Science, technology and innovation for sustainable development

Michael Bordt, Julio Miguel Rosa and Johanne Boivin
SIEID, Statistics Canada
August 26, 2006

1 Purpose of the paper

Our current science, technology and innovation (STI) classification systems, indeed any classification systems, cannot always track the fluid and multiple demands of the policy process, public opinion and current events. Therefore, it is necessary to (a) build tools that help us gain insights into emerging topics using existing data and classifications and to (b) reflect recurring needs in the revision of our concepts and classifications.

The purpose of the paper is to consider ***sustainable development*** (SD) as an example of the "intent" of STI. "Intent" here overlaps somewhat with socio-economic objective but could also include new technologies or other cross-cutting concepts not yet taken into account in the classification systems.

Better linkages between STI and SD will (a) provide insights into the influence of STI on SD, (b) allow policy makers to better gauge the relative efforts across various social, economic and environmental issues and (c) encourage the development of both STI and SD statistical systems to be more flexible and attentive to changing demands.

The Frascati Manual (OECD, 2002; Annex 4) already provides some advice on "special topics" such as health; information and communications technologies (ICTs); and biotechnology as cross-cutting issues that cannot easily be analysed with the current classification systems. This paper will provide a parallel discussion for SD and suggest some feasible approaches.

The paper reviews the STI classification systems, some existing survey approaches to obtaining information on SD and the international arrangements for integrating STI and SD indicator development.

2 Sustainable development as a statistical concept

Since the Rio Summit in 1992 (United Nations, 1992), the term "sustainable development" has taken on a multitude of meanings. The United Nations (2000) has followed a broad definition that includes sustainable social, cultural, political, economic and environmental development. This has resulted in the Millennium Goals. While their objectives as "foundations of a more peaceful, prosperous and just world" based on "the principles of human dignity, equality and equity at the global level" are admirable, they are not based on a systematic conceptual framework that accounts for the functional relationships between its various components. For example: What is the optimal amount of development assistance? How does deviation from the optimum detract from sustainability?

Environmental economists and statisticians often prefer a more systematic approach. It is possible to incorporate many ideals of sustainable development in the rather anthropocentric concept of sustainable *economic* development. The first principle being that it is possible to encourage *development that meets the needs of the present without compromising the ability of future generations to meet their own needs*. (World Commission on Environment and Development, 1987).

The framework adopted for this paper further focuses on the natural environment as a source of services required for maintaining and improving human welfare. Keeping the First Principle in mind, the consideration of future generations dictates the optimal use of these resources by making sustainable use of renewable resources, avoiding the depletion of non-renewable resources and minimizing waste. Statistics Canada's proposes a Natural Capital framework (Smith, et al., 2001), which views natural resource stocks, land and environmental systems (ecosystems) as necessary raw materials that need to be maintained for economic production.

We include a discussion of STI for (and by) developing countries here since their economic development is often more closely tied to SD than that of industrialized countries. In many developing countries, the majority of the population is simply trying to survive. Better agricultural and health practices contribute to major gains in survival. Education provides the basic opportunity for their citizens to participate in economic development. Many international development efforts focus on poverty reduction since, in many areas of the world, the immediate need for survival often implies exploiting the natural resource base unsustainably.

The main goal for economic development in developing countries is to leverage natural and human resources to improve welfare. The degree to which this is done sustainably will determine whether the development will succeed to a stage where the country is less dependent on its natural resources and can generate wealth from its produced capital and human resources.

3 How is SD represented in current STI classification systems?

The degree to which we can represent a concept in our classification systems determines the degree to which that concept can be easily analyzed, monitored and reported. Biotechnology, for example, is a technology activity (not an industry) but it is now possible to identify companies, R&D activities, products and patents that are related to biotechnology. The ICT sector is also well-defined as a set of industrial sub-sectors (OECD, 2002b). Developing international definitions of biotechnology and the ICT sector have required years of international cooperation, deliberations and compromises in revising concepts and classifications. SD is neither a technology activity nor a clear-cut set of industries. Is it probably best thought of as an objective, much like health. We can however, associate SD with certain socio-economic objectives, technologies, industries, goods and services, occupations and fields of science.

