Geoscience Canada

Chapter 2 : Present Socio-Economic Context and Projected Trends

Volume 22, Number 1-2, March 1995

URI: https://id.erudit.org/iderudit/geocan22_1_2art03

See table of contents

Publisher(s)

The Geological Association of Canada

ISSN

0315-0941 (print)
1911-4850 (digital)

Explore this journal

Cite this article

(1995). Chapter 2 : Present Socio-Economic Context and Projected Trends. *Geoscience Canada*, *22*(1-2), 11–17.

CHAPTER 2 PRESENT SOCIO-ECONOMIC CONTEXT & PROJECTED TRENDS

2 (a) Patterns of Canadian Imports and Exports

"... the demand for raw materials will translate into a need for more geoscience information, new exploration and exploitation techniques and increasingly technology, and better models to locate scarcer resources. Environmental concerns, on the other hand, will lead to a search for alternative materials, clean water and fuels, efforts to ensure less per capita consumption, and techniques to protect and remediate the environment, and to ensure the safety of growing population concentrations from natural hazards and for the disposal of waste."

Canada's wealth has been built on trade. It accounts for over half our gross domestic product, triple the ratio of the United States and more than half again that of Australia. Yet Canada's success has only been in the area of merchandise trade where, in 1993, we posted a $9.5 billion surplus; unfortunately this was more than offset by a $40 billion non-merchandise trade deficit leading to a current account deficit of over $30 billion.

Canada has the image of being largely dependent on natural resources in terms of international trade – the "hewers of wood and drawers of water" image. Natural resources still play an important role for Canada, but their position has been steadily declining over the past several decades, and particularly in recent years. The shift in relative importance from natural resources to manufactured goods and services began in earnest in 1965 with the Automotive Products Trade Agreement with the U.S. and accelerated with the collapse of oil prices in 1986, with increased competition from developing countries in commodities such as copper, and with the signing of the *Canada-U.S. Free Trade Agreement* and its successor, the *North America Free Trade Agreement*. Canada's dependence on the U.S. as a trading partner has, at the same time, steadily increased; by 1992 the U.S. purchased over 77% of Canada's exports of merchandise, up from less than half that amount in 1941.

Concurrently, there has been a significant move toward a more service-based economy, much of it trade-related and resource-related, from one dependent on the production of goods. In 1960 approximately 50% of Canadian workers were employed in the service sector compared to more than 70% in 1993 (Statistics Canada, 1994).

Despite these fundamental changes in the structure of the Canadian economy, minerals and energy still play an important role in ensuring a positive merchandise trade surplus. In 1992 non-fuel minerals accounted for 15% of Canada's exports, and in 1990 energy accounted for 11% of export income. Details are outlined below, but future investment, employment and tax revenue will be impacted by the environmental regulations discussed later under The Greening Trend.

Non-fuel Minerals

In 1992, the non-fuel minerals industry represented 4.2% of the Gross Domestic Product with production total-

Table 2.1 Canada's 1992 ranking in world global production of some metal and mineral commodities

COMMODITY	RANK	% OF WORLD TOTAL	VALUE ($ M)
Potash	1	30.2	900
Uranium	1	26.6	510
Nickel	1	21.8	1210
Zinc	1	18.3	1750
Sulphur	2	18.0	90
Asbestos	2	16.0	215
Cadmium	2	10.1	16
Titanium	3	13.3	–
Lead	3	11.5	210
Aluminum	3	10.1	–
Platinum Gp.	3	6.2	138
Cobalt	4	13.2	90
Copper	4	8.3	1760
Gypsum	4	7.7	83
Silver	5	8.8	152
Molybdenum	5	8.4	66
Gold	5	7.4	2258
Coal	–	–	1783
Peat	–	–	119
Salt	–	–	280
Clay	–	–	108
Cement	–	–	764
Lime	–	–	200
Sand/Gravel	–	–	736
Stone	–	–	470

(Mining Association of Canada, 1994)

