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Global Change Information Support:
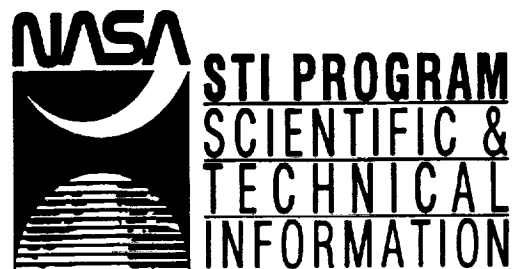# A North-South Coalition

W. Blados and G. Cotter

**NASA STI PROGRAM
SCIENTIFIC &
TECHNICAL
INFORMATION**

GLOBAL CHANGE INFORMATION SUPPORT:

A NORTH/SOUTH COALITION

W. BLADOS/G. COTTER

Abstract

On a daily basis we become more aware that our planet, earth, exists in a delicate balance; we, its inhabitants, must be informed caretakers. Global change communities have emerged around the globe to address this multidisciplinary subject. Information systems that integrate text, bibliographic, numeric and visual data are needed to support these global change communities. No one information center can hope to collect all the relevant data. Rather, we must form a coalition, North and South, to collect and provide access to disparate, multidisciplinary sources of information, and to develop standardized tools for documenting and manipulating this data and information. International resources need to be mobilized in a coordinated manner to move us towards this goal. This paper looks at emerging information technologies that can be utilized to build such a system, and outlines some cooperative North/South strategies.

Defining Global Change

Increasing carbon dioxide...the greenhouse effect...ozone holes...projections of worldwide sea-level rise...long term climatic changes...global warming...

These subjects, neatly categorized under the term "global change," regularly receive media attention. However, global change is a nebulous concept, sweeping in scope and multidisciplinary in nature.

The entire issue of global change is an extremely complex and controversial issue. Ernest Hollings, in his testimony before the Committee on Commerce, Science, and Transportation, stated that global change is caused by industrial development, population growth, and energy use. (1) Climate warming is considered to be the most pressing problem, but it is only one of the major components of global change. Acid rain, ozone depletion, global distribution of contaminants, biological diversity, deforestation, urbanization, erosion, water resources, and resource depletion are other factors being examined under the aegis of global change.

The essential characteristics of global change are that it is caused primarily by human activity, although the effect on global systems is inadvertent rather than deliberate; the effects are expressed, in different forms, worldwide; and the change is taking place rapidly. Two other characteristics are increasingly apparent. One is that the changes are progressive, with little evidence that the rate of change will diminish in the

foreseeable future, and the second is that several of the changes that may have the greatest impact on humanity are cumulative and probably irreversible beyond a certain threshold. In some cases, this threshold may already have been passed.

One of the definitions of global change, one that recognizes the links between human and natural systems is provided by Martin F. Price. His definition is that global change refers generally to the effects of human activity on the landscape, sea-level and ocean circulation, the atmosphere, and terrestrial and marine organisms, superimposed on naturally occurring changes. It also includes the physical and biological processes giving rise to these changes. (2)

Another definition is provided by Eugene Garfield. He considers global change as the "interactive physical, chemical, biological, social, economic and political forces that are causing global environment changes in the biosphere." (3) Coverage of source items in support of this definition concentrates on "anthropogenic changes in the biosphere, basic science about interactive atmospheric, oceanographic, geological and ecological processes and economic, political and demographic forces that drive global change." Garfield further states that support of global change considerations can pertain to "habitat destruction and extinction, climate change, conservation and depletion of non-natural resources, waste and toxins, demography and public health and environmental economics and politics."

Implications of Global Change

The 1990s are pivotal for environmental policy and research because the world population is growing, consuming natural resources, and producing pollutants at an unprecedented rate. During this decade, scientists expect to observe detrimental changes in climate that have been predicted using new models and methods developed in the 1980s. Political, economic, and personal lifestyle choices made during this decade are expected to influence the kind of environment future generations will inherit more directly than lifestyle choices made during any other decade in the last two centuries.

Research is needed to assess the feasibility of current and future alternatives and to devise strategies to deal with the environmental changes to which we are already committed. It is also needed to increase understanding about the effect human activities have on complex and dynamic global processes.