3.1 Socio-economic objectives

According to the Frascati Manual (OECD, 2002) "*Performer-based reporting of the socio-economic objectives (Table 1) of R&D is most easily applied in the government and private non-profit sectors … although individual countries have applied it in the higher education sector and even in the business enterprise sector.*"

The difficulty in applying socio-economic objectives (SEO) for R&D in the private sector is that the main objective of most of their R&D is to ensure the long-term profitability of the enterprise by developing and marketing new products. It is not a simple task to determine the use to which a given product is applied. But it could be done if activities were associated with specific products or broken down by projects. Australia (Australian Bureau of Statistics, 2002) is the only country that asks its business sector to identify the socio-economic objectives of their research.

The environment is included as one of the 12 socio-economic objectives in the Frascati Manual and is defined as: *"research into the control of pollution, aimed at the identification and analysis of the sources of pollution and their causes, and all pollutants, including their dispersal in the environment and the effects on man, species (fauna, flora, micro-organisms) and the biosphere. Development of monitoring facilities for the measurement of all kinds of pollution is included. The same is valid for the elimination and prevention of all forms of pollution in all types of environment.*"

Sustainable development is a much broader concept than control of pollution. Some issues are addressed under "5. Production, distribution and rational utilisation of energy" but in general, the SEO would require modifications and detail to appropriately represent SD.

The European Union uses the NABS[1] (EU, 2004) to provide a more detailed and compre-

Table 1 Socio-economic objectives of R&D

1. Exploration and exploitation of the Earth.
2. Infrastructure and general planning of land use.
3. Control and care of the environment.
4. Protection and improvement of human health.
5. Production, distribution and rational utilisation of energy.
6. Agricultural production and technology.
7. Industrial production and technology.
8. Social structures and relationships.
9. Exploration and exploitation of space.
10. Non-oriented research.
11. Other civil research.
12. Defence.

Source: OECD, 2002.

[1] NABS: Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets.

hensive set of components of “03 Control and care of the environment”:

- 03 Control and care of the environment
    - 0300 General research on the environment
    - 0301 Protection of atmosphere and climate
    - 0302 Protection of ambient air
    - 0303 Solid waste
    - 0304 Protection of ambient water
    - 0305 Protection of soil and groundwater
    - 0306 Abatement of noise and vibration
    - 0307 Protection of species and habitats
    - 0308 Protection against natural hazards
    - 0309 Protection against radioactive radiation
    - 0310 Other research on the environment

Australia’s business R&D uses the Australian Standard Research Classification “to allow R&D data to be classified according to the researcher’s perceived purpose” (Australian Bureau of Statistics, 1998). About 97 of the 594 classes in the ASRC are dedicated to the environment. Other aspects of SD are woven into the remaining classes. The ASRC could provide a useful starting point for a detailed international standard research classification that embodies SD.

What is not explicitly include in any of the SEO classifications, which would benefit the elucidation of R&D conducted for the “intent” of SD are, for example,

- R&D for developing countries (specific technologies, health solutions, sustainable agricultural practices, etc.);
- R&D in developing countries (poverty reduction, sustainable use of resources, development planning, etc.), and
- Valuation of resources (environmental economics, development economics); resource dynamics (e.g., forest regeneration rates, fish stock dynamics…)

3.2 Industrial classifications

We have at least three ways to identify non-standard industry groupings in our STI statistics:

