Environmental Information and Sustainable Development:

A Challenge for our Times

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Overview

Canada, indeed the world, is faced with an environmental crisis which is a direct result of the cumulative effects of past decisions on how humans have used the environment in support of social and economic objectives.

This reality led to the inevitable conclusion that if we are to have environmentally sustainable development, we must dramatically improve the integration of environmental considerations in decision making. All of us as decision makers, individually or as representatives of organizations, must accept responsibility for ensuring that environmental considerations are factored in our decisions.

Environmental information has a critical, direct impact on how well informed our decisions are, in terms of the environment. In turn, the decisions and actions we take regarding environmental information, information management and information technology directly affect our ability to make decisions which are environmentally sensitive. Improving the appropriateness, quality and accessibility of the environmental information available to decision makers will lead to better-informed choices with respect to sustainable development.

However, we are faced with a chaotic situation with respect to environmental information and its management. To deal with this chaos we need a well-articulated strategic framework which will enable us to improve, and further develop, an environmental information infrastructure.

Background

Evidence is mounting that human and cultural developments have resulted in environmental impacts that are both local and global in nature. These impacts threaten future economic development as well as the health and socio-economic well being of people, of their communities and of nations. In response to the environmental crisis, the international community has begun to chart a new course designed to cope with the challenge of sustainable development. This concept was put forward in the 1987 report of the United Nations World Commission on Environment and Development: Our *Common Future.* This report, commonly known as the Brundtland Report, identified sustainable development as development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

This discussion paper and the associated video - also entitled *Environmental Information and Sustainable Development: A Challenge for our Times* - *are* meant to prompt wide discussion among all interested parties. In this paper and video we suggest how Canada might take the first steps toward

supporting the goal of sustainable development by improving the quality and availability of the environmental information for decision making. The paper and video will be the basis for a workshop that will be convened to try and define the broad outlines of the strategic framework and what the overall objectives and priorities of the strategic framework should be. It is expected that at the workshop, agreements in principle would be reached with respect to the need for the strategic framework, how it should be implemented, how it should be funded. Also it is expected that an action plan would be agreed to and that the roles of the organizations to be involved would be established.

One of the most important tools we have to integrate environmental considerations at all levels of decision making is environmental assessment. To apply environmental assessment effectively at all levels of decision making depends heavily on having access to sound, timely and appropriate environmental information from the ecological, social and economic domains, from many different types of information holdings and from many sources. There are many examples of our inability to identify, capture, organize, store, access, analyze, represent or disseminate, timely, useable, quality environmental information in the formats or media required to support decisions affecting sustainable development.

The challenge of properly supporting the environmental information needs of decision making places extraordinary demands on our existing, but limited, environmental information infrastructure. It is crucial to the goal of sustainable development that Canada make it a national priority to improve our capability to bring the best, latest and most appropriate environmental information to bear on decision making in all realms. A key is to have a strategic framework within which to encourage current initiatives which support sustainable development, to create new initiatives and to foster development of a comprehensive, nation-wide environmental information infrastructure.

Environmental Assessment and Decision Making

The goal of all environmental assessment and decision making is to achieve sustainable development. Canada takes this goal as the basis of its environmental policies and both the Green Plan and the new legislation governing environmental assessment reflect this goal. The need to achieve sustainable development places new demands on environmental assessment and the associated decisions. It changes how environmental assessments are made and how decisions affecting the environment are made. These changes are conceptual, theoretical and practical.

Decisions regarding activities which have environmental impacts are made primarily in three domains - the economic, social and environmental. To date, most decisions affecting the environment have been based on economic considerations with emphasis on economic benefits. Assessment of

environmental costs, if considered at all, were focused on short-term, local effects. However, decision making must account for the combined effects of economic, social and environmental impacts. The effects in each domain must be considered in the light of effects in the other domains - in both the short term and in the long term.

Since decisions affecting the environment are made by all of us, the decisions run the gamut from major policy decisions of governments and major corporations, to day-to-day operational decisions of an administrative or personal nature. Obviously there are major differences in how decisions are made from one end of this continuum to the other.

There is also a need, when decision making impacts the environment, to evaluate environmental information in the context of the value systems and beliefs held by the parties of interest in the environmental decision-making process. At the same time there are more and more parties of interest whose concerns must be taken into account.

