Catalogue no. 16-200-XKE

Econnections

Linking the Environment and the Economy

Indicators and Detailed Statistics 1997

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Errata

Econnections: Linking the Environment and the Economy Indicators and Detailed Statistics 1997

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The following corrections (shown underlined) are made to the "Analysis" section of the Natural Resource Wealth indicator (page 3):

The first sentence of the second paragraph is changed to:

"The value of energy resource assets peaked at $257 billion in 1985 (Figure 1b), when they alone accounted for 13 percent of national wealth."

The last sentence of the third paragraph is changed to:

"By 1995, the value of crude bitumen assets had risen to about two-thirds that of conventional crude oil."

The first sentence of the fourth paragraph is changed to:

"The value of mineral resource assets peaked in 1980 at $124 billion, when they accounted for almost 8 percent of total wealth."

Figure 1a is replaced by:

Figure 1a
Natural Resource Assets and National Wealth

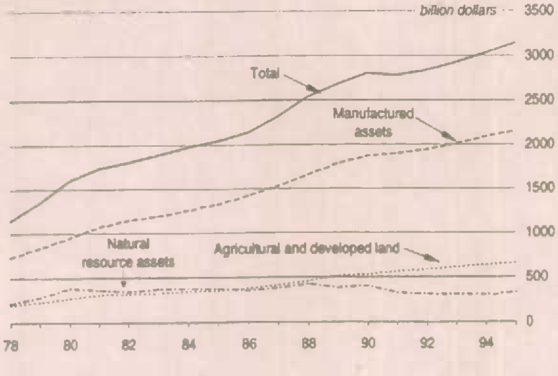
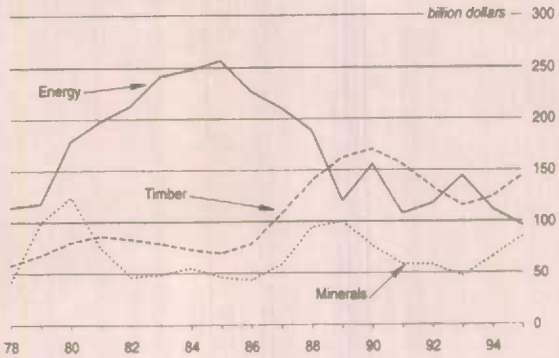


Figure 1b is replaced by:

Figure 1b
Natural Resource Wealth



Note: All corresponding data and text on the CD-ROM component of this publication have been corrected to reflect the above changes.

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Econnections

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Note of Appreciation

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Over 50 percent recycled paper, including 30 percent post-consumer fibre

Symbols

The following standard symbols are used in Statistics Canada publications:

..	figures not available
...	figures not appropriate or not applicable
-	nil or zero
- -	amount too small to be expressed
e	estimate
p	preliminary figures
r	revised figures
x	confidential to meet secrecy requirements of the *Statistics Act*
nec	not classified elsewhere

The paper used in this publication meets the minimum requirements of the American National Standard for Information Sciences - Performance of Paper for Printed Library Materials, ANSI Z39.48 - 1984.

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Indicators

Introduction

In the past, many Canadians took their natural heritage for granted. They viewed the environment as an almost limitless source of raw material to be exploited and fed to a growing economy. The pollution that inevitably accompanied this growth, to the extent that it was considered at all, was assumed to be dealt with by nature's equally unlimited waste absorption capacity.

This perception has changed. Canadians, like people in many other countries, have come to understand that the capacities of their environment to supply materials and absorb wastes are finite. They now recognize that these capacities must be respected and safeguarded if future generations are to enjoy the same level of environmental benefits that we enjoy today. Equally important, Canadians today realize that the environment has value beyond its direct use by humans. The preservation of wildlife habitat for wildlife's sake has, for example, become a primary goal of those calling for protection of the environment.

This growing environmental awareness has led to demands for new kinds of information. Beyond the traditional measures of economic activity to which they have become accustomed, Canadians are now asking for measures highlighting the relationship between the economy and the environment. In response to this demand, the Government of Canada–under the auspices of *Canada's Green Plan* (Government of Canada, 1990)–asked Statistics Canada in 1991 to develop a new environmental information system. The objective was to create a system that could be used to measure and study the relationship between the environment and the economy. The ten indicators presented in this document, along with the detailed statistics on the accompanying CD-ROM database, represent the first release of the system that has resulted from this initiative.

Why the *Econnections* Information System?

Statistics on the economy have been produced for decades. While newer than this, statistics on the environment have also been long available, for 25 years at least. Despite these long histories, the tendency has been to treat the two as covering independent and unrelated issues. This is attributable in part to the division of labour that separates them, and in part to the nature of the two domains; economic statistics have a long-standing focus on monetary measures while environmental statistics have tended to focus on physical measures. The resulting datasets have often been characterized by collection methods, definitions and classifications that are incompatible. As a result, integration of the two types of statistics has been rare.

The lack of integration of environmental and economic statistics has hindered Canadians' understanding of the relationship between the environment and the economy. Many of the most pressing environmental issues facing the country, and the world, today are directly related to economic activity. The absence of integrated statistics describing the relationship between the environment and the economy makes gaining a full understanding of these issues and arriving at wise solutions more difficult.

The new environment-economy information system presented here, titled *Econnections: Linking the Environment and the Economy - Indicators and Detailed Statistics 1997*, has been designed specifically to integrate environmental and economic statistics. This has been achieved in several ways.

- Statistics Canada's principal economic statistical framework, the *Canadian System of National Accounts*, has been extended to include new measures of the environment's contribution to economic activity and of the economy's effects on the environment.
- Existing Statistics Canada economic data have been disaggregated and reorganized to make explicit environmental information that has always been collected, but that has not always been easily accessible.
- Various environmental data sets collected by other federal and provincial government departments have been integrated with Statistics Canada's economic statistics to allow fuller analysis of the relationship between economic activity and the environment.

The approach taken to presenting the information that makes up this new system is two-pronged.

Summary indicators (presented in print and electronic form) are used to convey clear and concise information on specific environment-economy variables. Ten indicators comprise the first release of the system. Five themes are used to organize the indicators into groups:

- natural resource stocks;
- use of land resources;
- consumption of materials and energy;
- waste production; and
- environmental protection expenditures.

Intended for use by a wide audience, the indicators have been chosen to represent a few key environment-economy variables rather than a comprehensive picture of the complete environment-economy relationship. They will be updated and published annually,[1] providing Canadians with a means of monitoring their evolution. In this way, they will act as a sort of annual "report card" on the environment and the economy. It is hoped that Canadians will grow accustomed to monitoring these indicators over time, not unlike the way in which they have grown accustomed to following changes in the Gross Domestic Product, the Consumer Price Index and other key economic indicators.

1. Some indicators will be updated every five years rather than annually.

Recognizing that summary indicators cannot tell the full story, the second prong in the *Econnections* information system is a CD-ROM database containing the **detailed statistics** that lie behind the indicators. This database will allow users the opportunity to delve much more deeply into the information in search of answers to questions beyond those to which the summary indicators respond.

The *Canadian System of Environmental and Resource Accounts*

An information system such as that presented in this volume must rely on a set of underlying organizing principles and statistical methods. In the case of *Econnections*, these principles and methods are defined by the *Canadian System of Environmental and Resource Accounts* (CSERA).

The CSERA has been developed with the specific objective of organizing physical and monetary statistics related to the environment using classifications, concepts and methods that are compatible with the *Canadian System of National Accounts*. The latter is the source of many of Statistics Canada's most important economic statistics. Compatibility between these two systems ensures that the environmental statistics of the *Econnections* system can be directly integrated with those of the *Canadian System of National Accounts*.

Those users wishing to delve more deeply into the details of the CSERA and its relationship with the *Econnections* indicators and statistics are directed to *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts* (Statistics Canada, 1997).[1]

Other Environmental Indicator Series

It is important to note that the indicators presented in *Econnections* form just one of a growing number of environmental indicator series available from the Government of Canada. Many of the indicators on offer from other federal departments complement those presented here. Users are encouraged to consult these other indicator series in order to have the most complete understanding possible of the state of Canada's environment and the factors affecting it.

One of these other indicator series deserves particular mention here; this is the *National Environmental Indicator Series* produced by Environment Canada. The eleven indicators currently available in the *National Environmental Indicator Series* cover many of the same issues as *Econnections* (climate change, energy use and water use for example). The approaches taken in the two indicator series are complementary, rather than duplicative, however. Whereas the *Econnections* indicators focus on the integration of environmental and economic statistics to provide insight into environmental issues, the *National Environmental Indicators Series* is focused more closely on the state of the environment itself. For example, on the issue of climate change, *Econnections* offers an indicator of the contribution of household expenditures to greenhouse gas emissions. The *National Environmental Indicators Series*, in contrast, presents an indicator showing total Canadian carbon dioxide emissions along with the atmospheric concentrations of key greenhouse gases. Taken together, these two indicators present a much more complete perspective on climate change than either of them would in isolation.

So that users of the *Econnections* system will be aware when an indicator within the *National Environmental Indicator Series* covers a theme closely related to that covered by an *Econnections* indicator, the discussion of the indicator in this volume will include a pointer to the relevant *National Environmental Indicator Series* indicator.[2]

Statistics Canada and Environment Canada will continue to work to ensure that their two indicator series reinforce one another. This collaboration will help guarantee that Canadians are presented with the most useful environmental information possible.

The Future

Although well established both conceptually and empirically, the *Econnections* system remains a work in progress. Its current scope represents only a portion of what a complete system for Canada would cover. Rather than being viewed as the final word on the development of the system, the indicators and statistics presented in this volume should be viewed as an important, but initial, step.

As mentioned earlier, the system will be released annually. The indicators and statistics included in this first release will be updated with each new edition, most of them every year, but some less frequently depending upon the nature of the variable in question. New indicators and statistics will be added as our understanding of the interaction between the economy and the environment, and our ability to measure this interaction, grow.

1. An electronic version of this guidebook has been included on the CD-ROM component of *Indicators and Detailed Statistics 1997*. A printed version of the guidebook is also available; for ordering information, see the back of this publication.

2. Users interested in viewing the entire *National Environmental Indicator Series* are invited to visit Environment Canada's world wide web site at http://www.ec.gc.ca.

About the *Econnections* Name and Logo

The title under which this volume is released, *Econnections: Linking the Environment and the Economy*, has been coined to capture the essence of the system; that is, the linkage of the environment and the economy through integrated statistics. The name *Econnections* is intended to convey the notion that the economy is physically connected to the environment, that the environment is the foundation upon which the economy rests. The logo that appears on the cover of this publication is intended also to convey this connection. It portrays the economy in its various facets, symbolized by homes, offices and factories, as inextricably bound to the environment, symbolized by the roots of a tree.

Although they are making their first appearance on this 1997 edition of *Indicators and Detailed Statistics*, the *Econnections* name and logo will eventually appear on a broad suite of statistical products. The element common to all these products will be the statistical elaboration of the linkages between the economy and the environment. The products will offer a wide variety of physical and monetary statistics, both detailed and summary, in print and electronic formats. All of them will bear the *Econnections* name and logo to identify them as offering information relevant to understanding the nature of the linkages between the economy and the environment.

Acknowledgements

The 1997 edition of *Indicators and Detailed Statistics* has been prepared by the Environmental Statistics sub-division of the National Accounts and Environment Division under the direction of Philip Smith (Director, 1990-1995) and Claude Simard (Director, 1995-present). Robert Smith served as editor and project manager. Major contributions to the conceptual and empirical development of the system have been made by:

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The *Econnections* logo was designed by Shoreline Communications, Ottawa.

How to Use this System

Econnections: Linking the Environment and the Economy - Indicators and Detailed Statistics 1997 is a two-component information system. The first component is a **printed publication** containing two-page discussions of each of the 10 indicators currently available in the system. This publication is intended to provide users with quick access to the indicators in a format that is convenient and easy to read.

The system's second component is a **CD-ROM diskette** containing:

- a reproduction of the indicators publication in Adobe Acrobat™ format;[1]
- a database of detailed statistical tables supporting the summary indicators and accessible through Beyond 20/20 Browser™ software;[2]
- tutorials that explain the use of both the Adobe Acrobat and Beyond 20/20 Browser software; and
- an Adobe Acrobat reproduction of *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts* (Statistics Canada, 1997), the guidebook to the accounting framework that underlies the *Econnections* indicators and statistics.