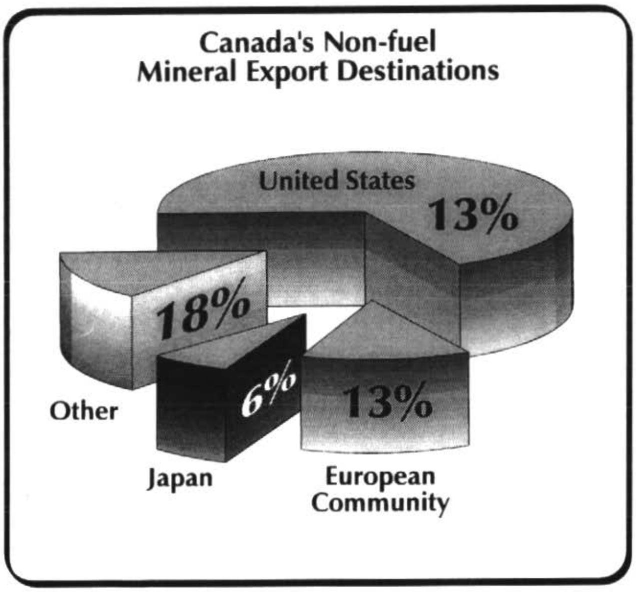

Figure 2.1. Pie diagram showing the major countries or trading blocks to which Canada exports non-fuel minerals.

ling $23 billion and exports of non-fuel minerals and metals totalling $14.6 billion. About 63% of Canada's non-fuel minerals exports went to the United States (Fig. 2.1). Imports were valued at $13.2 billion, resulting in a trade surplus of $9.8 billion (Statistics Canada, 1994a).

Canada ranks among the top ten countries in the world in the production of many of the most important mineral commodities (Table 2.1)

While it is difficult to predict the long–term trends in international trade in non–fuel minerals, several signals are apparent (Statistics Canada, 1994):

- there will be a continuing shift in metals demand from the developed world to developing countries such as China, Indonesia, and India;
- globally **copper** consumption is expected to grow at an annual rate of 2.0 to 2.5%;
- recent dramatic increases in the production of **zinc** in Canada (10% in tonnage; 25% in value from 1991 to 1992), coupled with an increase in price, augur well for at least the short–term future;
- the recent declines in western demand for **nickel** are expected to be offset by growing demand from emerging markets in China, Brazil, and South Korea;
- despite growing inventories and low prices for **lead** in recent years, the longer term outlook is for steady growth, but could be reduced by an increase in recycling;
- **gold, silver,** and **platinum** group metal production in Canada has seen a decline in production of 6 to 10% in recent years, with an uncertain future;
- Canadian **asbestos** mines are operating at 100% capacity and international markets are expected to remain strong through the 1990s related to building products used for housing;
- Canada is the world's leading exporter of **potash** and, despite decreased production worldwide, Canada's exports have remained relatively constant in recent years;
- **iron ore** shipments have been decreasing steadily over the past several years and are expected to continue to do so in the near future;
- Canada produces about 18% of the world's **sulphur**, most of which is used for the manufacture of fertilizers; despite recent decreases in exports of this commodity, the long–term trend is for growth based on increased agricultural needs in the future.

Water

Canada exports little water; it is expressly excluded from the terms of the *North America Free Trade Agreement*. Nevertheless, it is unimaginable that in the next century there will not be significant demands placed on Canada to export water to the U.S. Even the most conservative climate–change scenarios predict a significant increase in mid–continent aridity in the U.S. and Mexico which will lead to pressures for Canada to supply water to maintain agriculture in these areas.

Similar increased demands for water elsewhere in the world, either as a result of climate change or simply through population growth and demographic change, will lead to significantly increased opportunities for the export of Canadian expertise related to water resources by early in the next century.

Energy

In 1990, the energy supply sector accounted for about 7% of the Gross Domestic Product and 11% of export earnings. Overall, Canada has a net positive trade balance in energy, with imports amounting to about 40% of exports.

Fossil Fuels

Production of crude oil in Canada has risen from 97,000,000 cubic metres in 1990 to 106,000,000 cubic metres in 1993. Exports in 1993 amounted to 53,000,000 cubic metres (compared to 38,000,000 in 1990) while imports, principally in eastern Canada, were 34,000,000 cubic metres (compared to 31,000,000 in 1990) (Statistics Canada, pers. comm., 1994). Light crude oil production has declined in recent years from Alberta's older established oil fields whereas heavy oil production, both from oil sands and through enhanced recovery in conventional oil fields, has increased.

Similarly, marketable natural gas has increased from 99,000 million cubic metres in 1990 to 129,000 million cubic metres in 1993, with exports increasing from 41,000 to 63,000 million cubic metres between 1990 and 1993. It is anticipated that exports of natural gas will continue to increase in response to demands from the U.S. where Canada has now captured more than 10% of the market.

