Western States (Heimlich 2003). Much of this water irrigates crops in dry regions. Irrigation from groundwater sources exerts a major pressure on available water resources (OECD 2002b). For example, irrigated agriculture is the dominant land use overlying the High Plains aquifer, which yields about 30 per cent of the water used for irrigation in the United States. From 1980 to 1997, the average area-weighted water level in the High Plains aquifer declined 0.8m (2.7 ft) (USGS 2003).

Fertilizer use

Figure 64: Trend in apparent consumption of nitrogenous fertilizers, 1990–2000



Fertilizer use up slightly

Note: US data includes Puerto Rico.
Source: Compiled by author from OECD 2002b.

The indicator shows the trend in apparent consumption of nitrogenous fertilizer in North America between 1990 and 2000 in thousands of tonnes (Figure 64). The data in this indicator refer to the nitrogen (N) content of commercial inorganic fertilizers.

The use of nitrogenous fertilizer in North America continues to increase. The major source is commercial fertilizer, followed by animal manure. In the United States, consumption of all nitrogen products increased over 17 per cent between the 1991–92 and 1996–97 period. In Canada, nitrogen demand grew by 33 per cent in the same period (Korol and Larivière 1998). Given the much smaller agricultural base, Canada's fertilizer consumption is not nearly as high in absolute terms as that of the United States. Of all OECD countries, however, Canada's increase in the use of nitrogen fertilizer has been the largest (OECD 2004a). Increases vary across the country. More land in agriculture and more intensive use of the land in western Canada led to an increase of nearly 50 per cent since 1990, while in central Canada, a shift in crops and better management resulted in a decrease in fertilizer use despite increased yields in corn and other crops (Korol and Larivière 1998). In the United States, increases in the area planted account for the growth in use of commercial fertilizer, which rose to over 22 million tonnes during 1996–98. In 1998, 12.3 million tonnes of nitrogenous fertilizer was used, representing 55.4 per cent of total commercial fertilizer use. The increase was generally due to greater corn productivity that led to more demand by farmers (Daberkow, Taylor, and Wen-yuan Huang 2000).

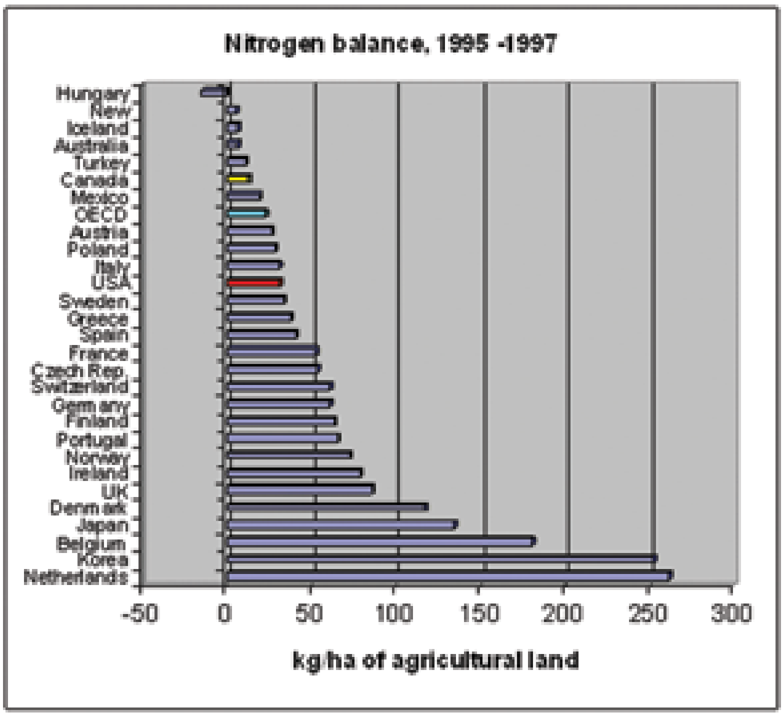
Dietary preference, especially the consumption of meat, is a significant driver of nitrogen use in agriculture. The concentration of industrial livestock farming has led to the concentration of manure. When manure application exceeds the uptake by crops, excess nitrogen enters the environment (CGER 2000; Howarth and others 2002). The impacts include air- and water-quality impairment, and especially the eutrophication of aquatic and estuarine systems. Excess nutrients from fertilizer runoff transported by the Mississippi River are thought to be the primary cause of a large "dead zone" in the Gulf of Mexico (Larson 2004).

A manure slurry is applied to this field to help manage the animal waste and to add nutrients to the soil. *Tim McCabe/UNEP/NRCS*

Nitrogen balance

Comparative indicator

Figure 65: Nitrogen balance, 1995–1997



Source: Adapted from OECD 2001, 97.