1. **Existing industry categories.** The ICT sector is defined as a set of existing industrial categories (OECD, 2002b).
2. **Technologies developed or used.** Biotechnology companies in Canada are identified by the fact that they use or develop specific technologies. All firms within target industry sectors are asked if they develop or use these technologies. Those that do are asked to answer more detailed questions (Statistics Canada, 2003a).
3. **Goods and services produced.** Statistics Canada identifies the “environment industry” based on the goods and services an establishment produces: “*The environment industry is composed of establishments operating in a variety of industries that produce environmental goods and services. Environmental goods and services are goods and services that are used, or can potentially be used to measure, prevent, limit or correct environmental damage (both natural or by human activity) to water, air, soil as well as problems related to waste, noise and ecosystems. They also include clean or resource-efficient (eco-efficient) technologies that decrease material inputs, reduce energy consumption, recover valuable by-products, reduce emissions and/or minimise waste disposal problems*.” (Statistics Canada, 2004)

NAICS 2002 (North American Industry Classification System; Statistics Canada, 2003b) includes many industry groupings at the 5-digit and 6-digit level that are related to SD (e.g., 54162 Environmental Consulting Services).

The International Standard Industry Classification (ISIC) Rev. 3 classification is limited to 4 digits, so the detailed industries found in the NAICS 2002 are subsumed in broader categories (e.g., K7421 Architectural and engineering activities and related technical consultancy).

Both industrial classification systems would require substantial refinement and additional detail to accurately reflect SD-related industries.

3.3 Fields of science and technology

Fields of science and technology classifications (FOS) provide a means of classifying activities by "communities of practice" rather than objectives or the industry of the activity. These are usually more appropriate to classify activities in higher education since, in practice, activities in government and industry requires varying combinations of sciences and technologies to achieve their objectives.

The FOS classification in the 2002 version of the Frascati Manual was revised in 2006 (Annex Table A1) and this revision does make the classification somewhat more amenable to differentiating some aspects of SD. For example, the social aspects of "1.5 Earth and related environmental sciences" are included in "5.7 Social and economic geography". Given the broad set of examples under 5.7 [Environmental sciences (social aspects); Cultural and economic geography; Urban studies (Planning and development); Transport planning and social aspects of transport], the title might be restrictive.

The detail added to "2. Engineering and technology" allows the classification of "2.7 Environmental engineering" and "2.8 Environmental biotechnology".

For the purposes of tracking R&D in and by developing countries, the science of "development economics" might be better emphasized as a sub-field of economics.

As with the SEO, highlighting SD at a higher level would improve the ability of the classification to be used to differentiate SD-related fields.

3.4 Occupation classifications

It would be useful to know *who* is working on SD-related activities. Occupational classifications can give some insight into this.

The International Standard Classification of Occupations (ISCO) is managed by the International Labor Organization (ILO). Although environmental activities and skills are mentioned explicitly in the detailed examples of the current version (ILO, 1988), there are no specific "sustainable development occupations". For example, "2142 Civil engineers" includes "establishing control systems to ensure efficient functioning of structures as well as safety and environmental protection".

The Canadian NOC-S 2001 (Statistics Canada, 2001) similarly includes many SD-related sample job titles within a broader category. For example, "E031 Natural and Applied Science Policy Researchers, Consultants and Program Officers" includes several example job titles such as "environmental impact analyst, environmental program co-ordinator, environmental program manager".

Development economist is mentioned in the NOC-S as an example under "E032 Economists and Economic Policy Researchers and Analysts".

Despite the relevant examples, it would be impossible, with either classification system, to discern, for example, the number of researchers specializing in R&D on sustainable development. Much like the industry classifications, a special survey would be required, perhaps sampling within those classes that include an environmental or other sustainable development component.

3.5 Commodity classifications

Sometimes the best way to distinguish SD-related industrial activities is to focus on the technology used or the product being produced.

Most countries apply a classification of products (or commodities or goods and services) that is based on that maintained by the World Customs Organization (WCO), The Harmonized Commodity Description and

Coding System, or HC. Although it comprises over 5,000 commodity groups and these tend to cover many of the products of concern in analysing SD.

Statistics Canada's Standard Classification of Goods (SCG) is an extension of the HC. The SCG adds two more digits to provide more detail for goods that are manufactured in Canada and for those that are imported. In several cases, the additional digits allow the classification of the use of the product (see Table 2).