Coal production has been steadily increasing in recent years with an annual increase in production between 1990 and 1991 of 3% and an increase in exports of 10%; Canada is a net exporter with an annual surplus of about $2 billion; sales of coal rose by over 30% between 1991 and 1992. Of current production, 48% is exported through Vancouver and Prince Rupert from British Columbia and Alberta mines; smaller amounts are shipped from Nova Scotia. About 85% of exports are used in steel making and the remainder for heating and power generation. Export growth is being driven by a strong steel industry internationally and increased energy demand from Canada's Pacific Rim trading partners. There have been recent indications that exports from British Columbia are expected to continue over the next few years to supply mainly the Japanese market.

Import of coal from the U.S., primarily used for electricity generation in Ontario, has diminished in recent years related to environmental considerations (U.S. coal contains more sulphur than domestic) and to diminishing demand, particularly in the Canadian steel industry. Domestic coal has not been used in Canadian steel–making since 1988, and the decline in this sector in Canada over the past few years has resulted in decreased demand for U.S. coal.

Electrical Power

Canada's generation of electrical power has increased considerably over the past two decades with most growth coming from hydroelectric generation in Quebec and British Columbia. Since the latter are significantly influenced by rainfall and rates of production, imports and exports have been somewhat irregular over this period. Canada now produces, on average, about 500,000 gigawatts of electricity, 62% of which comes from hydro, 22% from thermal plants, and 16% (in Ontario, Quebec and New Brunswick) from nuclear. Approximately 7 to 10% of Canadian production is currently exported to the U.S.; exports of hydroelectricity to the U.S. are anticipated to continue to grow in the coming decades.

Uranium

Canada is the world's largest producer of uranium and is highly dependent on the U.S. market. The *Canada – U.S. Free Trade Agreement*, signed in 1987, ensures ready access to this important market. About 85% of Canadian uranium production is exported. While in the short-term uranium exports are expected to remain relatively constant, the long-term outlook is less certain. The construction of new nuclear power facilities in the crucial U.S. market has declined in recent years. Elsewhere in the world it is expected that new plants will be brought on line and will likely lead to increased demands for Canadian uranium.

2 (b) Science and Technology Trends

Science and Technology (S&T) is becoming increasingly important in the creation of jobs, addressing environmental problems, and ensuring that Canada's resource industries remain competitive in the global market place. In fact, S & T now appears to be the principal engine of economic growth in the world and the key to international competitiveness. Despite this, Canada lags significantly behind most other developed nations in terms of investment in S & T relative to Gross Domestic Product (GDP) (Fig. 2.2), spending only 1.5% of GDP ($7.783 billion) in 1991.

Science and Technology (S & T) is defined as:

> *"... systematic activities which are closely concerned with the generation, advancement, dissemination and application of scientific and technical knowledge in all fields of science and technology. These include such activities as R & D, scientific and technical education and training (STET) and scientific and technological services (STS) ..." (Industry Canada, 1994a).*

Research and Development (R & D) is defined as:

> *"... creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of the stock of knowledge to devise new applications." (Industry Canada, 1994a).*

Canada's investment in R & D has been increasing in constant dollars since the mid–1970s (up 3% from 1991 to 1992) and slowly shifting from federal government to business. In 1993, industry funded 41% of R & D in Canada and performed 54% of it compared to 38 and 43%, respectively, in 1979. Federal shares have, over the same period, declined from 35 and 23% to 28 and 16%. While these trends may be encouraging, in fact fewer than 1% of all Canadian business enterprises conduct R & D and, of those, fewer than 1% account for half of the total R & D in the Canadian industrial sector (65% of industrial R & D is done by 100 companies) (Industry Canada, 1994a).