All of the above factors play heavily on the requirements for collection, management, access to, and use of, environmental information. Information from the environmental, social and economic domains is needed for decision making in many different settings, and for many different purposes. And, there are dramatic differences in the kinds and volumes of information required, depending on the nature of decisions being made.

Information Needs and the Nature of Environmental Information

Meeting the information needs of environmental assessment and decision making for sustainable development is complicated by the fact that in the three domains: economics, social and environmental, decisions are taken from entirely different perspectives or value systems. Further, the kinds and volumes of information currently available in the different domains are very dissimilar and tend to reflect the idiosyncrasies of the disciplines involved in each of the three domains. In business and finance, in the social sciences and in the physical and biological sciences, decision making is based on entirely different criteria and priorities.

There are many, many holdings of environmental information to which decision makers must have access. These holdings reside in many locations in many institutions. The contents of the holdings cover **a** vast range of subjects and exist in all forms and in all media. Moreover, **environmentally-**related information holdings of interest to decision makers are comprised of the whole range of information types from raw data in formal databases, to scientific publications, to legislation and regulations and, to personally-held informal collections.

These collections might result from information gathering and monitoring activities which are one-time, ad hoc projects or, they may be the products of national programs mandated by legislation. Likewise, the maintenance and

management of the information holdings may be haphazard, or rigorous in the extreme.

Even though there is already tremendous diversity of information required for decision makers, the diversity is increasing in all dimensions. This leads to ever-increasing complexity in the information management processes needed to support the environmental information needs of decision makers.

A Chaos in Environmental Information

Under the best of circumstances, bringing the right comprehensive, timely and accurate information to bear on environmental decisions would be a very large and complex problem. However, the current state of our environmental information base and its management is nothing short of chaotic. Our ability to manage, and use, environmental information needs much improvement in many ways. Note that while we certainly need to improve our ability to collect information, we must make much better use of information already at our disposal.

Inadequacy of Information Resources

Our environmental information holdings, while vast, are inadequate. Currently, the huge quantities of information in the economic domain are predominantly organized to support day-to-day operational decision making but significant amounts are devoted to policy formulation and high-level strategic decisions. In the social domain, the mix shifts to a more equal emphasis on administrative/operational decisions and policy/strategic decisions. In the environmental domain, much less information exists and practically all of the information is organized to support operational decisions with very little information to support policy development and strategic decisions. This situation militates against environmental decisions taking into account all the economic, social and environmental factors from a balanced perspective.

Lack of Broad, Integrated Indicators of Environmental Conditions

As yet, we have limited ways of representing information to indicate, holistically, the state of the environment. These "indicators" must represent the state of the environment at the local, regional and global scales.

Rather than continuing to rely on single parameter data variables to indicate the conditions in an ecosystem, we need analyzed, interpreted and integrated information which is derived from consideration of the whole range of important parameters. The new kinds of indicators must reflect a broader scope, bringing many more factors into the decision process. The indicators must reflect the linkages among economic, social and environmental impacts. And the indicators must help us appreciate the future effects of our actions - not simply reflect, after the fact, the results of past actions.

We are limited in the capacity to express the significance of environmental data and information in relation to such general critical issues as quality of life, social equity, health of the ecosystem, preservation of species, etc.

Developing new **ways** of representing environmental information for various decision makers and the public will be very much hindered by our inability to relate data and information from one source or from one discipline to the data and information from other sources and disciplines.

Complexity of the Information

The information holdings which support environmental decision making exist within all levels of government, the private sector, academic institutions, **ENGO's** and special interest groups. And, the information exists in all forms and in all media.

For example, Environment Canada's Envirosource project has identified over 1,000 major, separate repositories within Environment Canada alone. These repositories represent the full range of diverse content, form and media. Of course, not all of the necessary information is in the Environment Canada holdings. Vast amounts of data and information reside in the business and economic domains, within the resource management sector, in the sciences and in the social domain. And, this information is located in many institutions at many sites.