The Canadian Environment Industry survey (Statistics Canada, 2002) uses a custom list of goods, services and construction that have been designated as "environmental" (Annex Table A2). This list was developed in cooperation with clients and respondents since neither the HS nor the SCG provided sufficient detail to distinguish environmental commodities.

As with the other classification systems, there are opportunities to refine the categories to be more amenable to the analysis of SD.

Table 2 Example of additional detail in Canadian SCG

8417	M	Industrial or laboratory furnaces and ovens, including incinerators, non-electric
8417.10	ES	Furnaces and ovens for the roasting, melting or other heat-treatment of ores, pyrites or of metals
8417.10.10	I	Rotary open-hearth furnaces; amalgam cleaners
8417.10.20	I	Furnaces and ovens for sintering iron ore or flue dust
8417.10.30	I	Aluminum log and billet furnace, incorporating shear assembly and conveyor belt system
8417.10.90	I	Other

4 Some existing survey approaches that give insights into SD

Various approaches have been used in national surveys to obtain information on STI for SD. They provide examples of working within the existing STI framework of concepts and classifications.

4.1 Specialized R&D Surveys

The Canadian R&D surveys (Statistics Canada, 2005a) also ask respondents the proportion of their R&D dedicated to special areas. The current questionnaire asks for % of R&D expenditures attributable to:

- software development,
- biotechnology,
- prevention, treatment and reuse of pollutants and wastes, and reduction of material and energy use, and
- advanced materials.

The US (US Department of Commerce, 2005) applies a similar "tagging" approach for biotechnology, software and new materials.

Such "tagging" questions on emerging or cross-cutting issues are useful alone or as means for identifying sub-populations for further enquiry. Used alone, the questions can provide an indication of which sectors engage in R&D in these areas. In Canada, the questions were used to identify a core group of firms (e.g., core biotechnology firms were identified as those with more than 50% of their R&D in biotechnology, see Statistics Canada, 2001), the characteristics of which can then be further analysed in terms of sources of funds, human resource allocations, country of control and others.

Statistics Canada also conducts an energy R&D survey (Statistics Canada, 2004), which asks detail about R&D on renewable (such as solar, biomass, thermal) and non-renewable energy; energy conservation and transportation. One conclusion from the analyses of the data is that, while expenditures on all energy R&D in Canada grew by 10.5% over the past six years, R&D in alternative energy grew by almost 50% (Chiru, 2005).

4.2 Survey on public and private R&D intended to support developing countries

In 2004, the government of Canada made a commitment to increasing our national effort to “devote no less than 5% of our research and development investment to a knowledge-based approach to develop assistance for less fortunate countries”. This required a baseline. Canada is well endowed in scientific capital with almost 112,000 people engaged in R&D in the business enterprises sector and almost 14,000 in the federal government in 2002 (Statistics Canada, 2005c). Nevertheless, until recently, R&D expenditures devoted to international development by federal government and private sector was unknown. In response to these challenges, Statistics Canada, in collaboration with the Office of the National Science Advisor (ONSA) took the initiative to develop two surveys designed to capture that information. The first survey was a pilot survey to measure the federal government contribution and the second one was a pilot survey to measure the contribution of the business enterprises to the R&D assistance intended to benefit developing countries.

4.2.1 Challenges

The population covered by this project was relatively rare. The target population for the survey of Research and Development in Canadian Industry Intended to Directly Benefit Developing Countries, 2004 (Statistics Canada, 2006a) was 1,249 units. Although the response rate for this survey was 63 %, only 2.7 % of respondents declared having R&D expenditures for developing countries. For the survey of Federal Science Expenditures Intended to Directly Benefit Developing Countries, 2004-2005 (Statistics Canada, 2006b), the response rate was 90 % and only 13.8 % of departments declared making S&T expenditures for developing countries.