The CD-ROM diskette is found in the plastic pouch attached to the inside back cover of the indicators publication. Complete instructions for the computer installation of the system are also found there.

Indicators and Statistics Linked Electronically

To aid users in locating the statistical tables related to a particular indicator, electronic links have been established between Adobe Acrobat and the Beyond 20/20 Browser.

Each indicator in the Adobe Acrobat version contains a "hot button" that can be clicked with your mouse to open a list of Beyond 20/20 Browser tables containing the data associated with that indicator. Simply by clicking on the table that one is most interested in, the Beyond 20/20 Browser will be launched automatically with that particular table open for viewing.

Users can also go directly to the statistical tables simply by launching the Beyond 20/20 Browser directly from the *Econnections* welcome screen that is seen each time the CD-ROM component of the system is used.

1. Adobe Acrobat is a trademark of Adobe Systems Incorporated.
2. Beyond 20/20 Browser is a trademark of Ivation Datasystems Incorporated.

How to Get Help

Explanations of both the Adobe Acrobat and Beyond 20/20 Browser software are provided in the tutorials that have been included on the CD-ROM. These tutorials can be started simply by clicking on the appropriate icon in the welcome screen. Users are strongly encouraged to consult them; they will help ensure that one gets the most out of the *Econnections* information system.

Technical assistance: In the event that difficulties are experienced during the installation of the system or with the Adobe Acrobat or Beyond 20/20 Browser software, technical assistance may be obtained at no charge by dialing the **Electronic Products Helpline** at **1-800-949-9491** (users in the National Capital Region are requested to call (613) 951-5252).

Subject-matter assistance: Users with questions regarding the content of either the indicators or the detailed statistics that are presented in the *Econnections* system are requested to call **(613)-951-3640** and ask for the Information Officer.

Indicator Format

Each indicator in the *Econnections* system, whether in print or electronic form, is laid out using a standard two-page format containing 11 separate fields. To aid the user in interpreting the indicators, each of the 11 fields is briefly described below.

Theme: The thematic area into which the indicator falls. There are five such areas in the system, each of which is identified by its own title:

- natural resource stocks;
- use of land resources;
- consumption of materials and energy;
- waste production; and
- environmental protection expenditures.

Geographic scope: The geographic region covered by the indicator. Although most of the indicators are national in scope, many of them are supported by statistics that are provided at the provincial level on the CD-ROM component of the system.

Time series: The time period (in years) for which the indicator currently exists. Readers should pay careful attention to this field, as the period varies widely among indicators.

Frequency of update: The frequency with which the indicator is updated.

Description: A description of the indicator outlining what it measures and important characteristics or features of the indicator.

Significance: A discussion of the usefulness of the indicator for measuring one or more of:

- the environmental sustainability of economic development;
- the economy's reliance or impact on the environment;
- the contribution of the environment to the economy;
- societal responses to environmental degradation.

Method of calculation: A very brief description of the data sources and methods used in the calculation of the indicator. Users interested in more detailed descriptions of sources and methods are encouraged to consult *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts* (Statistics Canada, 1997). An electronic version of this guidebook (in Adobe Acrobat format) is included on the CD-ROM component of the system.

Data limitations: A discussion of the limitations imposed on the indicator by the quality of the underlying data and/or methods. Users are encouraged to bear these limitations in mind when interpreting the information presented in the indicator.

Reliability: A relative measure of the reliability of the indicator based on data quality and conceptual and methodological soundness. Indicators are given one of the following ratings:

- class 1 - very reliable
- class 2 - reliable
- class 3 - acceptable.

Indicators are considered to be "very reliable" (class 1) when they are characterized by source data that are:

- mainly derived from Statistics Canada surveys, or from other sources that are considered to be highly reliable; and
- easily integrated into the system without the need for major adjustments to correct for shortcomings in coverage (spatial, temporal, sectoral or environmental) or classification;

and when they are characterized by concepts and methods that:

- are based on accepted environmental, economic or statistical theory;
- do not require arbitrary or subjective decisions regarding important parameters; and
- are compatible with the concepts and methods used in the *Canadian System of National Accounts*.

Indicators that meet all but one of the above criteria are deemed to be "reliable" (class 2). Those that fail to meet two or more of the criteria are deemed to be "acceptable" (class 3).

Analysis: A discussion of the main trends in the indicator and, where relevant, the major factors lying behind these trends.

Related indicators: A list of related *Econnections* indicators and, where relevant, related indicators from Environment Canada's *National Environmental Indicators Series*. The basis for the relationship can be similarities in theme or methodological/conceptual approach.

Indicators

1 Natural Resource Wealth

Theme: Natural Resource Stocks

Geographic scope: National

Time series: 1978-1995

Frequency of update: Yearly

Description: *Natural Resource Wealth* measures the contribution of Canada's stocks of timber, energy[1] and mineral[2] resources to national wealth at the end of each year. Annual estimates of the market value of these resource stocks are made and compared with the other assets that comprise national wealth.[3] Not all stocks of timber, energy and mineral resources are measured however. In the case of energy and minerals, only the portion of Canada's total stock that is known to exist with a high degree of certainty and that can be profitably extracted today is valued. In the case of timber stocks, the portion of the forest that is valued is that which is accessible for harvesting, where commercially valuable species grow to a marketable size within a reasonable length of time, and where harvesting is allowed. These more limited timber, energy and mineral stocks, referred to here as natural resource *assets*, are the same stocks measured in physical terms in the indicator of *Physical Quantities of Natural Resource Assets* (page 4). The estimates presented in the two indicators are therefore comparable.

Significance: The monetary value of natural resource stocks serves as an indicator of the contribution of resources to our national wealth. Wealth, in turn, is an important indicator of economic well-being, as it represents the potential for future income.

Historically, Statistics Canada's measurement of national wealth has included only the value of manufactured assets (infrastructure, buildings and machinery). Natural resources were excluded from measurement, with the exception of agricultural land and land under structures. *Natural Resource Wealth* represents the first time that a broad measure of Canada's natural resource wealth has been combined with the wealth represented by manufactured assets.

The combination of natural resource wealth with the wealth represented by manufactured assets allows us to assess whether total national wealth is maintained over time. In other words, it tells us whether our current level of national income can be sustained. Questions that can be addressed by a combined measure of natural and produced wealth include:

- Is the value of our renewable resource stocks being maintained?
- To what extent is the value of our energy and mineral stocks being reduced by depletion or increased by exploration and development activity?
- If the value of natural resource stocks is declining, is there an offsetting gain in the value of manufactured assets to make up for this loss?

Method of calculation: Natural resource asset stocks are valued at their estimated market value, the price they would bring if they were sold in the open market. This value is based on the difference between the annual cost of extraction of a given resource and the revenue generated from sale of the resource. This difference is referred to as "rent." Costs of extraction include both operating costs, such as wages and supplies, and capital costs, such as expenditures on exploration, infrastructure and equipment. Data for these costs, and for the value of production, are obtained from annual surveys of the resource-producing industries. For energy and mineral resources, data for the petroleum and mining industries are used. For timber resources, unit rent is based on data for the logging and wood-processing industries.[4]

The total value, or wealth, associated with the stock is calculated as the present value of all future annual rent that the stock is expected to yield.[5] In each year, it is assumed that depletion of energy and mineral stocks will continue at the current rate until the stock is fully depleted. In the case of timber, the assumption is made that the rate of extraction in each year can continue indefinitely. To the extent that this harvest rate is above the long-term sustainable rate, the timber asset will be overvalued.[6]

Data limitations: The natural resources currently included in *Natural Resource Wealth* represent only part of the wealth associated with the natural environment. In particular, the value of services provided by the environment, such as waste assimilation or recreational opportunities, is omitted. So too are the environmental costs of resource extraction, such as the loss of wildlife habitat or degradation of water quality. Since changes in environmental quality can impact economic activity, some environmental services and costs can, in principle, be valued. Methods for doing so are still at the experimental stage. A number of natural resources are also excluded from the calculation due to lack of data.

1. Crude oil, natural gas and crude bitumen (tar sands) and coal.
2. Potash, copper, gold, iron, lead, molybdenum, nickel, silver, uranium and zinc.
3. Note that the estimates of natural resource wealth measure the value of the resources only and not the value of the manufactured assets used in resource extraction or processing. The latter is included in the estimate of produced wealth.
4. The wood-processing industries are included because of the high degree of vertical integration in the forest products industry.
5. If annual rent happens to be negative in a year, the resource stock is given a value of zero, rather than a negative value, for that year.
6. Full details of the method used to produce this indicator are available in Chapter 3 of *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts* (Statistics Canada, 1997).

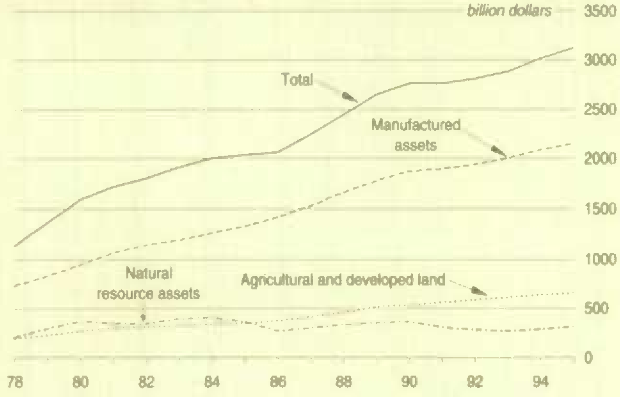
These include gypsum and other industrial minerals, marine resources, and parks and other protected land.

Reliability: The estimates of resource wealth are considered to be reliable (class 2).

Analysis: A broad, but not comprehensive, measure of natural resource wealth comprising energy, mineral and timber resources represented about 10 percent of total national wealth in 1995 (Figure 1a). In the late 1970s and early 1980s, these resources represented 20 percent of total wealth. The major reason for the decline in the relative importance of natural resources was changes in energy resource assets.

The value of energy resource assets peaked at $277 billion in 1984 (Figure 1b), when they alone accounted for 14 percent of national wealth. By 1995, these assets were worth less than a third of their peak value and represented only 3 percent of total wealth. The change in their value reflected the significant decline in world energy prices after 1986 more than it did declines in physical quantities of energy resource assets.[1] Since the value of resource assets depends on extraction costs as well as selling prices, the increased exploration costs associated with increasingly hard-to-find energy resources also contributed to the decrease in value. Technological development tended to reduce exploration and extraction costs over the period however, making exploitation of previously uneconomic resources feasible, and reducing the downward effect of energy prices on declining energy resource wealth.

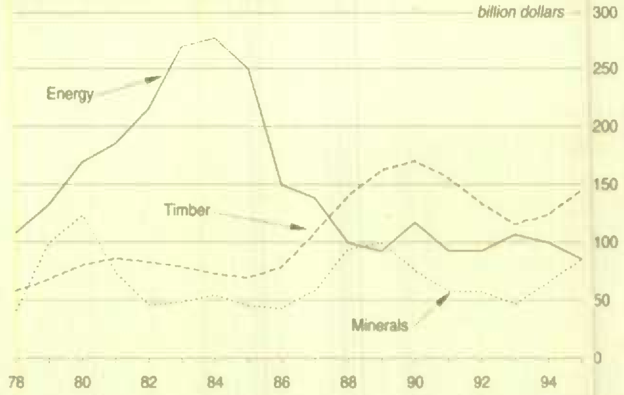
Figure 1a
Natural Resource Assets and National Wealth



The most striking change in energy resources since 1978 occurred for crude bitumen (tar sands). In 1978, when this industry was still young, crude bitumen assets had a zero value. Production at the time was very low and start-up costs were very high, resulting in negative rents in early years. By 1995, the value of crude bitumen assets had risen to surpass that of conventional crude oil.

1. See the indicator of *Physical Quantities of Natural Resource Assets* (page 4) for a discussion of the physical changes in resource assets.

Figure 1b
Natural Resource Wealth



The value of mineral resource assets peaked in 1980 at $123 billion, when they accounted for almost 8 percent of total wealth. In 1995, their value ($85 billion) represented 3 percent of national wealth. The changes in value of mineral assets closely followed the ups and downs of the economy, with declines in the early 1980s and early 1990s when the economy was in recession. The decrease in mineral stock values corresponded to some extent with changes in the physical quantity of assets. With the exception of gold, stocks of most metal assets have declined by 25 to 50 percent in physical terms since 1978.