The nitrogen balance of agricultural land in Canada and the United States is less than in most other industrialized countries

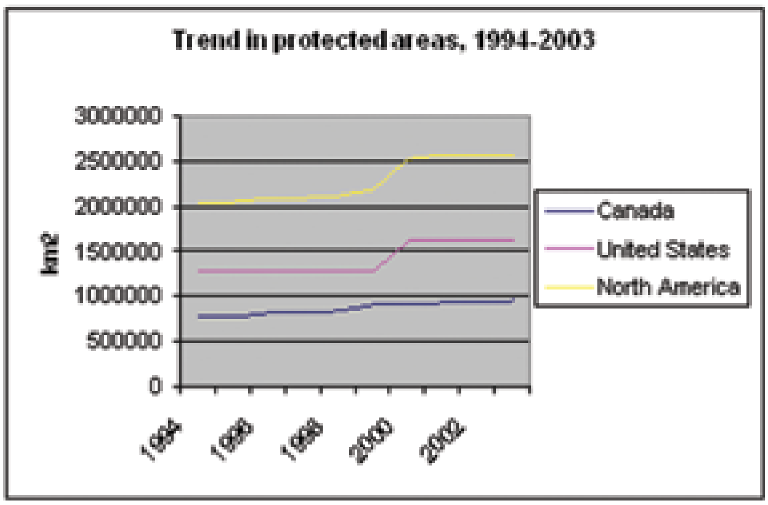
This indicator shows the average nitrogen balances in OECD countries between 1995 and 1997 (Figure 65). The nitrogen balance is the annual total quantity of inputs, mainly from livestock and chemical fertilizers, measured in kilogrammes per hectare of agricultural land. It provides information about the match between nutrient inputs and nutrient outputs and the potential loss of nitrogen to the soil, the air, and to surface or groundwater. The data exclude nitrogen loss to the atmosphere from livestock housing and stored manure (Daberkow, Taylor, and Wen-yuan Huang 2000; OEDC 2001).

Canada and the United States have relatively low nitrogen surpluses compared to other OECD nations. The impacts on the Canadian environment are felt regionally rather than at the national level (OECD 2004a). In the United States, nitrogen balances also vary regionally and from year to year, depending on the crop, the level of yields, and nutrient uptake (Daberkow, Taylor, and Wen-yuan Huang 2000).

Biodiversity

Protected areas

Figure 66: Trend in protected areas, 1994–2003



Source: Compiled by author from UN 2004.

Protected areas up

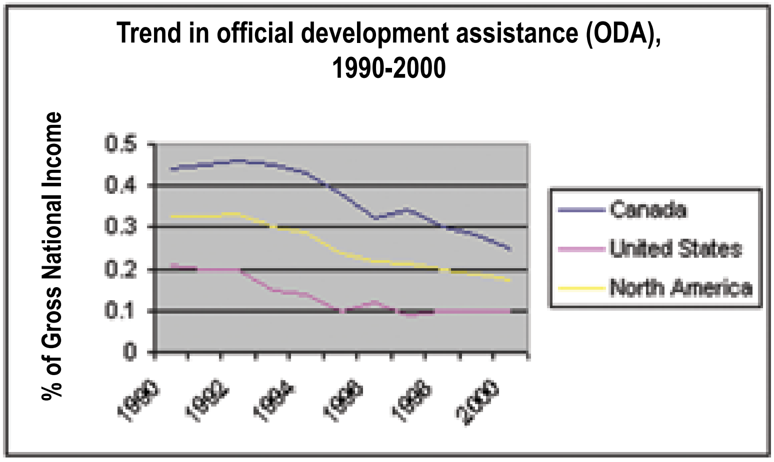
This indicator shows the trend in the area (square kilometers) of land and water set aside to protect and maintain biological diversity and natural and associated cultural resources (Figure 66). Protected areas are managed through legal or other effective means. The definition includes IUCN categories I–VI: areas under strict protection, national parks and monuments, areas conserved through active management, and protected landscapes and seascapes (UN 2004).

The area set aside for protection in North America has increased over the last decade, from 2 million to 2.6 million km^2 (494 million to 642.4 million acres). While such areas in North America and elsewhere may be categorized as protected, they vary in level of effective management. In 2003, some 10.9 per cent of the land area in the region was under some form of protection. The world average was 10.8. In Canada, 6.3 per cent of the land was protected under IUCN categories I–VI (excluding marine and littoral areas) in 2003 (WRI 2004). Canada has about 20 per cent of the world's remaining natural areas (OECD 2004a); some two-thirds of the land occupied by Canada's terrestrial ecoregions has some form of protection, but the other third has virtually none (NRCan 2004). Over the past decade, however, there was a 40 per cent increase in the area protected (OECD 2004a). Canada's target is to protect 12 per cent of its land. In the United States in 2003, 15.8 per cent was protected under IUCN categories I–VI. Although there has been a general increase in the area protected in the United States over the past 10 years, only three new parks have been created since 2000.

National Responses

Official development assistance

Figure 67: Trend in official development assistance (ODA), 1990–2000



Official development assistance down

Source: Compiled by author from OECD 2002b.

This indicator presents the trend in official development assistance (ODA) related to gross national income (Figure 67). Data refer to loans (except military loans), grants, and technical cooperation by the public sector to developing countries (OECD 2002b).

This is an important response indicator, since a large part of ODA goes towards conserving natural resources, protecting the environment, and funding population programmes in developing countries. It is appropriate that North America provide such aid to less developed regions since North America's large ecological footprint means that its activities have important impacts on regions beyond its shores, and since its own environmental quality depends on the health of global ecosystem goods and services. The indicator shows that Canada reduced the percentage of its gross national income devoted to ODA from 0.44 per cent in 1990 to 0.25 per cent in 2000 and the United States reduced it from 0.21 per cent to 0.01 per cent during this time. These amounts fall far short of the UN target, agreed to by the international community in 1970, of 0.7 per cent (ICPD 1994).