The concepts were difficult to define. Respondents commented they rarely do R&D specifically for developing countries although, eventually developing countries would benefit from the research. There was some confusion between exporting new products to developing countries and performing R&D for their benefit.

The variables measured didn’t correspond to a specific accounting item. The information captured by these surveys was not standard for accounting items or for other standard classifications. For example, in the accounting books of the business enterprises, there is no specific place to capture the amounts of R&D dedicated to development or economic assistance.

4.2.2 Some lessons and results

These surveys provided a first measure the investment by Canada in science intended to benefit developing countries. The federal government has dedicated 151 million dollars in R&D expenditures intended to directly benefit developing countries. This expenditure corresponds to 2.8% of the total federal expenditures on R&D. For the private sector, R&D spending intended for developing countries amounted to 0.4% of the total R&D spending performed in Canada.

Federal R&D expenditures for developing countries are highly concentrated (74%) in public health and agriculture (see Table 3). As mentioned previously, these are two areas that are essentially to improving basic survival. These two objectives account for only about 20% of federal R&D spending overall.

4.2.3 Potential direction to improve the surveys:

Such surveys in the future would benefit from international standard concepts and classifications, the detail of which would have to be developed through a concerted cooperative effort to:

- Improve the definitions and concepts. It should be possible to provide explicit definitions and examples of R&D to benefit developing countries.
- Identify the specific technologies that Canada develops for the direct benefit of developing countries.
- Revise the socio-economic objectives in the context of developing countries (e.g., poverty reduction, water supply, basic health needs, basic education, and family planning).
- Developing measures of the impacts of these technologies on the developing countries.

Table 3 Federal science expenditures intended to directly benefit developing countries by type of scientific expenditure for each socio-economic category, 2004-2005

Socio-economic category	R&D	RSA	Total S&T
	%	%	%
Education	4.2	4.1	4.1
Public health	32.9	42.5	39.6
Information and communication technology	7.3	2.8	4.2
Agricultural production and technology	26.9	37.7	34.4
Environmental management	4.8	2.9	3.5
Energy management	0.3	1.0	0.8
Social sciences excluding educational	11.9	0.9	4.3
Other (ex. Data collection; management of natural resources; materials for earth sciences, etc.)	11.7	8.2	9.3

Note: R&D (Research and development)
RSA (Related scientific activities)
S&T (Science and technology)
Source: Statistics Canada RDCI-DBDC Survey

4.3 Innovation surveys

The innovation surveys in Canada already contain special questions to identify industries, technologies and activities. For example, the 2005 Survey of Innovation (Statistics Canada, 2005d) contains specific questions on revenues from natural resource products. Previous surveys have included questions on geomatics, construction and transportation. This approach provides a “tagging”, much like the R&D surveys, to identify industries, technologies and products. Such an approach could be used to identify other SD-related activities.

4.4 The Bioproducts Development Survey

Recent advances in science and technology are creating a new range of products that can be made from biomass resources. These are referred to as bioproducts, *i.e.* commercial or industrial products (other than food, feed and medicines) made with biological or renewable agricultural (plant, animal), marine or forestry materials (Statistics Canada, 2005b). Bioproducts development and production form an emerging component of the economy and their global development can contribute to sustainability and economic growth. Furthermore, bioproducts can contribute to energy conservation, to reduce production costs and damage to the environment by offering alternative ways of manufacturing products. The world’s first Bioproducts Development Survey, conducted in 2004 by Statistics Canada, offers the potential to capture these new alternative products being developed and produced by Canadian firms and also to identify indicators that will eventually permit us to measure environmental, social and economic benefits of bioproducts development.

Before conducting the survey, data on the characteristics of firms engaged in bioproducts related activities were scarce and as in most emerging sectors, bioproduct firms face many challenges and barriers including access to capital, difficulty of attracting highly qualify personnel, etc. The objective of the survey was to gather data on the activities of Canadian firms engaged in the development and production of bioproducts to fill gaps in our understanding of the changes underway in these firms. Specifically, the survey collected information on the firm’s use of biomass and other renewable or sustainable biomaterials, the type and number of bioproducts being developed at different development stages, benefits and constraints related to developing bioproducts, human resources devoted to bioproducts, firm financial profiles, business practices, access to financing capital and the use of government support programs.