The value of timber assets rose to a peak of $170 billion, or 6 percent of national wealth, in 1990. As with minerals, timber stock values closely followed the pattern of economic activity, with declines corresponding to the recessions in the early 1980s and 1990s.

Related indicators:

Physical Quantities of Natural Resource Assets

Total Resource Base

2 Physical Quantities of Natural Resource Assets

Theme: Natural Resource Stocks

Geographic scope: National

Time series: Variable

Frequency of update: Yearly

Description: *Physical Quantities of Natural Resource Assets* measures the size of Canada's stocks of timber, energy[1] and mineral resources[2] at the end of each year. Not all stocks of timber, energy and mineral resources are measured however. In the case of energy and minerals, only the portion of Canada's total stock that is known to exist with a high degree of certainty and that can be profitably extracted is measured. In the case of timber, the portion of the forest measured is that which is accessible for harvesting, where valuable species grow to a marketable size within a reasonable time, and where harvesting is allowed.[3] These more limited timber, energy and mineral stocks, referred to here as natural resource *assets*, are the same stocks that are measured in monetary terms in the indicator of *Natural Resource Wealth* (page 2). The estimates presented in the two indicators are therefore comparable.

Significance: Free of fluctuations due to price changes, physical estimates of resource asset stocks portray the actual quantities of natural resources that Canada has at its disposal in the short term.

The interpretation of physical stock estimates differs for renewable and non-renewable resources. For renewable resources, a constant stock size indicates that annual harvesting and other losses are offset by annual growth. For non-renewable resources, a constant size means that additions to the asset stock through new discoveries offset depletion of existing assets. Additionally, the current annual depletion rate of non-renewable resources can be compared to the asset stock size to provide a measure of asset life, or the number of years it will take to deplete the remaining stock.

Method of calculation: Estimates of timber asset stocks are based on a computer simulation of the growth, regeneration, harvest and natural loss of trees on timber-productive forestland. Data from *Canada's Forest Inventory 1991* (Lowe, Power and Gray, 1994) are used as a starting point in the simulation.

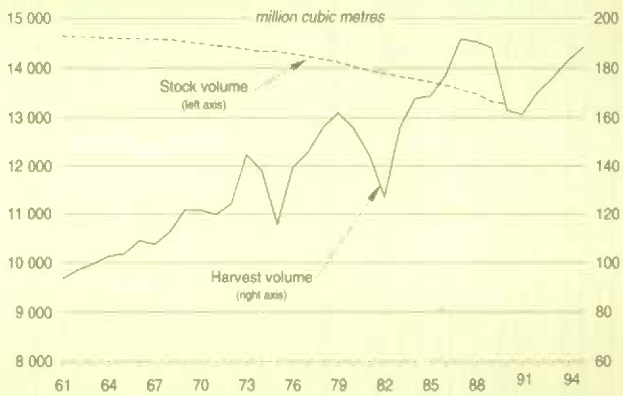
Estimates of energy and mineral asset stocks are taken from data published by a number of agencies and government departments. Estimates for crude oil, crude bitumen and natural gas are taken from the Canadian Association of Petroleum Producers, the Alberta Energy and Utilities Board and the departments of energy, mines and resources of Manitoba, Saskatchewan and British Columbia. Coal estimates are taken from Natural Resources Canada and the Alberta Energy and Utilities Board. Finally, estimates for metal resources are from Natural Resources Canada.[4]

Data limitations: The simulation model used to estimate timber stocks does not take into account changes in the area of forestland used for timber harvesting since 1961.

Reliability: Estimates of resource asset stock size are considered to be reliable (class 2).

Analysis: Over the period 1961 to 1990,[5] timber asset stocks declined by an estimated 9 percent in volume terms (Figure 2a). This result is not unexpected given the evolution of the land used for timber production in Canada in recent decades. This land could be described as being in transition from virgin forest made up of mainly mature, high-volume trees to a "production" forest containing a higher percentage of younger trees of lower volume.

Figure 2a
Timber Asset Stocks

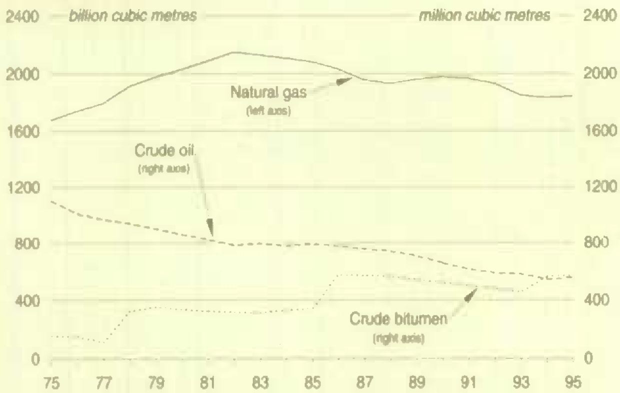


Total annual timber harvest increased substantially in recent decades, more than doubling from 93 million cubic metres in 1961 to 188 million cubic metres in 1995. Two factors suggest that this rate of increase may be difficult to maintain in the future. First, timber was already harvested on more than half of Canada's long-term timber resource base in the early 1990s (see Figure 3a on page 7). Second, much of the timber harvested in the last 30 years came from high-volume, first-growth forests. These are being replaced by production forests in which trees are harvested at an earlier age and lower volume.[6]

1. Crude oil, natural gas and crude bitumen (tar sands) and coal.
2. Potash, copper, gold, iron, lead, molybdenum, nickel, silver, uranium and zinc.
3. The *Total Resource Base* (page 6) indicator offers a perspective on resources that includes estimates for both resource assets and undiscovered stocks.
4. Full details of the method used to produce this indicator are available in Chapter 3 of *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts* (Statistics Canada, 1997).
5. No estimates of timber asset stocks are available beyond 1990.
6. Forest management techniques designed to increase the number of trees per hectare in production forests can offset the effect of harvesting trees of lower volume.

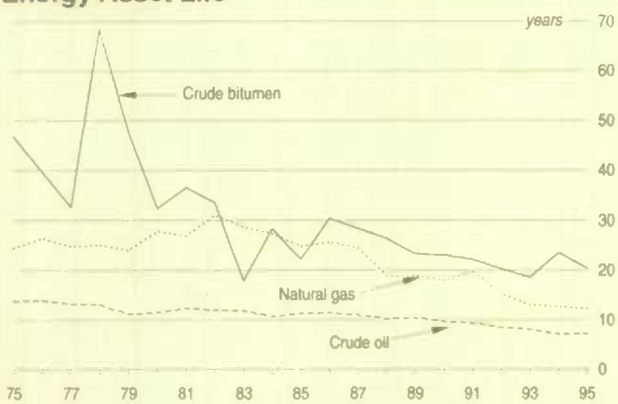
Turning to energy resources, conventional crude oil asset stocks declined by almost one half between 1975 and 1995 (Figure 2b). The drop in asset stocks is attributable to a declining rate of stock additions rather than to an increasing rate of depletion. As a result of the stock decline, crude oil asset life fell from 14 years in 1975 to 7 years in 1995 (Figure 2c).

Figure 2b
Energy Asset Stocks



In contrast to crude oil, both natural gas and crude bitumen asset stocks increased over the period. This was particularly so for crude bitumen assets, which increased in size by almost four times. Despite this increase, asset life for this resource declined over the period, reflecting rapid growth in extraction rates. Natural gas asset life declined as well, again reflecting increased rates of extraction.[1]

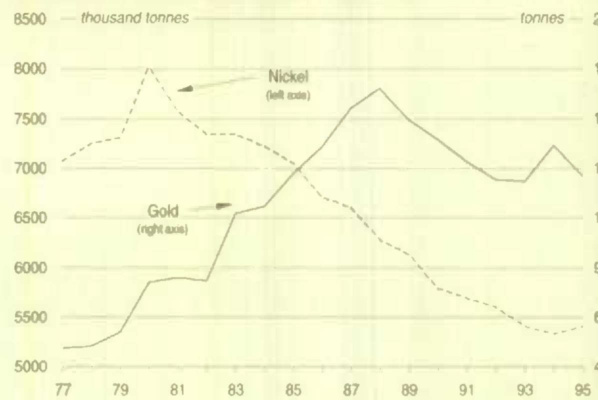
Figure 2c
Energy Asset Life



It is worth noting that physical changes in energy asset stocks have not always been reflected in changes in their value. Both crude oil and natural gas experienced dramatic increases in value in the late 1970s and early 1980s as a result of rising energy prices.[2] At the same time, the physical stock of crude oil assets actually declined; natural gas assets did grow in size, but they did so much less than in value. In the case of crude bitumen, despite the near quadrupling of the asset size between 1975 and 1995, asset value finished the period at essentially the same level at which it began.

Trends in asset stock size for gold and nickel are shown in Figure 2d. Nickel assets stocks fell by 23 percent between 1977 and 1995, forcing asset life for this metal (not shown) from 56 to 31 years. The trends for all other base metals were similar to those for nickel, with both asset size and life decreasing over the period. As with energy assets, there was a considerable divergence between the size and value of base metal assets; the value of these assets typically rose over the period while asset size fell. In contrast to base metals, both the size and value of gold resource assets rose considerably; asset life remained stable at about 9 years.

Figure 2d
Stocks of Selected Metal Assets



Related indicators:

Natural Resource Wealth

Total Resource Base

1. Asset size and life for coal and uranium (not shown in figures 2b and 2c) increased substantially over the period.
2. See the indicator of *Natural Resource Wealth* (page 2) for a complete discussion of the trends in natural resource values.

3 Total Resource Base

Theme: Natural Resource Stocks

Geographic scope: National

Time series: None

Frequency of update: Occasional

Description: *Total Resource Base* compares the portion of Canada's natural resources that are currently considered assets with estimates of the total resource base. For timber, the total resource base is the area of land that is suitable for timber production and where the harvesting of timber is allowed. For other resources, the total resource base is the estimated quantity that will ultimately prove exploitable with the technology and infrastructure that is currently available or is likely to be developed in the future.

Estimates of total resource base are revised only periodically by the responsible agencies. For this reason, the indicator does not show an annual time series of estimates, but presents a "snapshot" of the resource base at a point in time instead. A regular time series of estimates would be useful however, as it would allow assessment of the effect of changes in prices, production costs, infrastructure, land use and technical knowledge on Canada's resource base.

Significance: *Total Resource Base* is intended mainly as supplementary information for use in interpreting the physical and monetary estimates of resource asset stocks presented in the indicators of *Natural Resource Wealth* (page 2) and *Physical Quantities of Natural Resource Assets* (page 4). While stocks of natural resource assets measure resource availability in the near future, the total resource base provides a means of assessing the resources that might become available in a more distant future. The indicator also portrays the cumulative impact of economic activity on the resource base by showing the portion of the resource base that has been exploited to date and that which remains for future use.

Method of calculation: The estimate of the timber resource base is taken from a summary of *Canada's Forest Inventory 1991* (Lowe, Power and Gray, 1994) as summarized in the *Compendium of Canadian Forestry Statistics* (Canadian Council of Forest Ministers, 1997).

Estimates of the petroleum and natural gas resource base are produced by the National Energy Board (1994); estimates of the coal resource base are produced by Natural Resources Canada (1993). The total energy resource base is divided into two components: discovered resources and undiscovered resources. Discovered resources are those that have been shown to exist by drilling, testing or production. Undiscovered resources are stocks believed to exist based on geological and geophysical evidence. These can include extensions to stocks that are already part of discovered resources and expected new discoveries.

Discovered resources are further classified into three subgroups: cumulative production, remaining established reserves and other discovered resources. Cumulative production is that portion of the resource base that has been produced to date. Remaining established reserves are the part of the resource base that is known to be commercially viable today, but that has not yet been extracted. This is the component of the energy resource base that is measured in the indicators of *Natural Resource Wealth* and *Physical Quantities of Natural Resource Assets*. Other discovered resources, although known to exist, are those that are not presently economically viable. Their viability will require either an increase in selling prices, or a reduction in costs as a result of technological change or the construction of new infrastructure.

Data limitations: 1) No estimates of the resource base are currently available for non-energy minerals. 2) Estimates of the uranium component of the energy resource base are not currently available. 3) The estimates of crude oil and natural gas resources become increasingly uncertain as one moves from remaining reserves to other discovered resources and finally to undiscovered resources.