In 1992–93, the federal government spent $5.9 billion on S & T activities in its own labs and through transfers to industry, universities, private non–profit facilities, foreign performers, and provincial and municipal governments. Essentially half of the federally funded S & T is targetted towards wealth creation, while the remainder serves risk management and quality of life issues (31%) and the ad-

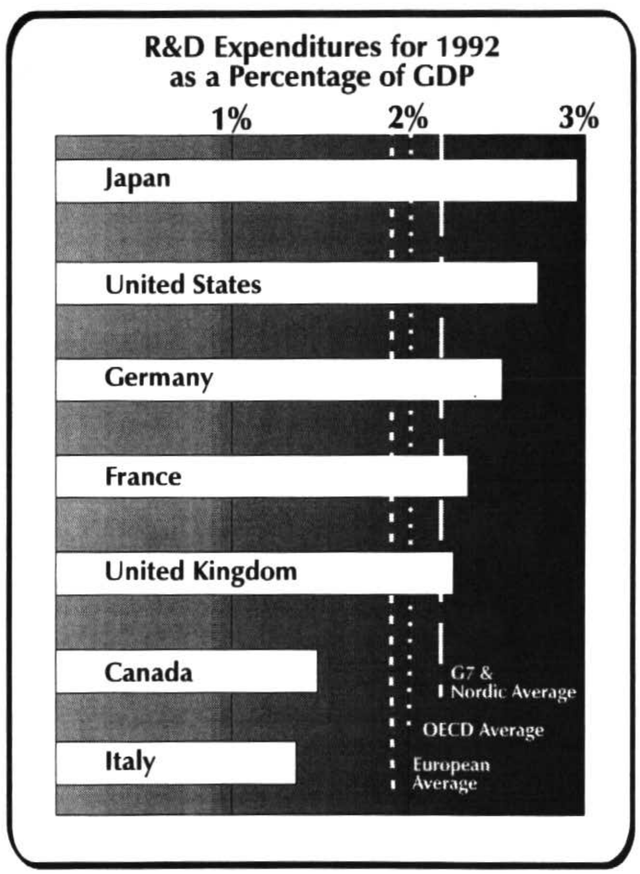

Figure 2.2 Research and development (GERD) expenditures as a percentage of GDP (Industry Canada, 1994b)

TABLE 2.2 Budgets and chief activities of the principal federal departments

Department	S & T Budget 1992–93 (M)	Activity Areas
Environment	$645	meteorology, climate, environmental conservation and protection, water quality and quantity, land use inventories
National Research Council	$505.6	transportation, construction, biotechnology, manufacturing systems, industrial materials
Natural Sciences and Engineering Research Council	$503	fundamental and applied research in all areas of science and engineering mostly in Canadian universities
Canadian Space Agency	$463	technology for space applications
Agriculture	$373	soils, water management, environmental quality, plant and animal breeding, genetics, processing, distribution, retailing
Natural Resources Canada (Energy, Mines & Resources)	$367	geological surveys, energy R&D policy, environmental geoscience, mineral deposits research, mineral processing, energy efficiency
Fisheries and Oceans	$248.4	biological, physical and chemical oceanographic research, marine environmental quality, fisheries habitat, hydrographic surveying
Canadian International Development Agency	$225	technical assistance in various areas to developing countries

vancement of Canadian science (20%) (Industry Canada, 1994a). Ninety percent of this funding was spent by 17 departments and agencies with half of the federal funding in natural sciences and engineering coming from 5 departments and agencies. Table 2.2 summarizes the budgets and chief activities of the principal federal departments and agencies engaged in natural science and engineering research activities.

Over the period 1979 – 1993 university–based research expenditures rose from $920 million to nearly $2.7 billion. In 1993 the largest portion of this ($991 million) was in the area of natural sciences and engineering. At present universities perform 26% of Canadian R & D and most of the "basic" research.

Provincial research organizations accounted for only 1% of total scientific activities in Canada in 1991, mostly related to the transfer of technology from the laboratory to production. These organizations spent $174 million and employed 2,100 people. In 1991, the Alberta Research Council was the largest of these facilities with a budget of $52 million, followed by Quebec's Centre de recherché industrielle, Ontario's ORTECH International and the Saskatchewan Research Council. Among its activities, ORTECH International researches energy conservation and runs a centre for alternative fuel use. Many provincial research organizations (e.g., the Alberta Research Council's Geological Survey) have sustained major budget and staff cuts recently.

Private non–profit organizations in Canada account for about 1% of all R & D conducted in Canada, 80% of which is undertaken in Ontario and Quebec. In 1991, 92% of the total $111 million was spent on health–related research such as drugs, immunology, cellular biology and cancer.