The survey showed that, 232 firms were engaged in bioproducts development and production in Canada in 2004 (Boivin, 2006). The survey also demonstrated that, while smaller firms may be engaged exclusively in bioproducts, for larger firms, this is a segment that is complementary to other business activities.

The existence of a bioproduct development sector in Canada itself indicates a change in our enterprises to shift toward the use of more renewable inputs. Other data such as R&D expenditures, human resources dedicated to bioproducts, benefits and constraints related to developing bioproducts are also useful indicators to help understand how this set of activities can support SD.

5 International institutional arrangements

Although the collection of environmental statistics has achieved some degree of harmonization at the international level. For example, the United National (United Nations, 1984) has produced a Framework for the Development of Environmental Statistics, and these standards have been applied to some degree in national and international collections. However, it is not evident that there is an international consensus on the systematic measurement of the broader concept of sustainable development and its linkage to the economy. According to Gault (2006):

> *If the purpose of 'development' is to have an impact on the economy and society, then impact indicators are needed, but they are not yet well developed. Part of the reason, of course, is that 'impacts' do not just result from one activity at one time, but from many activities at many times and it is difficult, if not impossible, to tie activities and impacts together, except, perhaps, at the project level. If a project is established to improve the drinking water in the community and fewer people die as a result, that may be evidence of a social impact. However, it may also be evidence of better training in food preparation and personal hygiene, suggesting that the establishment of the causal link is not simple.*
>
> *Indicators for 'sustainable development' go beyond indictors of 'development', and their uses are still evolving. There is no one organization that takes the lead on the production of indicators and guidelines for their development and use and there is a debate on how to approach the question. This debate can be simplified to a question of whether it is preferable to have lists of indicators under descriptive adjectives such as economic, environmental or social, the so called 'three pillar' approach, or whether a systems approach is preferable with environmental stocks and flows and the inclusion and measurement of natural capital as a particular stock.*
>
> *There are also sustainable development indicator initiatives in the OECD (Stevens, 2005), Eurostat (2005), non-governmental organizations, government organizations and, recently, there has been an initiative that may provide sustainable development indicators with the same means of development and acceptance as used for science and technology indicators. In 2003, the OECD Statistics Directorate convened a conference on Measuring Sustainable Development (OECD, 2004) which looked at integrated economic, environmental and social frameworks. This gave rise to the creation of a Working Group of the UN Economic Commission for Europe (ECE) Conference of European Statisticians (CES) which published terms of reference for a Working Group of Statistics for Sustainable Development in November 2005 (CES, 2005). The Working Group is to be jointly supported by the CES and by the Statistics Directorate of the OECD and it will report to the CES and the OECD Annual Meeting of Sustainable Development Experts at the end of its work. This Working Group, chaired by Robert Smith of Statistics Canada, will take on the task of bringing coherence to indicators of sustainable development.*

There are likely many further opportunities to improve international cooperation to (a) improve the acceptance and coherence of SD indicators and to (b) further the cross-fertilization of STI and SD statistical development activities.

6 Recommendations

6.1 Improved cooperation

If the STI classification systems and Frascati "family" of manuals are to be sensitized to SD, there will need to be a great deal of cooperation between the international STI and SD statistical communities. This may possibly start as a simple cross-representation in the respective OECD committees but eventually international organizations will need to agree on a single set of concepts for SD.

6.2 Improved classifications

The paper provides some directions in which to make closer investigation of the existing STI classification systems and to initiate projects to improve the visibility and treatment of SD concepts. This exercise would benefit from the previous recommendation concerning improved international cooperation.