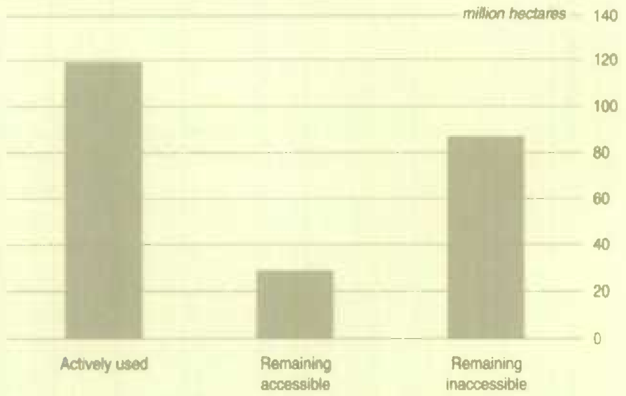
Reliability: The estimates of total resource base are considered to be reliable (class 2).

Analysis: Canada's estimated total timber resource base in 1991 was 234 million hectares. This was the forest area that was considered capable of producing commercially valuable timber in a reasonable period of time and on which harvesting was allowed. Of this area, timber harvesting actually occurred on 119 million hectares, while another 29 million hectares were accessible for harvesting but not actively used. Inaccessible timberland represented the remainder (86 million hectares) of the total timber base (Figure 3a).

Canada's short-term timber resource base can be taken as the sum of the 119 million hectares of actively used timberland plus the remaining 29 million hectares of accessible, unemployed timberland (148 million hectares in total). The full 234 million hectares of timberland on which harvesting is commercially viable and permitted represents our long-term timber resource base. The land in use for timber harvesting in 1991 thus represented 80 percent of the short-term resource base, and one half of the long-term base. Both of these figures may be underestimates however, as some of the land that is classified as accessible is not necessarily commercially viable,[1] and no allowance is made for possible decreases in the resource base if further land is protected from logging.

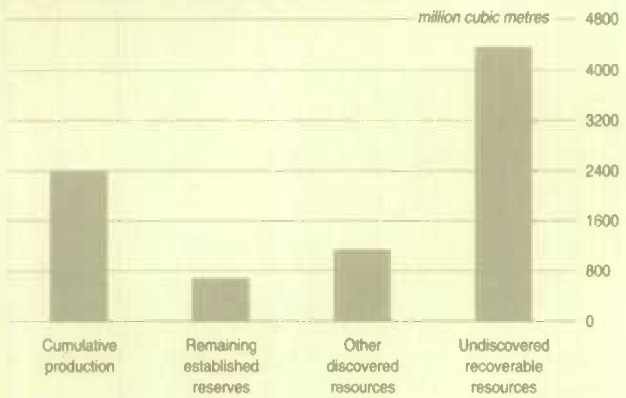
1. Timberland that is near a transportation corridor may be accessible, but it is not necessarily close enough to a market to be commercially viable.

Figure 3a
Timber Resource Base, 1991



Turning to energy resources, the estimated total crude oil resource base in 1992 was 8.6 billion cubic metres. Of this, cumulative production had consumed 2.4 billion cubic metres, while remaining established reserves represented another 700 million cubic metres. Other discovered resources represented a further 1.1 billion cubic metres. Undiscovered resources were thought to be on the order of 4.4 billion cubic metres, the majority of which (3.6 billion cubic metres) situated in "frontier," or undeveloped, areas (Figure 3b).

Figure 3b
Crude Oil Resource Base, 1992

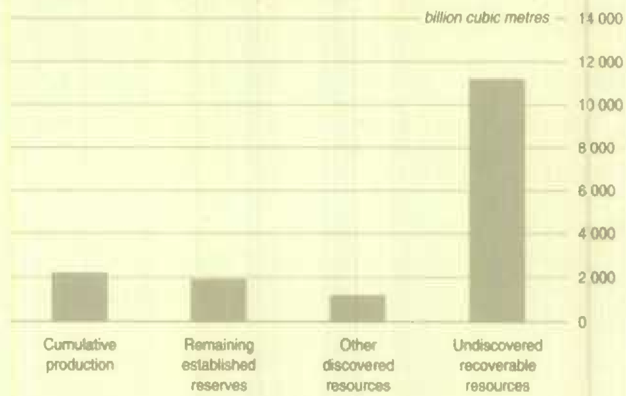


The estimated total natural gas resource base in 1992 was 16.4 trillion cubic metres. Of this, cumulative production had consumed 2.2 trillion cubic metres and remaining established reserves represented another 1.9 trillion cubic metres. Other discovered resources, located in frontier basins such as the Beaufort Sea and the Grand Banks, made up 1.2 trillion cubic metres. Undiscovered resources were estimated to be 11.2 trillion cubic metres, of which 3.1 trillion cubic metres were thought to remain in Western Canada and 8.1 trillion cubic metres in frontier basins (Figure 3c).

The estimated total crude bitumen resource base in 1992 was a very substantial 49 billion cubic metres.[1] Cumulative production had used just 300 million cubic metres, or less than one percent, of this. Remaining established reserves represented another 500 million cubic metres; other discovered resources made up the rest of the estimated total resource base. No estimate was made for undiscovered resources, as they were expected to be insignificant relative to the size of the discovered resource.

It is clear that the remaining crude oil resource base in Canada is very much overshadowed by our crude bitumen resource base. Given this, and the fact that cumulative production of crude bitumen was negligible in comparison the total resource base in 1992, crude bitumen appears very likely to one day replace crude oil as our principle source of petroleum.

Figure 3c
Natural Gas Resource Base, 1992



Finally, the total coal resource base was estimated to be 78.8 billion tonnes in 1992, of which 6.6 billion tonnes were remaining established reserves. Data on cumulative production, other discovered or undiscovered coal resources were not available.

Related indicators:

Natural Resource Wealth

Physical Quantities of Natural Resource Assets

1. Since the total crude bitumen resource base is so large in comparison to cumulative production and remaining established reserves, no figure is presented for this resource.

4 Agricultural Land Use and Supply

Theme: Use of Land Resources

Geographic scope: National

Time series: 1901-1996

Frequency of update: Every five years

Description: *Agricultural Land Use and Supply* measures the area of dependable agricultural land available in Canada and contrasts this with the area of land actually under cultivation. Dependable land is that which is generally free of severe constraints for the long-term cultivation of Canada's most common crops. It is, in other words, our good farmland. The area under cultivation is the sum of all areas actually used for crop production, whether dependable farmland or not.

Significance: This indicator provides a dual measure of the long-term sustainability of agricultural activity.

First, by contrasting the supply of dependable farmland with the area actually under cultivation, the indicator portrays the extent to which agricultural activity relies on marginal land. This is significant, because marginal land is often unsuitable for stable, long-term agricultural production. Such land is, by definition, affected by severe constraints for crop production (poor soil texture, inadequate drainage and adverse slope for example). Production on marginal land may also be more environmentally harmful, as these lands are often susceptible to soil damage resulting in erosion, and require greater inputs of fertilizers, pesticides and water to achieve a given yield. A sustainable agricultural system would, ideally, be one in which the area under cultivation coincided with the area of available dependable land.

Second, the indicator demonstrates how the total supply of dependable land has diminished since 1901. This loss has been brought about in large part by the conversion of agricultural land to urban and other uses.[1] Loss of dependable land to other uses is a key measure of the long-term sustainability of farming in Canada. Despite Canada's size, dependable agricultural land is a scarce resource in this country; less than five percent of our land is free from severe constraints on crop production.

Method of calculation: The area of land under cultivation, comprising both cropland and summerfallow areas, is available every five years from the *Census of Agriculture*.[2] Estimates for non-census years are made by assuming a simple linear trend in area under cultivation between census years.

The total area of dependable agricultural land in Canada is taken as that classified to *Canada Land Inventory* agricultural land classes 1 through 3 (Environment Canada, 1981). These classes include all land areas that are not hampered by severe constraints for crop production. The area of dependable land that is actually available for agricultural use in a given year is estimated by subtracting the area of dependable land occupied for urban and other non-agricultural uses from the total area of dependable land in the country.

The data required to estimate urban and other non-agricultural uses of dependable land are taken from two sources. The first is the *Canada Land Use Monitoring Programme* (Environment Canada, 1989), which provides data on the area of dependable land occupied by major Canadian cities. Data for smaller urban centres and for other non-agricultural uses are taken from estimates compiled for the Organisation for Economic Cooperation and Development (1996) by Environment Canada. Urban land-use data are available only every five years, following the population census. Estimates of urban land use for non-census years are made by assuming a simple linear trend in the area of dependable land occupied by urban land from one census year to the next.[3]

Data limitations: 1) There was some under-coverage of agricultural land when the *Canada Land Inventory* was compiled in the 1960s and 1970s. This was partly because only the southern, populated region of the country was surveyed for the inventory. Although this region includes the vast majority of Canada's dependable agricultural land, small pockets of dependable land outside the region were not captured in the inventory. Under-coverage also resulted from the fact that large urban areas were not surveyed for the inventory. Since many of these cities occupied dependable land at the time, total dependable land is under-estimated by the inventory. 2) The available data on the area of dependable land used for urban purposes underestimate the area occupied by smaller urban centres.

Reliability: The *Census of Agriculture* data used to derive the estimate of land under cultivation are very reliable (class 1). Data from the *Canada Land Inventory* and other sources used to calculate the supply of dependable land are considered acceptable (class 3).

Analysis: Canada's cultivated land area increased five-fold between 1901 and 1996 (Figure 4). In contrast, the supply of dependable agricultural land declined by 16 percent over the same period, as a result of the increased use of this land for urban and other non-agricultural purposes. Much of

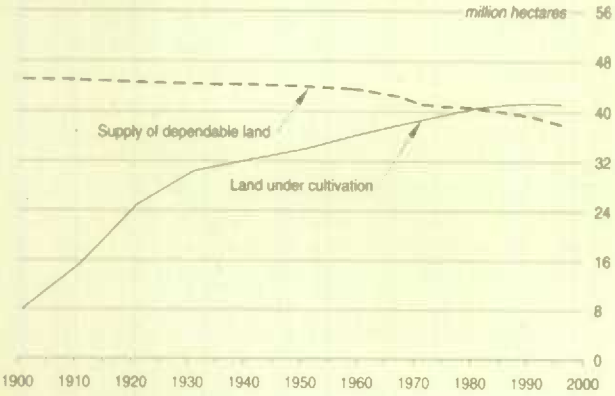
1. Aside from urban areas, other non-agricultural uses of dependable land include roadways, railroads, power lines, pipelines and parkland.
2. Statistics Canada, Agriculture Division.
3. Full details of the method used to produce this indicator are available in Chapter 3 of *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts* (Statistics Canada, 1997).

this loss occurred around the urban centres of southern Ontario, an area that boasts more than half of the very best farmland in Canada.[1] This means that urbanization in this century has consumed a higher share of our very best farmland than it has of our dependable land in general. The proximity of our very best land to urban centres–most of it within 160 kilometres–will likely lead to its further loss as the expansion of urban areas continues.

Sometime during the early 1980s, the area of land under cultivation in Canada surpassed the supply of dependable land. This means that agricultural production has been increasingly reliant on marginal land in recent years. As noted above, marginal land suffers from severe growing constraints and is often unsuitable for stable, long-term crop production. Its use for agricultural purposes may also bring about greater environmental damage than the use of better-quality land.

Given the probable loss of more dependable land to urban and other uses in the future and the fact that cultivation has already moved onto marginal land, gains in agricultural production will be increasingly difficult to obtain. Much will depend on extracting higher yields from a diminishing stock of dependable land. Finding means of improving the productivity of marginal land will also be important.

Figure 4
Agricultural Land Use and Supply



Related indicators:

Urban Land Use

1. More than half of the *Canada Land Inventory* class 1 land in Canada is found in southern Ontario. Class 1 land is the only land in the country with no significant constraints for crop production. See the indicator of *Urban Land Use* (page 10) for a more detailed discussion of the loss of class 1 land to urbanization.

5 Urban Land Use

Theme: Use of Land Resources

Geographic scope: National and provincial

Time series: 1971-1996 (five year intervals)

Frequency of update: Every 5 years

Description: *Urban Land Use* measures the area of land used for urban purposes in Canada and the portion of this area that occupies dependable agricultural land.[1]

Significance: Despite Canada's relatively small population and large size, urban land use is an important issue in this country. Urbanization, and the changes in land use that go along with it, can have profound effects on the environment: groundwater and soil contamination; air pollution; land subsidence; increased flooding; displacement of natural flora and fauna; and loss of farmland to name a few.