Stephen Schneider at the National Center for Atmospheric Research has observed that research in earth science is increasingly directed toward a "whole-earth" or "earth-as-a-system" approach that attempts to integrate knowledge of global

processes from many disciplines. According to Schneider, true interdisciplinary research is needed to understand global change, and it is something different from the multidisciplinary research previously undertaken. He states that "by 'interdisciplinary' I mean that the search for solutions takes precedence over traditional disciplinary boundaries. Researchers in different disciplines interact frequently and try to learn enough about each other's field to generate new approaches that might not otherwise have been discovered." (4)

International research programs are hard to track. The literature that results from them is scattered and it may be difficult to identify any one piece of research as emanating from a particular program. The aim of information support and services for global change is to provide and encourage communication across various disciplines and among interested parties at the national and international level through annotated literature citations, news, and a calendar of conferences and other activities.

In 1986, Freeman and Smith of the National Oceanic and Atmospheric Administration (NOAA) began a comprehensive review of environmental information by declaring that environmental information services "...are closely intertwined with strong social forces; understanding the context and background of a particular system is as important as knowing about its internal processes and its products." (5)

Consistent with environmental information in general, the two categories of clientele for this literature are the public and scientists: physical and biological scientists studying global change and social scientists studying the human response to global change. To formulate and evaluate policy options, government officials and the public need to understand complex geological and biological processes not yet well understood by scientists. Recognizing and responding to this need, scientists are taking on new roles by attempting to interpret these processes for the public. Many are also taking a new approach to research by trying to learn enough about disciplines outside their own to find new solutions to the problems that global change issues present, a change from years of increasing specialization. This kind of interdisciplinary approach, combined with the scope of global environmental change will present challenges for researchers and the information specialists who serve them. Information support and services experts will be needed as part of the team that will plan for and manage vast amounts of information and data required and generated by lengthy research projects that are planetary in scope.

Meeting Information Requirements of the Global Change Community

Early in this paper, it was stated that the entire issue of global change is an extremely complex and controversial issue. This is especially true in providing information support and services to the global change community.

The expanding use of information technology, the growth of interdisciplinary research, and an increase in international collaboration and development of international standards are having a significant impact on the conduct of science and the corollary management activities.

The expanding range of media and transmission alternatives, along with the continual increase in computing capacity and software building knowledge, are now removing barriers to the creativeness of scientists and engineers. Electronic mail expands the collegial campus, and electronic publishing improves the information transfer capability of documents.

Then too, computerized instruments gather data many orders of magnitude greater than previous methods. Data are available, not only in computerized databases, but also from sensing and other data-gathering instruments. New analytical approaches have been made possible through graphics, color enhancement, animation, and other visualization techniques.

These problems are further compounded by the growing internationalization of science. STI is being produced, enhanced, and stored around the globe. While single countries in some cases are acknowledged leaders in select scientific and technical disciplines, many of the major research efforts involve worldwide data collection. Many of the significant research challenges today are interdisciplinary in nature, which requires expanding the circle of collaborators and the range of information sources. Not only are a variety of disciplines involved, but scientists from around the world are participating in these efforts. The users in these projects are distant geographically as well.

All of these factors tend to overwhelm traditional data management techniques and create pressure to change accepted information practices. In spite of these vast and large databases, the different methodologies, vocabularies, and cultures of individual disciplines create obstacles to efficient information exchange. Merging existing data collections from different fields to perform analyses creates new problems. It becomes extremely difficult to compare data that were derived using different techniques or approaches. Contributing to this problem is the lack of standards for data exchange formats which hamper the building of these multidisciplinary and interdisciplinary databases.

The bottom line, however, is that we must be prepared to import external information to support the internal global change requirements, and to assure real-time delivery of information to support the transfer and transition of technology within the global change community.

In short, the pace of data collecting, the growth of international approaches to research, and the tendency to cross traditional disciplinary boundaries all cast a new perspective on earlier information issues, and raise new challenges for effectively providing critical information to the end user.