2 (c) The Debt–Deficit Crisis

Canada faces a fiscal crisis of staggering proportions, at a scale rarely confronted by an advanced nation in recent times. The federal debt is approximately $548 billion – 73% of our Gross Domestic Product (GDP) – resulting from accumulated annual deficits which today stand at about $40 billion. Nearly 40% of tax revenues now go simply to pay the interest on this debt, $44 billion. In addition, Canada is carrying a further $200 billion in provincial government debt. The combination of these two debt loads, much of which is held by foreign investors, results in Canada holding the distinction of having the highest debt to GDP ratio of any major developed country in the world. Put another way, Canada owes nearly $28,000 for every man, woman and child! And international confidence in our economy by these same foreign lenders is rapidly eroding as we are forced to devote an ever increasing share of our wealth to service the debt, leading to an escalation in interest rates and accelerating our headlong rush towards "the wall".

To douse this fiscal wildfire requires massive cuts to government spending at all levels and in virtually all areas without impacting the nation's ability to advance economically in step with its competitors. Bringing revenues in line with expenditures by 1997–1998 will require a reduction in program expenditures from $119 billion to $95 billion, $24 billion (debt charges by that time will be at $50 billion annually). Whereas increases in revenues would clearly have similar results, there is a reluctance to increase taxation significantly because of the negative impact this action would have on economic growth.

What impact will attacks on the nation's debt crisis have on the geosciences in Canada or, indeed, on science in general? While governments at the federal and provincial levels have not fully explained how they intend to achieve a balanced budget, it is clear from recent events that science support – including major geoscience research programs, – will be seriously impacted. The Geological Survey of Canada in Natural Resources Canada, for example, has recently sustained cuts and is planning for immediate cuts of more than 30% over three years. In Alberta the Geological Survey has been restructured as part of the most aggressive attack on provincial debt in this country. Other government departments and agencies involved indirectly in geoscience activities (e.g., Fisheries and Oceans Canada, Agriculture Canada, Forestry Canada) have similarly had budget reductions averaging about 30% over 2 - 3 years.

Among those programs which are hardest hit are cooperative programs with provinces, such as Mineral Development Agreements, and grants and contributions. Mineral Development Agreements were an important mechanism to promote federal–provincial cooperation and dialogue while GSC Research Agreements (and similar programs in other science departments) were a particularly important vehicle in forging cooperative initiatives between the academic and government sectors in the geosciences.

Academic research funding is likewise under pressure. Within intended cuts of 50% in the budget of Industry Canada over the next three years, and certain draconian cuts to federal and provincial S & T programs, the budget of NSERC's research grants will be reduced by 14% over three years. In 1995–1996 support for the solid earth sciences and environmental earth sciences will decrease relative to the average for all science and engineering disciplines. The effects on post-secondary education of the significant reductions in federal transfer payments over the next few years have yet to be fully realized.

2 (d) Federal Science and Technology Reviews

Over the past thirty years various organizations and agencies (e.g., National Advisory Board on Science and Technology, the Science Council of Canada, Royal Commissions, parliamentary committees, Auditor General) have reviewed the state of S & T in the federal government. Among the issues addressed were mechanisms for science policy delivery, national goals and priorities for government S & T, overall budget levels and allocation, relationships with industrial and university S & T sectors, and structural aspects of S & T delivery by government.

In its February 1994 budget the federal government announced its intention to launch a sweeping review, involving extensive dialogue with interested groups across the country, of federal science and technology priorities with the aim of developing a new S & T strategy for the country. Twenty–five community based meetings with various constituencies across Canada were held in July and August, and a national conference was convened on October 12. The results were assessed and the release of the new federal strategy was scheduled for early in 1995.

The national conference in October brought together 200 business, academic, and government representatives. They reviewed Canadian S & T under four thematic areas: (1) Sustainable Wealth and Jobs; (2) Quality of Life; (3) Advancement of Knowledge; and, (4) Managing Science and Technology Investments. The conference produced a draft "vision statement," a proposed approach to accountability in a federal S & T strategy, guidelines for producing a national strategy, and 15 specific proposals on themes such as industrial–sector competitiveness, technology transfer, education, infrastructure, integration of economic, social, and environmental goals, and evaluation of success.