The fact that ninety percent of Canadians live in a narrow band along our southern border means that the effects of urbanization in Canada are concentrated in this relatively small area. Since this is the same strip of land where much of our dependable agricultural land is located, one of the major effects of urbanization is the loss of farmland. To address this concern, this indicator tracks not only the changes in total urban land use over time, but also the changes in urban use of dependable farmland. Since dependable farmland is scarce in Canada–covering less than five percent of the country–the indicator provides one measure of long-term agricultural sustainability.

Method of calculation: This indicator is derived from "digital enumeration area boundary files."These electronic maps define the boundaries of the enumeration areas used in Statistics Canada's population census. Using maps of this sort in combination with computer-based geographic information systems, it is straightforward to calculate the area occupied by urban enumeration areas in each census year.[2] This is the area that is defined as "urban land" for the purposes of this indicator.

Digital enumeration area boundary files first became available for the 1991 census. Prior to 1991, only enumeration area centroid (points representing the "centre" of an enumeration area) were available in digital format. Centroids cannot be used to estimate the area occupied by an enumeration area, so calculation of urban land area in other years (1971, 1981 and 1996) starts from an average urban enumeration area estimate based on the 1991 digital boundary file. This average area figure is used to digitally create circular buffer zones around enumeration area centroids. The areas within these circular buffer zones are then summed to yield an estimate of total urban land area. These urban area estimates are then developed into a separate digital map for each year.

To estimate the portion of urban land that occupies dependable agricultural land in each year, the digital maps representing urban areas are overlaid with digital maps from the *Canada Land Inventory* showing the extent of dependable agricultural land in Canada. The intersection of the two represents the area of urban land that occupies dependable agricultural land.[3]

Data limitations: 1) The definition of an urban enumeration area used in this indicator is taken from the population census. This definition is such that some enumeration areas that are not entirely built-up, or that contain small amounts of agricultural land, are defined as urban. There are few such cases however, and they do not influence the estimates of total urban area by more than one or two percent. 2) Some error is inherent in the method used to estimate urban land use in years other than 1991. For example, an apartment building located at the centre of an enumeration area could be given a circular buffer representing several square kilometres, when, in fact, the building occupies only a small fraction of this area. The opposite error is also inherent in the method: a low-density suburban enumeration area might well occupy a larger area than that given it in the calculation. 3) There was some under-coverage of agricultural land when the *Canada Land Inventory* was compiled in the 1960s and 1970s. This was partly because only the southern, populated region of the country was surveyed for the inventory. Although this region includes the vast majority of Canada's dependable agricultural land, small pockets of dependable land outside the region were not captured in the inventory. Under-coverage also resulted from the fact that large urban areas were not surveyed for the inventory. Since many of these cities occupied dependable land at the time, total dependable land is under-estimated by the inventory.

Reliability: The estimates of urban land area are of acceptable reliability (class 3). Estimates of urban land occupying dependable agricultural land are also considered acceptable (class 3).

Analysis: Canadian cities and towns expanded steadily between 1971 and 1996, gobbling up more than 12 250 square kilometres of surrounding land (Figure 5a). This area, more than twice the size of Prince Edward Island, represented an increase of some 77 percent in urban land use over the period. Much of the expansion occurred

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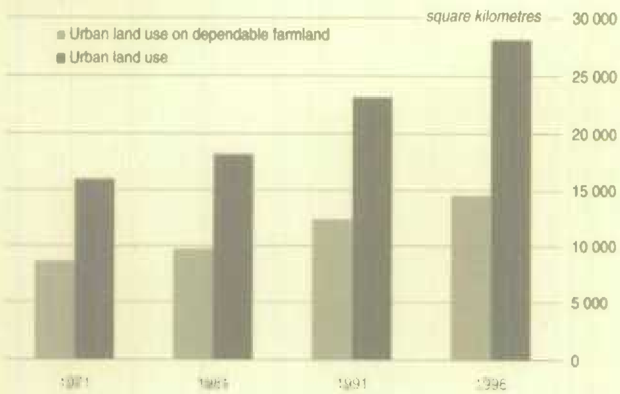
1. Dependable agricultural land is defined as that falling into *Canada Land Inventory* classes 1 through 3 (Environment Canada, 1981). This includes all land that is generally free from severe constraints for crop production. See the indicator of *Agricultural Land Use and Supply* (page 8) for a more detailed discussion of the evolution of dependable land in Canada.
2. An urban enumeration area is one in which the population is at least 1000 and has a density of at least 400 persons per square kilometre.
3. Full details of the method used to produce this indicator are available in Chapter 3 of *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts* (Statistics Canada, 1997).

around smaller centres (those with populations of less than 100 thousand persons), where it was not uncommon to record a doubling in the area of urban land.

Of the total amount of land converted to urban uses during the period, slightly less than half, or 5 900 square kilometres, was dependable agricultural land. The expansion of urban areas in Canada in the last 25 years has thus resulted in a substantial loss of farmland. As of 1996, urban land in Canada occupied 3.2 percent of the total *Canada Land Inventory* class 1-3 land in the country.[1]

Figure 5a

Urban Land Use



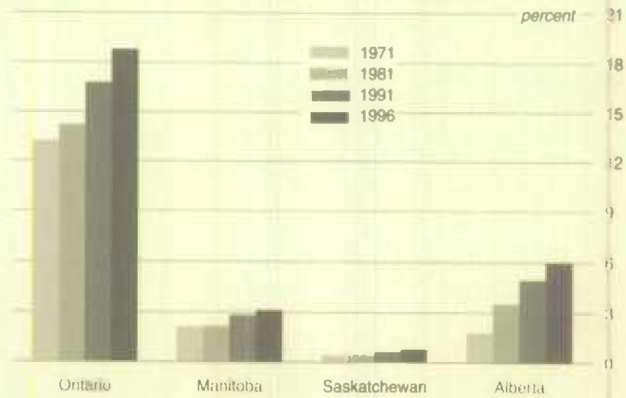
More than 52 percent of Canada's very best farmland–that classified to *Canada Land Inventory* class 1–is concentrated in Ontario.[2] Moreover, most of this land is found in the same part of the province where urbanization has been, and continues to be, the greatest: the densely populated south. One of the results of urbanization in Ontario has therefore been the loss of a substantial portion of the province's class 1 farmland. As of 1996, nearly 19 percent of this land was being used for urban purposes (Figure 5b).[3] This land is, for all intents and purposes, permanently lost to agriculture.

Outside of Ontario, other provinces having significant areas of class 1 farmland have also experienced losses due to urbanization. The most important of these occurred in Alberta and Manitoba; Saskatchewan still retains most of its class 1 land.[4]

Much of the growth in urban areas since 1971 can be attributed to a population that increased both in size and in average age. Between 1971 and 1996, urban dwellers grew from 16.4 to 22.5 million people, an increase of 37 percent. Combined with the entry of the "baby boom" generation into the housing market, this dramatically increased the demand for new homes, a key determinant of urban land use.

Figure 5b

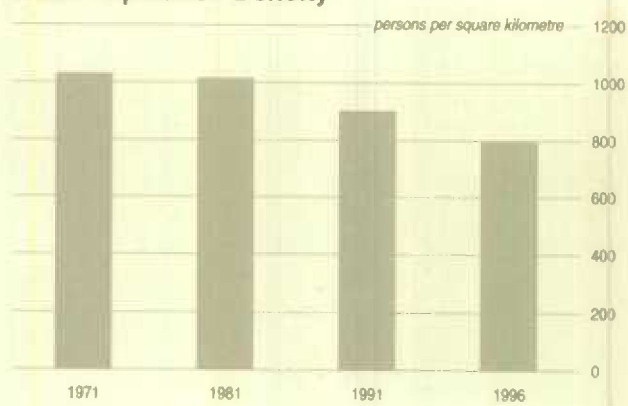
Class 1 Farmland Occupied by Urban Land



At the same time that population growth pushed up the demand for urban land, population densities steadily declined. In 1971, the average population density in Canadian cities was 1030 persons per square kilometre (Figure 5c). This figure fell to 796 persons per square kilometre in 1996, reflecting the growth of low-density suburbs. Since lower population densities translate into the use of more space to house a given population, the decline in population density since 1971 has also contributed to the growth of our urban areas.

Figure 5c

Urban Population Density



Related indicators:

Agricultural Land Use and Supply

1. This figure does not include the amount of dependable land occupied by large urban areas prior to the development of the *Canada Land Inventory*. Neither does it include areas occupied for non-agricultural purposes outside of cities, such as road and utility networks.
2. Class 1 land is Canada's only land with no significant constraints for crop production
3. See Footnote 1.
4. No other province in Canada is home to a significant amount of class 1 land.

6 Energy Use per Unit of Household Expenditure

Theme: Consumption of materials and energy

Geographic scope: National

Time series: 1981-1992

Frequency of update: Yearly

Description: *Energy Use per Unit of Household Expenditure* measures the quantity of energy used in association with an average $1000 of goods and services purchased by Canadian households.

So that the indicator tracks only real changes over time in energy use per unit of household purchases, these purchases are measured in constant (or inflation adjusted) dollars. This eliminates the effect of inflation, which would otherwise tend to push the value of the indicator downward over time.

The indicator captures households' "direct" energy use (energy used for family cars and home heating for example) plus their "indirect" energy use (the energy needed to produce the goods and services that households buy). The indicator includes an estimate of the indirect energy that is used to produce the imported products that Canadian households purchase. In this way, it gives a complete picture of the energy use associated with household expenditures, regardless of the actual user of the energy: households themselves, Canadian industries or industries in other countries.

Significance: Few other activities are as important to the economy as the consumption of energy. At the same time, few other activities have as wide-ranging environmental effects:

- changes in land use to accommodate pipelines, power lines and energy production plants;
- disruptions of rivers and lakes for hydroelectric power generation and for cooling purposes at thermal generating stations;
- emissions of enormous quantities of airborne wastes, leading to acid rain, urban smog and the build-up of greenhouse gases in the atmosphere;
- creation of substantial amounts of solid waste, including large quantities of nuclear wastes; and
- contamination of surface and groundwaters with potentially toxic compounds from the refining, delivery, storage and combustion of fossil fuels.

Because energy use is related to so many important environmental issues, its measurement is a key indicator of the overall impact of the economy on the environment.

Putting energy use in the context of household expenditures is helpful because it brings this important aspect of economic activity "close to home." The indicator highlights the fact that, as consumers, Canadians are responsible not only for the energy they use directly in their daily lives, but also indirectly for the energy that is needed to produce the products they purchase.

By linking energy use with household expenditures, the indicator also helps measure Canada's progress toward an environmentally sustainable economy. An important goal for sustainability is keeping the use of natural resources, like energy, within limits that the environment can manage. This suggests that energy use per unit of household expenditure should be at least stable, and preferably declining, over time.

Method of calculation: Estimates of energy use per unit of household expenditures are derived by first calculating households' direct plus indirect use of energy in a given year (measured in physical units) and then dividing this total by the value of household expenditures in that year (measured in inflation-adjusted dollars).

Estimates of direct energy use by households are derived from a variety of Statistics Canada sources. Included in these estimates is the energy used around the home for heating, lighting and cooking, the fuel burned in our cars, and the energy needed for various other purposes (motorized equipment and recreational vehicles for example).

Indirect household energy use is estimated using a technique known as input-output analysis. This technique allows estimation of the portion of business' energy use that is associated with the production of goods and services that are purchased by households. The starting point for the indirect household use estimates, energy use by Canadian industries, is derived mainly from Statistics Canada survey sources. These sources cover the most important energy-using industries in the economy; namely, the mining, manufacturing, transportation and electric power industries. Together, these industries account for the majority of business' energy use in Canada. Estimates of the small amount of energy used by industries not included in these surveys are available in monetary units from other Statistics Canada sources.[1] These are converted to physical units by division with average prices.

Energy use associated with the imported products purchased by households is also estimated using input-output analysis. To simplify the calculation, it is assumed that the production of our imports requires the same quantity of energy as similar goods made in Canada.[2]

1. These estimates are taken mainly from the Input-Output Accounts compiled annually by Statistics Canada.
2. Full details of the method used to produce this indicator are available in Chapter 4 of *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts* (Statistics Canada, 1997).