6.3 More experience in technology surveys

This paper focuses on the Canadian experience in survey approaches to obtaining information on SD and other cross-cutting and emerging concepts. A project to gather experience in other countries could result in a wealth of existing knowledge. From this, perhaps, international core surveys could be developed.

7 References

Australian Bureau of Statistics. 1998. Australian Standard Research Classification (ASRC). Catalogue no. 1297.0.

Australian Bureau of Statistics. 2002. Survey of research and experimental development, business 2000-2001. Survey RD101.

Boivin, Johanne. 2006. Bioproducts development in Canada: the state of an emerging and promising sector. Innovation Analysis Bulletin Vol. 8 no. 1 (January, 2006). Statistics Canada Cat. no. 88-003-XIE.

CES. 2005. Terms of Reference for a Working Group for Sustainable Development, ECE/CES/BUR/2005/12/Rev, 24 November 2005.

Chiru, Radu. 2005. The increasing importance of energy R&D in today's context. *Innovation Analysis Bulletin Vol. 7 no. 3 (October 2005).* Statistics Canada Cat. no. 88-003-XIE.

Gault, Fred. 2006. Assessing International S&T Co-operation for Sustainable Development: Criteria and Indicators. [in] Workshop on International Scientific and Technological Co-operation for Sustainable Development, OECD, Paris, France.

International Labour Organization. 1988. International Standard Classification of Occupations 1988. http://www.ilo.org/public/english/bureau/stat/class/isco.htm)

OECD. 2005. International science and technology co-operation for sustainable development: Background and issues, www.oecd.org/dataoecd/33/44/35677680.pdf. Accessed January 13, 2006.

OECD. 2002. Frascati manual: Proposed standard practice for surveys on research and experimental development. Paris, France.

OECD. 2002b. Measuring the information economy. Paris, France.

OECD. 2004. Measuring Sustainable Development: Integrating Economic, Environmental and Social Frameworks, Paris: OECD.

Rosa, Julio. 2006. Research and development in the field of advanced. Statistics Canada Cat. no. 88F0006XIE2006005, Working paper No. 5.

Statistics Canada. 2002. Environment industry survey: Business sector. Cat. No. 16F0008XIE.

Statistics Canada. 2003a. Biotechnology use and development survey, 2003. Survey record number 4226.

Statistics Canada. 2003b. North American Industry Classification System – NAICS Canada. Cat. no. 12-501-XPE.

Statistics Canada. 2004. Energy R&D expenditures by area of technology. Survey record number 4205.

Statistics Canada. 2005a. Research and development in Canadian industry (RDCI). Survey record number 4201.

Statistics Canada. 2005b. Bioproducts development survey. Record number 5073.

Statistics Canada. 2005c. Estimates of research and development personnel in Canada, 1979 to 2002, SIEID working paper. Cat. no. 88F0006XIE2005008.

Statistics Canada. 2005d. Survey of innovation 2005. Record number 4218.

Statistics Canada. 2006a. Federal Science Expenditures Intended to Directly Benefit Developing Countries. Survey record number 5096.

Statistics Canada. 2006b. Research and Development in Canadian Industry Intended to Directly Benefit Developing Countries. Survey record number 5097.

Stevens, Candice. 2005., Measuring Sustainable Development, Statistics Briefs, September 2005, Paris: OECD.

United Nations. 1992. *Earth Summit 1992* http://www.un.org/geninfo/bp/enviro.html.

United Nations. 2000. Resolution adopted by the General Assembly 55/2. United Nations Millennium Declaration. http://www.un.org/millenniumgoals/.

US Department of Commerce. 2005. 2005 Survey of industrial research and development. http://www.nsf.gov/statistics/srvyindustry/surveys/srvyindus_rd1_2005.pdf.

World Commission on Environment and Development, 1987, *Our common future (The Brundtland Report)*, Oxford University Press, New York.

World Customs Organization. 1988. Harmonized system. http://www.wcoomd.org/ie/En/Topics_Issues/HarmonizedSystem/SH%20-%20multipurpose%20tool.htm