Incompatibility of Information Sets

By the nature of the information involved, it is very difficult to move information across domains and between sites of different kinds. Sometimes the same information needs to be used in entirely different ways depending on the decision-making objectives and styles being supported. Often the methodologies for gathering, analyzing and representing information are markedly different in the various disciplines which support decision making in the different domains. The same forest, for example, would be seen and described in entirely different terms by the economist, the biologist, the resource manager and the environmental planner. And, the analysis techniques used in one discipline are usually foreign to another discipline, all of which inhibits the free flow information.

Difficulties in Accessing **Information**

There are many problems associated with access to the required information. Under current conditions, access to needed information is extremely expensive and difficult, if not impossible. The access problem has four key aspects:

- incompatibility of information for the reasons described immediately **above;**
- lack of information about information - meta information - what information is available, where it is and how it can best be used;

- constraints rising from information ownership further inhibit the freer flow of information for environmental decision making; and,
- inadequate application of information technologies and the need to organize the technology resources into a coherent national infrastructure.

Meta information A major barrier to better information access is the lack of information about information - meta information. Meta information identifies, describes and indicates the location of information and provides information about how to access information. Meta information is generally in the form of directories, indexes and catalogues. Other kinds of meta information amplify the traditional directory information by providing assessment and annotation of the information in question so potential users can make judgments as to the usefulness and validity for their particular needs, of specific information collections.

Over the long run it will be more and more important to rigorously determine and describe the absolute quality of the information elements contained in information sets. While these processes are very expensive and time consuming, they represent an investment which will be required, either directly at the collection stage or, after the fact.

Ownership Another problem contributing to the chaos in environmental information is that of information ownership. Ownership - or perceived ownership - of information often creates serious barriers to wider dissemination of information to people who need it. All too often, even in government where there are no proprietary monetary interests in the value of information, people in organizations are often most reluctant to allow access to their information collections. There are many reasons for this. Some are valid, many are not so valid. While these reasons are beyond the scope of this discussion, the issue needs to be raised because the traditional reluctance to share information is not, in general, consistent with the strong pressures for more information sharing and exchange.

Inadequate Technologies Adding to these problems, which make access to environmental information difficult and expensive, there are problems which can be attributed to inadequacies in our application of information technology and the fragmented and incomplete nature of our environmental information infrastructure. The issue of inadequate application of information technology and the need for a much-improved infrastructure is addressed in a section which follows.

The Strategic Framework

Many of the problems discussed above result from Canada's lack of an overall national strategic framework to ensure that the wide range of environmental information needed by decision makers is readily available and easily accessible for use. Developing the strategic framework must be an immediate

priority. Current initiatives which are directed at improving the quality and usefulness of environmental information and developing components of the information infrastructure are isolated, underfunded and have little synergy.

The **strategic** framework will be the basis for coordinating the accelerated development of the environmental information infrastructure. It would, through the **organizations** contributing to the strategic framework, be the mechanism for better identifying the environmental information needs of decision makers. It will be the means for postulating the most cost-effective **ways to** improve our environmental information resources and to get the information to the decision makers in the most useful form.

The strategic framework will be a vehicle for policy development, setting of priorities and guiding the further development of the environmental information resources and the required information technology. It will facilitate coordination of programs, initiatives and projects to achieve the synergy which is now lacking. Given a strategic framework, the Central Agencies and other institutions will be able to ensure that maximum cost benefit is derived from investments in environmental information infrastructure. In short, the role of the strategic framework will be to guide and coordinate the planning, funding, development and maintenance of the environmental information infrastructure.

The Environmental Information Infrastructure

If our information resources are to be improved and information of many types from diverse sources at many locations is to be brought to bear in decision making, an environmental information infrastructure is required. This infrastructure is made up of at least six major components as follows:

- information;
- **meta** information;
- networks and gateways;
- standards and protocols;
- information services and brokerage; and,
- geomatics.

Information

The primary component of the environmental information infrastructure is the environmental information holdings wherever they reside. These of course include information from the economic and social domain as well as scientific and other information regarding the environment, or ecosystems. And, the information ranges as we have noted, from raw scientific data in databases to the literature, to statistics and all manner of so&-economic data, and to all kinds of studies and reports.

Meta Information

The second component is **meta information, information about the source information** contained in holdings. This meta information is normally contained in directories, indexes and other vehicles for conveying annotations regarding source information. In the long term we will see directories of directories, etc., as meta information begets meta information. Moreover, the amount of meta information required to support the use of source information can be expected to be much more voluminous and complex than the source information it describes.