Data limitations: This indicator has no significant data limitations.

Reliability: The estimates of energy use per unit of household expenditure presented in this indicator are considered to be very reliable (class 1).

Analysis: Over the period 1981 to 1992, energy use per unit of household expenditure declined by 11 percent. Taken alone, this trend would indicate a positive change in the contribution of households to Canada's total energy use during this period. At the same time that energy use per unit of expenditure was falling, however, the value of household expenditures rose by 41 percent in inflation-adjusted terms. The net result was an increase of 25 percent in total energy use associated with household expenditures (Figure 6).

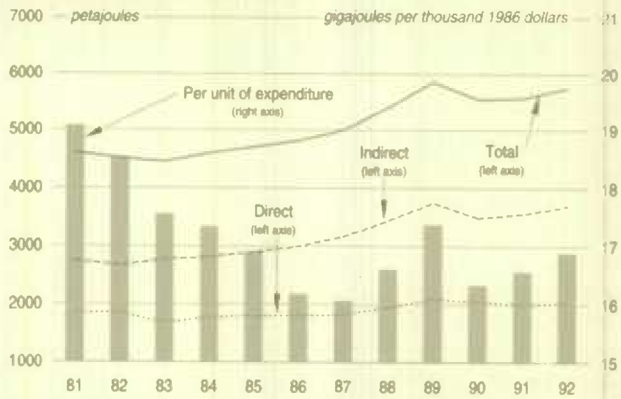
Looking at Figure 6 in more detail, three distinct periods are apparent. The first of these is 1981 to 1986, during which there was a steady decline in energy use per unit of expenditure. Two major factors contributed to this decline: the economic recession of 1981/82; and the generally rising cost of energy during first half of the 1980s. The combined effect of these factors was to restrain growth of both household direct and indirect energy use. Direct household energy use actually fell between 1981 and 1987, while indirect use rose at slightly less than two percent annually. At the same time, the inflation-adjusted value of household expenditures grew at an annual rate of over four percent. The result was the decline in energy use per unit of household expenditure seen in Figure 6. The message behind this result is clear: when energy prices are high, businesses and households can, and do, respond by increasing their energy efficiency.

The second period of interest in Figure 6 is the mid-1980s. The major event of relevance during this time was the dramatic fall in domestic energy prices that occurred around 1986. Both household and businesses were quick to respond to this fall, posting 16 and 18 percent increases in their direct energy consumption respectively between 1986 and 1989. The result was the rapid increase in energy use per unit of household expenditure seen between 1987 and 1989 in Figure 6. This stands in stark contrast to the early 1980s, when energy prices were high and energy use per unit of household expenditure was falling sharply.

The final period of interest in Figure 6 is that from 1989 onward. The effect of the recession of 1990/91 is clearly evident in the decline in energy use per unit of household expenditure between 1989 and 1990. Two and four percent declines respectively in household and business direct energy use, combined with weak, but positive, growth in household expenditures were behind this drop. The immediate post-recession period was marked by an increase in energy use per unit of expenditure, even though household direct energy use continued to fall and household expenditures were essentially flat over the period. This unusual combination of events can be explained by a shift in the composition of household expenditures toward a more energy-intensive mix of goods and services, leading to increased indirect energy use by households.[1]

Despite the upward effect of expenditure composition on energy use per unit of expenditures in 1991 and 1992, the general effect of composition over the full period 1981 to 1992 was downward. In fact, if the mix of products bought by households in 1981 had remained constant over time and only the total value of expenditures had increased, energy use per unit of expenditure in 1992 would have been six percent higher than it actually was. Thus, about one half of the 11 percent decline in energy use per unit of household expenditure between 1981 and 1992 can be attributed to changes in the composition of expenditures; the remainder was due to increased energy efficiency.

Figure 6
Household Energy Use



Related indicators:

Greenhouse Gas Emissions per Unit of Household Expenditure

Water Use per Unit of Household Expenditure

Energy Consumption[2]

1. Not all goods and services require the same amount of energy in production. Paper products, for example, use more energy per dollar of production than do entertainment services. A mix of household expenditures that contained a lot of paper products and few trips to the cinema would therefore require more energy than a mix with less paper and more movies.
2. Part of Environment Canada's *National Environmental Indicator Series*.

7 Water Use per Unit of Household Expenditure

Theme: Use of materials and energy

Geographic scope: National

Time series: 1981, 1986, 1991

Frequency of update: Every five years[1]

Description: *Water Use per Unit of Household Expenditure* measures the quantity of water withdrawn from the environment in association with an average $1000 of goods and services purchased by Canadian households.

So that the indicator tracks only real changes over time in water use per unit of household purchases, these purchases are measured in constant (or inflation adjusted) dollars. This eliminates the effect of inflation, which would otherwise tend to push the value of the indicator downward over time.

The indicator captures households' "direct" water use (water used for cooking and cleaning for example) plus their "indirect" water use (the water needed to produce the goods and services that households buy). The indicator includes an estimate of the indirect water that is associated with the imported products that Canadian households purchase. In this way, it gives a complete picture of the water use associated with household expenditures, regardless of the actual user of the water: households themselves, Canadian industries or industries in other countries.

Significance: Canada is home to many of the world's largest freshwater lakes and rivers. Despite this abundance, much of our fresh water flows northward to the Arctic Ocean, away from the southern areas where demand is greatest. As a result, water availability is occasionally inadequate to meet demand in some regions, especially in the agricultural regions of the Prairies. Measuring water use is therefore important, even for Canada.

Questions of supply aside, measuring water use is important because it serves as an indirect indicator of the pollutant burden on our lakes and rivers. Much water is used by households and businesses simply to carry away sewage and processing wastes. Water use can therefore be taken as an indirect guide to the amount of these wastes produced by economic activity. Treatment of drinking water and sewage are also among the most important ways in which chlorine is released into the environment. And the substantial amount of energy used in the withdrawal, filtering, treatment and delivery of clean water to households and businesses has its own environmental impacts.[2]

Putting water use in the context of household expenditures is helpful because it brings this important aspect of economic activity "close to home." The indicator highlights the fact that, as consumers, Canadians are responsible not only for the water we use directly in our daily lives, but also indirectly for the water that is needed to produce the products we purchase.

By linking water use with household expenditures, the indicator also helps measure Canada's progress toward an environmentally sustainable economy. An important goal for sustainability is keeping the use of natural resources, like water, within limits that the environment can manage. This suggests that water use per unit of household expenditure should be at least stable, and preferably declining, over time.

Method of calculation: Estimates of water use per unit of household expenditures are derived by first calculating households' direct plus indirect water use in a given year (measured in cubic metres) and then dividing this total by the value of household expenditures in that year (measured in inflation-adjusted dollars).

Estimates of direct water use by households are derived mainly from an Environment Canada survey of municipal water utilities (Environment Canada, 1994). Data from this survey are supplemented with estimates of water use in rural households to arrive at the estimate of total direct water use in Canadian households.

Indirect household water use is estimated using a technique known as input-output analysis. This technique allows estimation of the portion of business' water use that is associated with the production of goods and services that households purchase. The starting point for the indirect household use estimate, water use by Canadian businesses, is derived mainly from a survey of water consumption in the mining, manufacturing and thermal electric power industries. This survey is conducted jointly by Environment Canada and Statistics Canada every five years (Tate and Scharf, 1995). The vast majority of industrial water use is captured in the survey. Estimates of water use for industries not included in the survey are made by combining data from a wide variety of non-survey sources, such as water audits and water-use forecasting models.

Water use associated with the imported products purchased by households is also estimated using input-output analysis. To simplify the calculation, it is assumed that the production of our imports requires the same quantity of water as similar goods made in Canada.[3]

1. This indicator will be updated annually once suitable data sources and methods are identified.

2. See *Energy Use per Unit of Household Expenditure* (page 12) for a discussion of these impacts.

3. Full details of the method used to produce this indicator are available in Chapter 4 of *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts* (Statistics Canada, 1997).

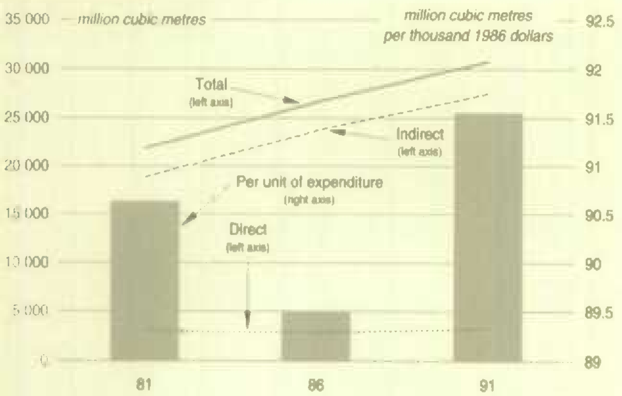
Data limitations: Estimates for most uses of water by households and industries are obtained directly from survey sources. These estimates are generally of high quality. Slightly more than 13 percent of water use in Canada is estimated using non-survey sources however. The quality of these sources varies significantly. Many of the estimates based on non-survey sources are subject to a substantial degree of error.

Reliability: The estimates of water use per unit of household expenditure are considered to be reliable (class 2).

Analysis: The period 1981 to 1991 saw a small increase (one percent) in water use per unit of household expenditure. Taken alone, this would indicate that the contribution of household expenditures to water use in Canada was essentially stable over this period. At the same time that water use per unit of expenditure had stabilized however, the total value of household expenditures rose by 41 percent in inflation-adjusted terms. The net result was an increase in total water use associated with household expenditures of some 40 percent over the period (Figure 7).

Looking at Figure 7 in more detail, it can be seen that households' direct water use (water consumed in and around the home) was nearly constant over the period, even though population was growing. This suggests that households became more efficient in their use of water, perhaps because of the installation of water metering systems in many municipalities where none existed before.

Figure 7
Household Water Use



In contrast to direct use, households' indirect water use (the water needed by businesses to produce the goods and services purchased by households) grew by 46 percent between 1981 and 1992. Much of this growth is explained by the above-mentioned 41 percent increase in household expenditures. However, the upward pressure that increased expenditures placed on indirect water use was offset by changes in expenditure composition.[1] If the mix of products bought by households in 1981 had remained constant until 1991, with only the total value of expenditures increasing, indirect household water use would have been five percent higher in 1991 than it actually was. Thus, there was an implicit increase of approximately 10 percent in indirect household water use that can only be attributed to increased water use by certain industries. This result stands in contrast to that seen in the indicator of *Energy Use per Unit of Household Expenditure* (page 12), where increased energy efficiency on the part of businesses kept the growth of household indirect energy use below the growth in total expenditures.

The most important factor behind the increase in household indirect water use beyond that explained by increased household expenditures was the increasing importance of fossil fuel and nuclear (or thermal) electricity between 1981 and 1991. Over this period, thermal electric power generation increased from 32 percent to 39 percent of total electricity production in Canada (the remainder was hydroelectric generation). A great deal of water is used in thermal power stations for cooling purposes, so this change in the composition of electricity production meant that more water was required per unit of electricity produced in 1991 than in 1981.[2] Since households purchase a lot of electricity, the growth in water use per unit of electricity was responsible for much of the increase in household indirect water use beyond that which is explained by increased household expenditures.

Related indicators:

Greenhouse Gas Emissions per Unit of Household Expenditure

Energy Use per Unit of Household Expenditure

Municipal Water Use and Wastewater Treatment[3]

1. Not all goods and services require the same amount of water in production. Paper products, for example, require more water than do entertainment services. A mix of household expenditures that contained a relatively high share of paper products and few trips to the cinema would therefore require more indirect water than would a mix with less paper and more movies.
2. The water used to power turbines in hydroelectric generating stations is not considered to be withdrawn from the environment and, therefore, is not included in the estimates of water use in this indicator.
3. Part of Environment Canada's *National Environmental Indicator Series*.

8 Greenhouse Gas Emissions per Unit of Household Expenditure

Theme: Production of wastes

Geographic scope: National

Time series: 1981-1992

Frequency of update: Yearly

Description: *Greenhouse Gas Emissions per Unit of Household Expenditure* measures the quantity of carbon dioxide, methane and nitrous oxide emitted in association with an average $1000 of goods and services purchased by Canadian households. Emissions of these gases are added together and reported in terms of a single measure called "carbon dioxide equivalent emissions."