The proposed "vision statement" is:

> *"We see a Canada where science and technology advance the quality of life for all Canadians, where innovation is a dimension of our national identity and where the commercialization of the products of research is a national priority."*

By the year 2000, individual Canadians, Canadian companies, and Canadian operations of multinational companies will be world leaders in technology-based innovation and the implementation of products and processes in focussed and strategic areas. Our national infrastructure will represent a key competitive advantage. Business will be driven by market considerations and the research community will be more knowledge-driven. Interactions among these players will be stronger. All Canadians will be more discriminating in the recognition of, and demand for, quality; and all players will be accountable for ongoing evaluation and improvement of performance."

The conference's proposed approach to federal S & T accountability was:

1. The authority and accountability that ministers have for their respective portfolios should be preserved.
2. Short and long-term goals should be articulated and made public.
3. Methodology should be developed to measure both quantitative and qualitative indicators of progress toward achieving these goals.
4. A report of federal investments in science and technology and related activities should be published annually, along with an assessment of progress toward achieving the goals of the strategy.
5. A federal minister should be identified as responsible for overseeing implementation of the strategy and should be accountable to Parliament for it.

In an another review, the 1994 Auditor General's Report dwelt at some length on the shortcomings of government S & T; among its observations and recommendations:

- Despite the current government's commitment to manage its S & T more strategically, "Previous efforts to do so in the last 30 years have failed."
- Previous reviews of government S & T have not led to "... results-oriented action plans that lay out priorities to meet Canada's economic and social needs and opportunities."
- Government spending must be focussed on "... areas with greatest need, opportunity and potential payback."
- A "revised structure" may be needed to ensure successful development and implementation of a true strategy involving a joint effort of federal and provincial governments, industry, and universities.
- Government needs a "... framework and indicators to monitor ... performance in science and technology ..."
- More consideration must be given to "...long–term human resource requirements, and ... a stronger and more effective research management capability."
- Research organizations must "... set clear goals for their activities and focus more on results". They must "... set priorities based on a full recognition of the needs of their clients and of the opportunities in their respective sectors of activity."

2 (e) The Greening Trend

In 1987 the World Commission on Environment and Development of the UN (the "Brundtland Commission") called upon the nations of the world to develop strategies for sustainable development. Faced with the increasingly apparent conflicts among population growth, resource consumption, environmental quality, wealth distribution and diminishing quality of life in many regions of the world, this commission outlined the principles of sustainable development and a broad range of actions to achieve it in its report "*Our Common Future*". This was followed in 1992 by the Earth Summit in Rio de Janeiro, chaired by Canadian Maurice Strong, at which 105 nations adopted *Agenda 21*, a detailed plan of action on environment and development (United Nations Conference on Environment and Development, 1992).

Few in the world have embraced these aims with such enthusiasm as the people of Canada, both individually and institutionally. In fact, polls have shown that, in contrast to our American neighbours, Canadians feel far more personally empowered to "make a difference" where their environment is concerned. The result: 'blue boxes' proliferate, demand for more parks and protected areas has skyrocketed, 'green products' have sprouted everywhere. Concern and even outrage are being expressed at the destruction of the East Coast fishery and at logging practices in British Columbia. Another example is the recent termination of Alcan's Kamano River diversion scheme in northern B.C. because of concern for its negative impact on the salmon fishery.

The preservation and enhancement of the environment often have become the most important considerations in development projects, particularly those related to non-renewable resource exploration and exploitation. The site of a huge and very rich ore deposit at Windy Craggy, B.C., has been declared a park and thus closed to mining; petroleum exploration in the foothills of the Rockies has been severely restricted because of concerns about sensitive natural habitats in the area. The messages from Canadians, reflecting their expectations for environmental stewardship, have thus been heard by both industries and governments. The *Whitehorse Mining Initiative*, for example, discusses at considerable length issues such as environmental protection, environmental assessment, protected areas, and land use. The overarching principle of environmental protection agreed upon at this multi-stakeholder conference demonstrates the commitment of both industry and environmentalists alike:

> *"Environmentally responsible mining exploration, development, operations and public policies are predicated on maintaining a healthy environment and, on closure, returning mine sites and affected areas to viable, and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities." (Whitehorse Mining Initiative, 1994)*

Governments, too, have responded with vigour. The Liberal Party's 1993 policy handbook, "*Creating Opportunity*" (the "*Red Book*"), devotes an entire chapter to sustainable development, stating:

> *"Managing economic development and human growth without destroying the life-support systems of our planet demands of Canadians a fundamental shift in values and public policy. We must aspire to be less wasteful of our natural and human resources, to place greater worth on the welfare of future generations, and to take pride in maintaining a healthy, productive Earth." (Liberal Party of Canada, 1993)*

The vision a Liberal government purports incorporates the qualities of thrift, collaboration, and a special physical and spiritual tie to the land that are important to the Canadian identity. It is a vision of a society that protects the long-term health and diversity of all species on the planet, promotes energy efficiency and clean technologies as the basis of a competitive industry, and wisely manages and conserves its natural resources.