Networks and Gateways

The third component of the information infrastructure consists of the **information highways needed to facilitate access to, and the movement of, information from sources and repositories to end users. This** requires a national system of networks **and gateways** based in part on the public telecommunications structure and in part on private, special purpose systems some of which might also be based on the public network. The networks and gateways will also necessarily be linked to international networks as international cooperation on environmental matters expands. With the networks and gateways in place, users could be linked to existing databases and information repositories. Over time, the networks and gateways would encourage the growth of heterogeneous distributed databases at many different sites and operating across different disciplines and domains.

Standards and Protocols

The fourth component of the infrastructure consists of the standards **and protocols which ensure compatibility of various technologies, methods and processes operating within the infrastructure.** Wherever possible, the standards and protocols would be those promulgated by the International Standards Organization and the Canadian Standards Board. These institutions develop the standards to implement the open systems interconnection concept through a consultative process involving all the parties of interest: governments, industry and users of systems.

Information Services and Brokerage

The fifth component consists of the services and brokerage facilities which are needed to assist people and institutions seeking information. These services will provide consulting, education and publishing of value-added information and meta information. We can expect that these services, given proper encouragement, will develop rapidly and become increasingly important as information holdings expand and become more complex, and as the number of participants in environmental decision making grows.

Geomatics

The sixth component of the information infrastructure for environmental information consists of the **schemas for organizing and referencing information sets so they can be** related one to the other and located according to their place in the organizing schema. The most important and powerful referencing schema for environmental information is based on the spatial dimension and is governed by the principles of cartography. This geo-spatial **referencing** - the discipline of geomatics - couples digital electronic representation of the information elements to an electronic map/chart base. Geomatics can greatly enhance the management and use of environmental information. Geomatics provides the principles and tools for formal representation of information in, or on, maps and charts. If information sets with a spatial component are each properly plotted directly on formal, rigorously-defined maps and charts in electronic form, each of these sets are automatically reconciled to the map and thereby indirectly, with each other. The importance of the geomatics concept can hardly be overestimated.

Application of geomatics can also provide very powerful indexing systems for environmental information. Any kind of information object, for example, a remote sensing image or an environmental assessment report can be indexed by an electronic map, chart or atlas if the object can be referenced to something represented therein. This *something* might be a point of latitude and longitude, a geographic area, a place name or a geographical object, etc. Geomatics can also provide the basis for entirely new techniques for analysis and information modeling by computer.

Developing Canada's Information Infrastructure: Current Efforts

Canada has already put in place the beginnings of an environmental information infrastructure. Also, much has been done to apply new methods and new technologies for creating and organizing environmental information. There is a growing number of new and important initiatives which are already contributing to the information infrastructure. These exist at all levels of government, in industry, business, the public and in the academic communities. For example, efforts are under way to develop inventories and directories to facilitate networking of environmental information.

Three such projects are:

- Environment Canada's Envirosource project;
- Fisheries and Ocean's Inland Waters and Coastal Ocean Information Network (ICOIN) project: and,
- Indian and Northern Affairs' Northern Information Network project.

In other areas, for example, there is strong movement to develop the **electronic chart** concept and produce new computer-based ocean maps. There are also a number of efforts to improve monitoring and reporting on the state of the environment.

However, these projects to improve the management of environmental information, and others which could also be identified, suffer from a lack of a **strategic** framework:

- they are not being coordinated;
- they often duplicate effort; and,
- ultimately they might not be able to meet national and international standards for open access to the systems and the information they contain.

The need for a strategic framework coordinating the development of the information infrastructure for environmental information is immediate. We must ensure that the current and future initiatives do not become isolated, mutually exclusive or redundant. Given the limits on the available resources, cooperation rather than competition must prevail.

Current initiatives must be strengthened and accelerated: new initiatives must be developed to deal with problems not now being addressed. But, most important, all the initiatives in support of achieving sustainable development, must become integrated within the strategic framework. A Canadian-wide environmental information infrastructure is needed and this information infrastructure, like other initiatives, can be properly developed only within a strategic framework.