So that the indicator tracks only real changes over time in carbon dioxide equivalent emissions per unit of household expenditure, expenditures are measured in constant (or inflation-adjusted) dollars. This eliminates the effect of inflation, which would otherwise tend to push the value of the indicator downward over time.

The indicator captures households' "direct" greenhouse gas emissions (those that come from private cars and home heating for example) plus their "indirect" emissions (those associated with the production of the goods and services that households purchase). The indicator includes an estimate of the indirect greenhouse gas emissions that are associated with the imported goods and services that Canadian households purchase. In this way, it gives a complete picture of the greenhouse gas emissions associated with household expenditures, regardless of the source of the emissions: households themselves, Canadian industries, or industries in other countries.

Significance: Household greenhouse gas emissions contribute to the build-up of greenhouse gases in the atmosphere. Most scientists predict that this build-up will lead to an increase in the planet's temperature, or global warming, in the coming decades. While the effects of global warming are still uncertain, possibilities include flooding of coastlines from rising ocean waters; increased occurrences of severe storms, droughts, heat waves and other extreme weather events; and rapid changes in plant and animal habitat due to changes in weather patterns.

Putting greenhouse gas emissions in the context of household expenditures is helpful because it brings this important consequence of economic activity "close to home." The indicator highlights the fact that, as consumers, Canadians are responsible not only for the greenhouse gas emissions that result directly from their daily activities, but also indirectly for the emissions arising from the production of the goods and services that they buy every day.

By linking greenhouse gas emissions with household expenditures, the indicator also helps to measure Canada's progress toward an environmentally sustainable economy. An important goal for sustainability is keeping the releases of wastes, like greenhouse gases, within limits that the environment can manage. This suggests that greenhouse gas emissions per unit of household expenditure should be at least stable, and preferably declining, over time.

Method of calculation: Annual estimates of greenhouse gas emissions per unit of household expenditure are derived by first estimating households' direct and indirect emissions of carbon dioxide, methane and nitrous oxide in a given year and then converting this total to carbon dioxide equivalent emissions. This figure is then divided by the value of household expenditures in that year (measured in inflation-adjusted dollars).

Estimates of direct greenhouse gas emissions from households are made by multiplying the quantities of different fossil fuels used by households by appropriate emission coefficients. These emission coefficients, which are developed by Environment Canada (Jaques, 1992), measure how much of a given greenhouse gas, carbon dioxide for example, is released when a set amount of fossil fuel is burned.

Indirect household emissions are estimated using a technique known as input-output analysis. This technique allows estimation of the portion of business' greenhouse gas emissions that is associated with the production of the goods and services purchased by households. Estimates of business' emissions are made for the following sources: fossil fuel combustion (both for heat and transportation); non-combustion uses of fossil fuels; manufacturing processes[1]; and agricultural activities. The methods used to estimate the emissions from these sources are also adopted from Environment Canada (Jaques, 1992).

Greenhouse gas emissions associated with the imported products purchased by households are also estimated using input-output analysis. To simplify the calculation, it is assumed that the production of these products results in the same quantity of greenhouse gas emissions as similar goods made in Canada.

Carbon dioxide equivalent emissions are estimated by converting methane and nitrous oxide emissions to carbon dioxide equivalents using a weighting index known as global warming potential (Houghton *et al.*, 1996). Global warming potential measures the global warming impact of each gas relative to carbon dioxide. Methane has a global warming potential of 21; that is, every tonne of methane released to the atmosphere is the equivalent of 21 tonnes of carbon dioxide. Nitrous oxide has a global warming potential of 310.[2]

1. Cement, lime, ammonia and natural gas production.
2. Full details of the method used to produce this indicator are available in Chapter 4 of *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts* (Statistics Canada, 1997).

Data limitations: 1) Although the majority of carbon dioxide, methane and nitrous oxide emissions associated with household expenditure are captured in the indicator, some emissions cannot be estimated using available data and methods. The most important of these missing sources is methane emissions from landfill sites; no means is yet available to determine the share of these emissions attributable to households. 2) The data and methods used to estimate methane and nitrous oxide emissions are at an early stage of development. The emission estimates for these two gases are, therefore, subject to uncertainty.

Reliability: The estimates of carbon dioxide equivalent emissions per unit of household expenditure presented in this indicator are considered to be reliable (class 2).

Analysis: The period 1981 to 1992 saw a decline of 19 percent in greenhouse gas (GHG) emissions per unit of household expenditure. Taken alone, this trend would indicate a reduction in the contribution of household expenditures to Canada's GHG emissions. At the same time that emissions per unit of expenditure were falling however, the total value of household expenditures rose by 41 percent in inflation-adjusted terms. The net result was an increase in total GHG emissions associated with household expenditures of 14 percent over the period (Figure 8).

A comparison of GHG emissions per unit of household expenditure from Figure 8 with energy use per unit of household expenditure (Figure 6 on page 13) reveals a close correlation between the two. This is to be expected, as energy use is by far the most important source of greenhouse gas emissions in Canada. Readers are encouraged to consult the *Analysis* section of the energy use indicator for a discussion of the factors influencing household energy use between 1981 and 1992; this analysis is directly relevant to GHG emissions as well.

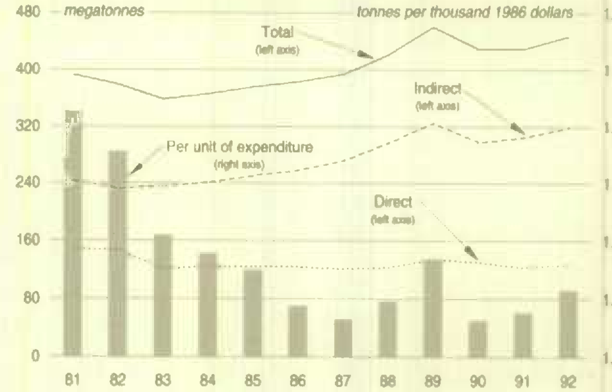
One factor influencing GHG emissions per unit of household expenditure that was not relevant to the analysis of energy use is change over time in the mix of fossil fuels used in association with household expenditures. Not all fossil fuels release the same quantity of greenhouse gases when they are burned. Coal, for example, releases almost twice as much carbon dioxide (the most important greenhouse gas) per unit of energy as does natural gas. Petroleum products, such as gasoline and heating fuels, fall between the two. Thus, the mixture of fossil fuels used directly and indirectly by households plays an important role in determining the GHG emissions associated with their expenditures.

Over the period 1981 to 1992, there was a substantial shift in the mixture of fossil fuels used in association with household expenditures. Most significantly, natural gas rose over the period from 35 to 44 percent of fossil fuel use, while petroleum and coal products fell from 65 to 56 percent. Since natural gas produces the lowest greenhouse gas emissions per unit of energy of any fossil fuel, the effect of this shift on greenhouse gas emissions per unit of household expenditure was downward. This explains in part why greenhouse gas emissions per unit of household expenditure declined by 19 percent from 1981 to 1992, when the same measure for energy fell by only 11 percent.

Just as the mix of fossil fuels used in association with household expenditures influences GHG emissions per unit of expenditure, so too does the overall composition of household expenditures.[1] Changes in expenditure composition over the period 1981 to 1992 resulted in GHG emissions per unit of expenditure that were 7 percent lower than would have been the case had the 1981 expenditure composition remained constant over time and only the value of expenditures increased. Thus, about one third of the 19 percent decline in GHG emissions per unit of household expenditure between 1981 and 1992 can be attributed to changes in the composition of expenditures; the remainder was due to the above-mentioned changes in fossil fuel mix and to increased energy efficiency.

Figure 8

Household Greenhouse Gas Emissions



Related indicators:

Water Use per Unit of Household Expenditure

Energy Use per unit of Household Expenditure

Climate Change[2]

Energy Consumption[2]

1. Not all goods and services result in the same quantity of GHG emissions during production. Paper products, for example, release more GHGs per dollar of production than do entertainment services. A mix of household expenditures that contained a lot of paper products and few trips to the cinema would therefore result in more indirect GHG emissions than a mix with less paper and more movies.
2. Part of Environment Canada's *National Environmental Indicator Series*.

9 Environmental Protection Expenditures in the Business Sector

Theme: Environmental Protection Expenditures

Geographic scope: National

Time series: Variable

Frequency of update: Yearly

Description: *Environmental Protection Expenditures in the Business Sector* measures operating and capital-and-repairs expenditures made to prevent, abate or control pollution and other causes of environmental degradation. For the purposes of this indicator, these expenditures are defined as those made to comply with environmental regulations and conventions that apply (or are anticipated to apply) in Canada.[1] These expenditures are split into the following groups.

- **Pollution abatement and control (PAC) expenditures:** purchases of solid waste and sewage management services; outlays on environmental monitoring; and expenditures on machinery, equipment, buildings and infrastructure intended for PAC purposes. PAC expenditures can be for "end-of-pipe" systems that treat pollution after it has been created, or for modifications to production processes so that less pollution is created in the first place ("process-integrated" PAC systems).
- **Other environmental protection expenditures:** site reclamation and decommissioning; environmental assessments and audits; wildlife and habitat protection; environmental fees, fines and licences; and "other" expenditures (outlays for the administration of environmental projects for example).

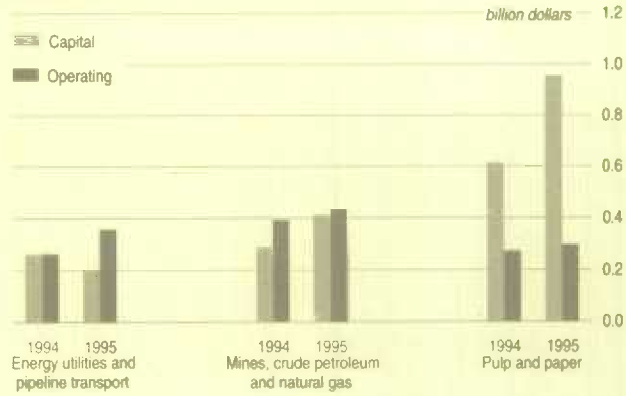
Significance: Environmental protection expenditures represent one response of businesses to the environmental effects of economic activity; that is, their financial contribution to preventing or limiting these effects. They also measure the financial burden imposed on businesses by environmental regulations and conventions.

Method of calculation: Estimates of business capital-and-repairs PAC expenditures between 1985 and 1993 are taken from the *Capital and Repairs Expenditure Survey*.[2] Some adjustments are made to the survey data to better reflect the investments of certain industries. After 1993, environmental expenditure estimates (for PAC and other purposes) are taken from the *Environmental Protection Expenditure Survey*[3] for most industries.[4]

Data limitations: 1) Business sector environmental protection expenditures, particularly those with multiple objectives of which only one is environmental protection, are likely underestimated by available data. 2) No data are available for operating expenditures on environmental protection prior to 1994. 3) No data for depreciation and holding costs on the capital stock employed for environmental protection are currently available. 4) Capital-and-repairs expenditure data up to 1993 capture only major investments in buildings and equipment for solid waste disposal facilities, sewage systems and other large PAC facilities. Smaller investments related to PAC may not have been reported by businesses as "environmental" in the *Capital and Repairs Expenditure Survey*.

Reliability: Data from the *Environmental Protection Expenditure Survey* are considered to be reliable (class 2). Data from the *Capital and Repairs Expenditure Survey* are also considered to be reliable (class 2).

Figure 9a
Environmental Protection Expenditures, Selected Industries



Analysis: Total expenditures on environmental protection by the industries included in the *Environmental Protection Expenditure Survey*[5] were estimated at $4.7 billion in 1995. Figure 9a shows that the pulp and paper industries were responsible for the largest share of these expenditures (27 percent in 1995). Other industries with large expenditures in 1995 were mining, crude petroleum and natural gas (18 percent), energy utilities and pipeline transport (12 percent) and primary metals (10 percent). These same industries also reported large environmental protection expenditures in

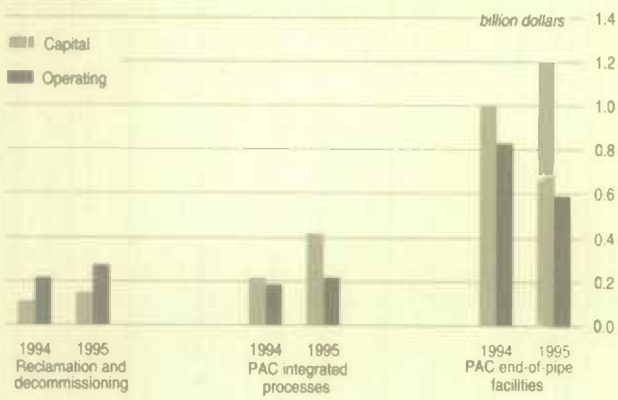
1. Note that this definition applies only to the 1994 and 1995 data. In earlier years, companies were allowed to determine for themselves which of their expenditures they considered to be for environmental protection.
2. Statistics Canada, Investment and Capital Stock Division.
3. Statistics Canada, National Accounts and Environment Division.
4. Full details of the method used to produce this indicator are available in Chapter 5 of *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts* (Statistics Canada, 1997).
5. Logging, mining, crude petroleum and natural gas, manufacturing, energy utilities and pipeline transport industries. Not covered were agriculture, construction, transportation, trade, services and commerce.