We now find that our customers want expanded subject coverage, not only national but international; they want to see more types of information such as numeric, factual, and multimedia; and they want rapid access to the full text of documents, along with improved systems of on-line bibliographic citations and delivery of documents.

These issues all fit into the theme of supporting the decision-making process. Researchers, scientists, engineers, program managers, and administrators need access to decision-supporting information regardless of the country of origin. They also need access to interdisciplinary information, not just to their own specialty.

Providing information in support of the global community would appear to be a formidable and overwhelming task. Especially so, when provision of information must take into account the vast array of multidisciplinary databases, the requirement to provide observation data, graphic representations of observation data, information available through personal contacts, as well as being able to supply complete reports of research on demand. The end users are a diverse group with many diverse needs. They require different types of data, different products, different services, and different user interfaces.

No one information center can hope to collect all the relevant data in support of their global change community participants. Our only recourse at this time is to form an international coalition, North and South, East and West to collect and provide access to disparate, multidisciplinary sources of information, and to develop standardized tools for documenting and manipulating this data and information. International resources need to be mobilized in a coordinated manner to move us towards this goal.

Recent advances in information retrieval systems have focused on developing and applying interface technology to create an environment where networking and interoperability strategies are possible on a global basis. One of these technologies is the development of gateways. Gateways allow users to interconnect

with multiple, diverse information systems. In essence, gateways act as intelligent switches. Gateways are being designed and developed to operate in environments ranging from single-user microcomputers to multi-user, central processing mainframes. These gateways allow simple interconnections, registration into multiple systems, and provide telecommunication paths and protocols, and logon and logout procedures. More sophisticated gateway systems incorporate menus, common command language, data analysis routines, artificial intelligence, and related technology.

To date, access to online information sources of scientific and engineering data has been limited to a large extent by factors such as inadequate telecommunication systems, non-standard query language syntax, lack of standardization in the information, and lack of adequate tools to assist in searching.

The NASA STI Program has recently began testing a prototype gateway system, the NASA Access Mechanism (NAM), which offers a solution to these problems by providing the user with a set of tools that provide a graphical interface to remote, heterogeneous, and distributed information in a manner adaptable to both casual and expert users. The NAM will provide access to many Internet-based services such as electronic mail, the Wide Area Information Servers (WAIS) system, peer locating tools, and electronic bulletin boards.

One requirement of the future NAM is that the user interface be easily customized for specific user communities. Another requirement for the future is to provide for two- and three-dimensional visualization and rendering of datasets, both for user input and results output.

Our goal at NASA is to meet the requirements of our customers and to establish as comprehensive and complete a database as possible. The most practical way to achieve this it to work with all the other organizations worldwide who share this goal, and to develop cooperative strategies to realize it. Development and use of gateway systems appear to have potential for the immediate solution of gaining access to the many databases available worldwide.

Using gateway technology, we can determine which relevant databases exist to solve an information query; from there we can learn how to access them, how to retrieve information from them, and how to manipulate the retrieved information. The NAM can provide a single, easy-to-use interface for identifying, accessing, interrogating, and post-processing information from numerous databases relevant to global change information needs.

In terms of peer locator databases, or "people bases," the NAM can be designed to answer questions such as what expertise is

available on the network, how to communicate with the experts, and how to share information with colleagues. The system acts as an integrated information system that allows human experts, information users, and information resources to exist and interact in harmony.

In short, the NAM or any other gateway will help us ensure that the proper sources are used, and that relevant information is retrieved. Such systems can also help us avoid leaving out important sources of information and retrieving volumes of irrelevant data. Gateway technology will help us to:

- Maintain a constant alert for new databases/services.

- Register for, and maintain accounts with each of the services.

- Select the right service(s) for the query.

- Learn the diverse command structures associated with each of the services.

- Become knowledgeable regarding the terminology used in each database.

- Merge and analyze results from multiple sources.

The basic components of the NAM provide a directory of resources, subject searchable; a common method for accessing and searching diverse databases; tools for downloading and post-processing data; and tools for communicating with a network of experts and colleagues. The NAM is still in its infancy, but it has the potential for extraordinary growth.

Strategies for Cooperation

There are two strategies that can be implemented quickly to improve the availability of information to the Global Change communities.