But more than vague rhetoric, the federal government has committed Canada to some of the most aggressive carbon-dioxide emissions targets in the world – 20% reductions (from 1988 levels) by the year 2005 and an ambitious program to increase energy efficiency and the use of renewable energy. Furthermore, the current government has agreed to direct 25% of all new government R & D funding to technologies that will substantially reduce the harmful effects of industrial activity or that will specifically enhance the environment.

Many provinces have also responded to the call for clear policies and actions on issues such as land use, air and water quality, and resource exploitation. In British Columbia, for example, the Commission on Resources and the Economy (CORE) is engaged in developing and implementing an ambitious strategy related to land use and associated resource and environmental management; the cornerstone of this initiative is a proposed Sustainability Act for the province.

Clearly, the geosciences have many roles to play in responding to these national and international imperatives related to the environment in:

> *"identifying environmental problems, understanding causes, predicting future consequences and developing solutions". (Commission on Geological Sciences for Environmental Planning, 1994).*

The need for such geoscience information and expertise is, in many instances, urgent and a fundamental shift of emphasis in the earth sciences, especially within government agencies, is required from the more traditional role focussed on finding new mineral and fossil fuel resources to one which contributes effectively to sustainability. The needs are as diverse as the range of geoscience itself – from floods, hurricanes, and landslides to radon, sea level change, earthquakes, soil degradation, acid mine drainage, and radioactive waste disposal, to name but a very few.

> *"Environmental problems, challenges and issues are widespread. There are few parts of our planet without an environmental situation that requires attention, and a global inventory would be a massive undertaking. Population pressure and poor planning have often turned minor problems for small groups into potential or actual catastrophes for large numbers of people. We cannot turn off these processes, but it is the aim of environmental geoscience to improve the way that we plan support for human communities." (Commission on Geological Sciences for Environmental Planning, 1994)*

2 (f) Population and Consumption Pressures

The exponential growth of both human population and its consumption of goods are the two single greatest threats to the long-term survival of the species and, indeed, of life

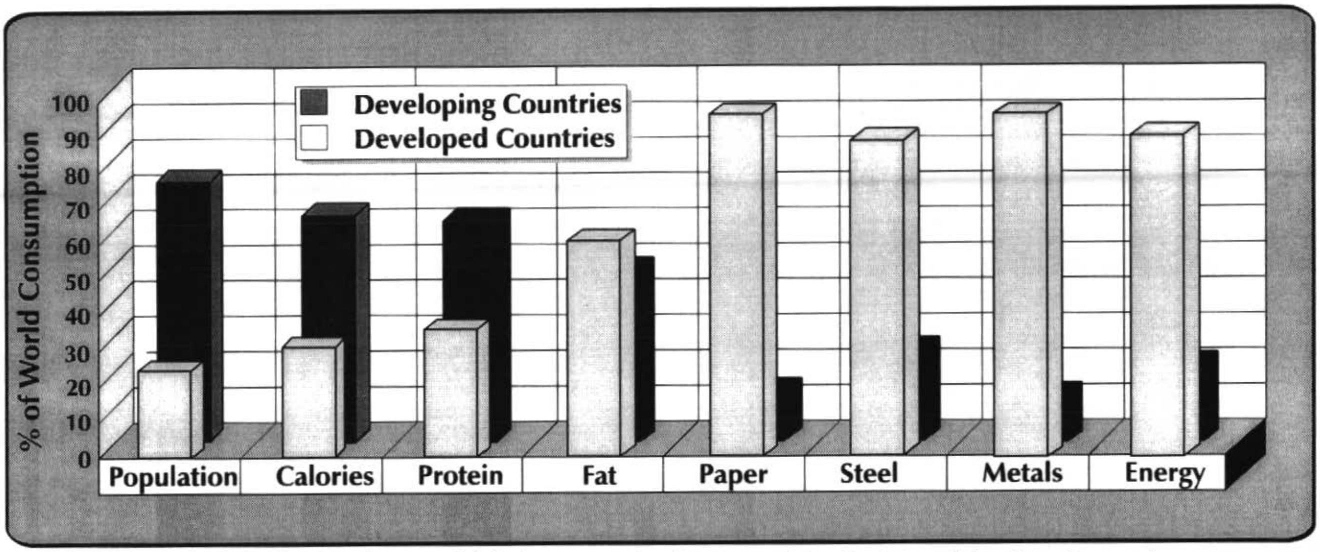

Figure 2.3 The distribution of global consumption in terms of developing and developed countries (Royal Society of Canada, 1994).