1994. No other industry contributed more than 10 percent of total expenditures in either year.

Turning to environmental protection expenditures by activity, Figure 9b shows that the majority of business sector environmental protection expenditures in 1994 and 1995 were made for PAC systems. Most of these expenditures were for end-of-pipe PAC systems, suggesting that many companies consider pollution control as an "add-on" to their production processes, rather than an element to be designed directly into the processes themselves. Process-integrated PAC expenditures did rise from $402 million in 1994 to $637 million in 1995 however, signalling that the end-of-pipe approach may be on the decline.

Figure 9b

Environmental Protection Expenditures by Activity



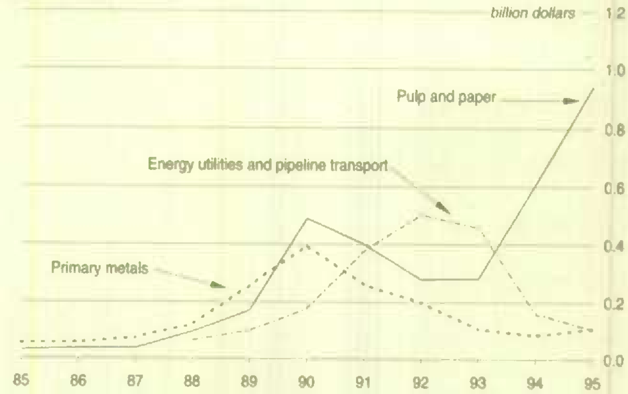
Site reclamation and decommissioning expenditures also increased between 1994 and 1995 (by 29 percent), although their share of total expenditures was relatively small in both years (less than 12 percent).

Capital-and-repairs expenditures on PAC systems: Total capital-and-repairs expenditures on PAC systems were $2 billion in 1995, or two percent of all business investment. Figure 9c portrays the three industries with the highest average capital-and-repairs expenditures on PAC systems from 1985 to 1995: pulp and paper; primary metals; and energy utilities/pipeline transport. On average, these industries made up 66 percent of total capital-and-repairs expenditures on PAC systems over the period.

Capital-and-repairs expenditures on PAC systems by the pulp and paper industries grew at an average annual rate of 41 percent between 1985 and 1995. Expenditures increased considerably in the late 1980s and then declined during the 1991 recession, only to return to record levels by 1995. The $940 million spent on PAC systems in 1995 represented over one quarter of total capital expenditures by the pulp and paper industries; the equivalent figure in 1985 was only two percent. Expenditures on PAC systems by these industries were made mainly in response to regulations limiting emissions of dioxins and furans.

Figure 9c

Capital-and-repairs PAC Expenditures, Selected Industries



The primary metals industries experienced a 49 percent average annual increase in capital-and-repairs expenditures on PAC systems between 1985 and 1990. Expenditures declined thereafter, and had fallen below their 1988 level by 1995. Spending by these industries was primarily for compliance with sulphur dioxide emission regulations.

The energy utilities/pipeline transport industries saw their expenditures increase annually at an average rate of 67 percent from 1988 to 1992. This was also the result of initiatives undertaken for compliance with sulphur dioxide emission regulations. Expenditures declined after 1992, by which time most control measures had been installed; by 1995, expenditures had returned to their 1989 level.

Related indicators:

Pollution Abatement and Control Expenditures in the Government Sector

10 Pollution Abatement and Control Expenditures in the Government Sector

Theme: Environmental Protection Expenditures

Geographic scope: National

Time series: Variable

Frequency of update: Yearly

Description: *Pollution Abatement and Control Expenditures in the Government Sector* measures current and capital-and-repairs expenditures made to prevent, abate or control pollution. These are expenditures for solid waste and sewage management, control of other pollution, and "other" environmental services (environmental assessments and administration for example). Expenditures are split into the following groups:

- **consolidated total expenditures on PAC** (current plus capital-and-repairs) for all three levels of government, from which inter-governmental transfers have been eliminated;
- **non-consolidated total expenditures on PAC** (current plus capital-and-repairs) for each level of government;
- **capital-and-repairs expenditures on PAC** for each level of government.

Significance: Pollution abatement and control (PAC) expenditures represent one response of governments to the environmental effects of economic and human activity; that is, governments' financial contribution to preventing or limiting these effects.

Method of calculation: Estimates of total PAC expenditures for the federal and provincial/territorial governments are derived from public accounts data. For local governments, estimates are based on information from two surveys: the *Local Government - Current Revenue and Expenditure Survey*[1] and the *Local Government - Capital Expenditure Survey*.[1] Local government survey data are validated using the financial report of the department of municipal affairs of each province/territory.

Consolidation of expenditures is carried out by netting inter-governmental transfer payments related to PAC from the expenditures of all three levels of government.

The *Capital and Repairs Expenditure Survey*[2] is the source for the estimates of capital-and-repairs PAC expenditures for the federal and provincial governments.[3]

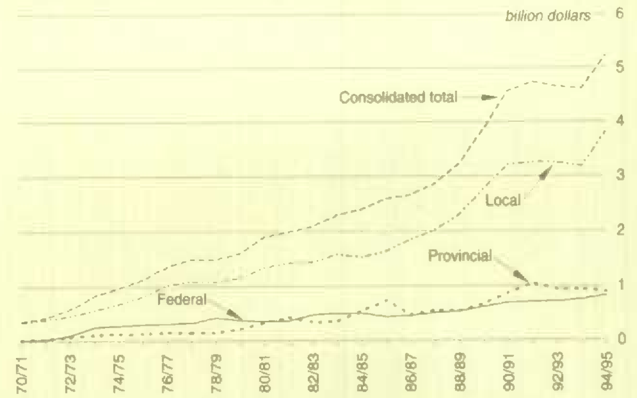
1. Statistics Canada, Public Institutions Division.
2. Statistics Canada, Investment and Capital Stock Division.

Data limitations: 1) The available data on intergovernmental transfer payments related to PAC do not allow the elimination of all local government transfers to other levels of government. The breakdown of consolidated total PAC expenditures by level of government and by type of activity therefore leads to minor double counting of expenditures. 2) Capital-and-repairs expenditure data capture only major investments in buildings and equipment for solid waste disposal facilities, sewage systems, and other large PAC facilities. Smaller investments related to PAC may not be classified as "environmental" in government accounting systems. 3) It is likely that some government expenditures on sewage management are reported as drinking water treatment and supply expenditures; government expenditures on sewage management may therefore be underestimated.

Reliability: Data on total PAC expenditures are considered to be reliable (class 2) while their breakdown by level of government and activity is considered to be reliable (class 2). Data on PAC capital-and-repairs expenditures are considered to be reliable (class 2).

Analysis: Consolidated total government expenditures on PAC grew at an average annual rate of 12 percent between 1970/71 and 1994/95 (Figure 10a). The $5.2 billion expenditures on PAC in 1994/95 represented three percent of total government expenditures; the corresponding figures for 1970/71 are $350 million and two percent of total expenditures.

Figure 10a
Total Government Expenditures on PAC



As shown in Figure 10a, most public PAC expenditures between 1970/71 and 1994/95 were made by local governments (68 percent on average). The period leading up to 1990/91 saw the majority of growth in these expenditures, as government downsizing led to declines in the early 1990s. Infrastructure programs commenced in 1994 reversed this trend however, and total local government expenditures on PAC grew by 20 percent in

3. Full details of the method used to produce this indicator are available in Chapter 5 of *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts* (Statistics Canada, 1997).

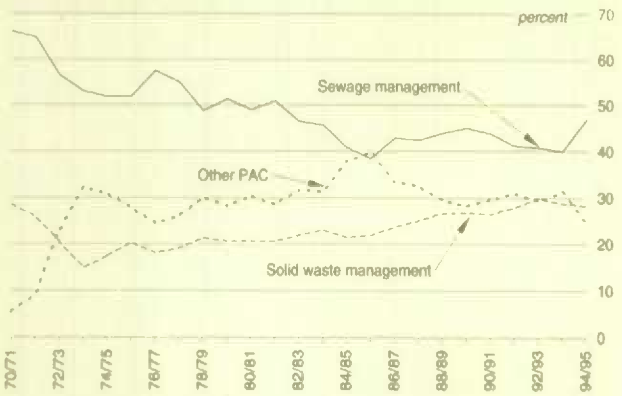
1994/95. Most of this growth was directed at sewage management facilities, as is reflected in the increases in local government capital-and-repairs expenditures between 1993 and 1994 shown in Figure 10c. Over the entire period, local government expenditures on PAC represented a stable four to six percent of their total expenditures.

Federal and provincial/territorial government expenditures on PAC accounted for less than one percent of their respective total expenditures from 1970/71 to 1994/95. The nature of their mandates means that these governments spend relatively less on PAC systems than their local counterparts; the federal and provincial/territorial governments are responsible primarily for the development and implementation of environmental legislation and programs (site remediation initiatives for example).

Turning to consolidated total PAC expenditures by activity, on average between 1970/71 and 1994/95 about half of consolidated total government PAC expenditures were associated with sewage management (Figure 10b). In comparison, solid waste management (including recycling) represented an average of just 23 percent of expenditures over the period. Unlike solid waste management, which represented about the same share of total expenditures at the end of the period as at the beginning, sewage management's share declined steadily over the period. This decline was mainly due to the increasing importance of "other" PAC expenditures (that is, those made for purposes other than solid waste and sewage management).

Figure 10b

Consolidated Total Government Expenditures on PAC by Activity

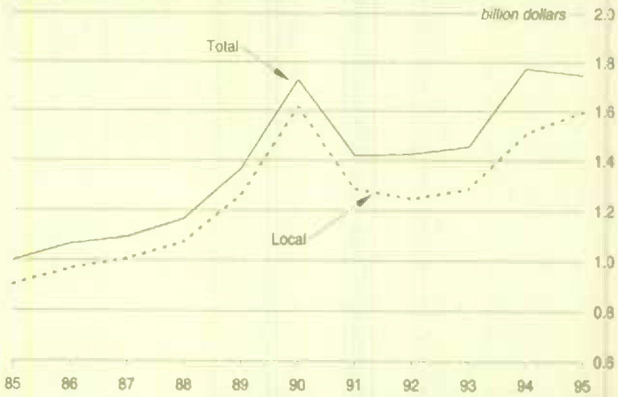


Of all PAC activities, "other" expenditures registered the highest average annual growth over the period (19 percent). Most of these expenditures were made by the federal and provincial/territorial governments, and their growth can be attributed in large part to the creation of ministries of the environment in the early 1970s. The resulting rapid increases in federal and provincial/territorial environmental expenditures led to the growth in "other" PAC expenditures from 5 percent of total expenditures in 1970/71 to 32 percent in 1973/74. Expansion of environment ministries' activities as environmental legislation was enacted throughout the 1970s and 1980s meant that "other" PAC expenditures maintained an important share of total PAC expenditures from 1973/74 onward.

Capital-and-repairs PAC expenditures: Government capital-and-repairs PAC expenditures comprise purchases of machinery, equipment, buildings and infrastructure for solid waste and sewage management and other PAC systems. The vast majority of these expenditures are made by local governments. Figure 10c illustrates the growth of local government expenditures on capital-and-repairs for PAC systems from $903 million in 1985 to $1.6 billion in 1995 (an average annual rate of 6 percent). Approximately 85 percent of these expenditures were for the construction and repair of sewage management facilities.

Figure 10c

Government Capital-and-repairs Expenditures on PAC



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