Economic Development Considerations

There is another major benefit of developing the environmental information infrastructure, over and above that of meeting Canada's goal of sustainable development. With the strategic framework in place, there would be economic development spin-offs of great importance. The strategic framework and the information infrastructure which it subsumes will be a strong impetus for a more dynamic, highly-qualified and competitive Canadian environmental technology industry. Canada's focus on improving environmental information for improved decision making through an improved, comprehensive information infrastructure, will provide many opportunities for the environmental industry to expand its efforts in the environmental marketplace. Servicing Canada's strategic program to improve the availability, management, dissemination and application of information in support of environmental decisions will strengthen Canadian companies. The resulting expertise, credibility and financial strength of the industry will allow it to compete as a leader in the international trade in environmental information systems, value-added information, consulting

and education. This market will be a significant high-growth sector of the overall environmental technology marketplace..

An Agenda

The challenge to develop the strategic framework and the environmental information infrastructure rests with the Federal Government. It is the most obvious, and the generally-accepted leader in the environment and information management areas. The Federal Government must create the policy climate required for the strategic framework.

But where to begin? First of all, organizations and individuals must buy into the idea that a strategic framework is needed. Then work can begin to define and subsequently develop, the framework itself. As the strategic framework evolves and new policies, priorities and initiatives are put in place, the environmental information infrastructure will evolve in step.

The objectives of the strategic framework would be along the following lines:

- to develop a strategic plan for the information infrastructure to address information content, technology, organizational linkages, international standards and cost-effective access to information for all level of decision making;
- encourage those initiatives now underway which support integration and sharing of information among the major sectors of Canadian society;
- foster cooperation among all levels of Canadian government, educational institutions, industry, business, the general public and with various international bodies;
- provide strategic funding from all sectors of Canadian society; and,
- support development of environmental industries in Canada.

Before these objectives can be met a number of issues must be resolved. Some of the key issues are as follows:

- what policies are required to enable the strategic framework;
- where and how the required funding support can be obtained;
- how to establish the leadership required;
- how to create the mechanisms to build cooperation among governments, universities, and the private sector;
- what organization, or organizations will oversee the planning and execution of the action program;
- how to organize participation in the action program;
- what the priority objectives for the environmental information infrastructure should be;

- how to inventory existing infrastructure components available for environmental information, and how to assess the strengths and weaknesses of each;
- how to identify the gaps in the infrastructure and set priorities for improvement and further development of the infrastructure;
- how to integrate ongoing activities and initiatives into the strategic framework; and,
- how to create, or encourage the creation of, infrastructure components according to the established priorities.

Action Plan

The initial **stage** of the action program will begin to create the strategic framework within which to develop the environmental information infrastructure. The first step will be to conduct a workshop to define broad outlines of the strategic framework and what the overall objectives and priorities should be. Following the workshop, a conference would be convened to achieve a consensus regarding the priority issues involved in bringing the strategic framework to fruition. The conference would reach agreements in principle with respect to the need for the strategic framework, how it should be implemented, how it should be funded. Also it is expected that an overall action plan would be agreed to and that the roles of the organizations to be involved would be established.

There are a number of important roles to be filled. The Central Agencies of the Federal Government must take the lead in developing a strategic framework. The departments and agencies of the Federal Government must commit to the development of the infrastructure components. For example, Environment Canada with the assistance of Supply and Services and the Department of Communications, will need to spearhead the development of the information technology systems and protocols for the networks and gateways to move information between information repositories and users.

All organizations will need to commit to improving the quality, availability and usability of their information holdings and providing the directories and other required **meta** information. Building the geo-spatial referencing system will require the support of the government's base mapping agencies.

It will **also** be especially important that officials, in the corporate world as well as in government, do what they can locally with respect to the development and management of information under their own purview. They also need to ensure that their initiatives and the resources at their disposal support, and work in concert with, the environmental information infrastructure as it emerges.

Conclusion

With an action plan for the strategic framework and the environmental infrastructure in place, Canada will be empowered to better meet the information needs of those making environmental decisions so as to support the goal of sustainable development. Having the best environmental information available means we can support decision making for sustainable development with more confidence.

We can be confident that important environmental factors will not be overlooked and that the environment will receive the priority it deserves. Harnessing our environmental information resources in support of decision making to achieve sustainable development is truly:

A Challenge for our Times.