One strategy is to build gateway connections between the existing databases of our North/South partners. This will increase the availability of the existing databases, and create a base for establishing and promoting a global scientific and technical information network (STINET).

The second strategy would build upon the first, as a next step in this international cooperative effort. This strategy is to organize and establish an advisory group of representatives. The first action this advisory group might undertake would be the development of a comprehensive list of issues to be addressed,

such as how can current existing exchange relationships form the basis for more cooperative international efforts. Other tasking for this group could include:

- Determining the types of agreements and relationships that will encourage involvement.

- Determining whether a formal group should be established to set policy and establish procedures for the sharing of existing international databases.

- Determining how to make the bibliographic database more comprehensive and timely, by identifying how information producers can be motivated to provide input, and how coverage of those parts of the world not participating in the effort might be accomplished.

- Addressing the issue of database availability. Who would be eligible for access, what should the pricing strategies be, and what is an appropriate network architecture?

- Identifying what strategies will be necessary to go beyond bibliographic cooperation into sharing of other kinds of data and information, including improvements in systems and technology for delivery and management of information, by determining how to reconcile the need on the part of participants in the international cooperative effort national for proprietary information.

- Providing oversight of a global STINET. This would require intellectual maintenance, in addition to the maintenance requirements associated with hardware and software. Some of the challenges for the advisory group would involve tracking changes instituted at remote resources to initiate appropriate modifications to preclude disruption of network harmony. Maintenance would also involve adding new resources to the network, and an appropriate task for the advisory group would be to determine what resources should be added to the network and in what priority order. Most importantly, the advisory group would be called upon to attest to the validity and reliability of data sources, ensuring that resources are credible.

- Developing policies concerning how nationally generated information will be controlled and validated. The use of incorrect information for decision making and planning could prove disastrous to an individual or to an organization.

- Examining strategies for an automatic translation
  facility. This would be useful in cases where
  pertinent information is stored in a language that is
  not native to the user. Automatic translation could
  make the information rapidly available in a useful
  format, and help eliminate the language barrier among
  users on the network. It could be used in conjunction
  with the "people bases."

- Addressing when to distribute resources on optical
  media for local use rather than making the resources
  available through telecommunications. Optical and
  video technology introduce us to the era of hypermedia,
  where conventional definitions of information systems
  and the data they contain must be redefined.

The challenge of building a global scientific and technical
information network will stretch far into the future. Network
services will be added and deleted based on changes in technology
and user requirements. The unchanging factor in successful
development of the global network will be the partnership among
end users, information specialists, and network developers. As
long as this cooperative relationship continues, the STINET will
continue to grow and expand.

Conclusion

The closing statement from a speech by the Prime Minister of
Norway, Gao Harlem Bruntland, as contained in the report on the
United States Global Change Research Program serves well to
conclude this paper.

> *In closing, let me stress the need for all of us to
> view environmental problems in interdisciplinary terms,
> not with the narrow terms of specialization. The world
> is replete with projects that made excellent
> engineering sense but were economically catastrophic.
> The global environment cannot be separated from
> political, economic, and moral issues. Environmental
> concerns must permeate all decisions, from consumer
> choices through national budgets to international
> agreements. We must learn to accept the fact that
> environmental considerations are part of a unified
> management of our planet. This is our ethical
> challenge, our practical challenge, a challenge we all
> must take. (6)*

Let us, as information specialists, take this as our
challenge, and provide the support and services necessary to meet
the global change issues.

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On a daily basis we become more aware that out planet, earth, exists in a delicate balance; we, its inhabitants, must be informed caretakers. Global change communities have emerged around the globe to address this multidisciplinary subject. Information systems that integrate text, bibliographic, numeric and visual data are needed to support these global change communities. No one information center can hope to collect all the relevant data. Rather, we must form a coalition, North and South, to collect and provide access to disparate, multidisciplinary sources of information, and to develop standardized tools for documenting and manipulating this data and information. International resources need to be mobilized in a coordinated manner to move us towards this goal. This paper looks at emerging information technologies that can be utilized to build such a system, and outlines some cooperative North/South strategies.

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