as we know it on this planet. Even accounting for predicted decreases in fertility, global population is expected to reach about 15 billion by the year 2050, nearly triple the current population, with most of that growth occurring in the least developed countries of the world and most of that in urban centres and coastal areas. At the same time, consumption of goods and services is expected to increase eightfold (Malone, 1994). Thus only a small percentage of increased global production will actually go towards fulfilling basic human needs, such as food and shelter; most will be to satisfy human desires for luxury and convenience.

The links between population growth, resource exploitation and consumption, and the environment are well known and are exemplified by deforestation in Amazonia, air and water pollution in urban areas, and greenhouse gas emissions and climate change. The relationships are not the same throughout the world, however; at present the developing nations of the world, which occupy only 56% of the earth's land surface, account for over 75% of its population but annually consume only 10 to 20% of its exploited natural resources (Fig. 2.3). For some commodities the differences are even more striking: an average Canadian consumes as much energy as 60 Cambodians.

Alarming as these differences appear they will be further exacerbated in the coming decades by several other trends which are expected to continue. The rate of population growth will be 3 to 4 times higher in developing countries than in developed nations (Fig. 2.4); European and North American populations are growing at 0.5 to 1.0% per annum while Asian, Latin American, and African populations are growing at 1.8, 2.0, and 3.0% per annum, respectively. By 2050 the population of the 62 poorest nations of the world will be greater than the entire global population in 1991. The recent growth in total and per capita non-renewable resource consumption has been staggering: energy production globally has increased 52% over the past two decades and, between 1975 and 1990, world consumption of bauxite rose by 57%, nickel by 46%, zinc by 38%, and iron ore by 23%. If anything, these rates will only increase as the developing world expects a more even distribution of wealth and access to the amenities now taken for granted in developed nations; while virtually all Canadian families possess a refrigerator, for example, at present only 5 million out of a total of 850 million Indians have access to one. The tremendously overheated economies in parts of Asia (e.g., China) have been coupled with markedly increased demands for energy and other resources, as well as for consumer goods and luxury items which were hitherto virtually unknown in that part of the world.

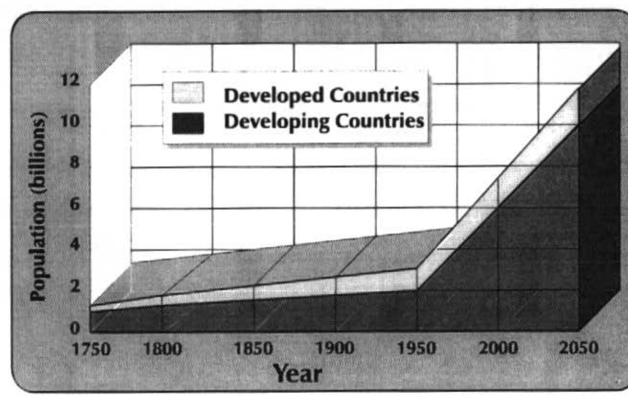

Figure 2.4 Population growth of developing and developed countries from the year 1750 projected to the year 2050 (Royal Society of Canada, 1994).

The implications for the geosciences are clear: the demand for raw materials will translate into a need for more geoscience information, new exploration and exploitation techniques and increasingly technology, and better models to locate scarcer resources; environmental concerns, on the other hand, will lead to a search for alternative materials, clean water and fuels, efforts to ensure less per capita consumption, and techniques to protect and remediate the environment, and to ensure the safety of growing population concentrations from natural hazards and for the disposal of waste. The 200,000 deaths in coastal Bangladesh from a storm surge in 1991 and the thousands of casualties from mudslides on the deforested slopes of Mount Pinatubo, Philippines, provide a glimpse of the scale and character of natural disasters expected in the next century.