DOCUMENT RESUME

ED 339 351 IR 015 297

AUTHOR	Carroll, Bonnie C.; And Others
TITLE	Data Policy and Availability Supporting Global Change Research, Development, and Decision-Making: An Information Perspective.
INSTITUTION	National Aeronautics and Space Administration, Washington, DC. Scientific and Technical Information Branch.
REPORT NO	NASA-TM-105137
PUB DATE	Oct 90
NOTE	17p.
AVAILABLE FROM	National Technical Information Service, Springfield, VA 22161.
PUB TYPE	Information Analyses (070) -- Viewpoints (Opinion/Position Papers, Essays, etc.) (120)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Access to Information; *Computer Networks; *Databases; Decision Making; Global Approach; Higher Education; *Information Management; Information Networks; *Information Retrieval; Information Systems; *Online Systems; Policy Formation; Research and Development; Scientific and Technical Information
IDENTIFIERS	Information Policy

ABSTRACT

An explosion of information has created a crisis for today's information age. How to use the best information resources, tools, and technology must be determined. To do this, leadership must exist at the interagency level to promote a coherent information policy. It is also important to find ways to educate users of information regarding the tools available to them. Advances in technology have resulted in efforts to shift from disciplinary and mission-oriented systems to decision support systems and personalized information systems. One such effort is being made by the Interagency Working Group on Data Management for Global Change (IAWGDMGC). Five federal agencies--the Department of Commerce (DOC), Department of Energy (DOE), National Aeronautics and Space Administration (NASA), National Library of Medicine (NLM), and Department of Defense (DOD)--have an on-going cooperative information management group, CENDI (Commerce, Energy, NASA, NLM, and Defense Information), which is meeting the challenge of coordinating and integrating their information management systems. Although it is beginning to be technically feasible to have a system with text, bibliographic, and numeric data online for the user to manipulate at the user's own workstation, it will require national recognition that the resource investment in such a system is worthwhile to promote its full development. It also requires close cooperation between the producers and users of the information--that is, the research and policy community, and the information community. National resources need to be mobilized in a coordinated manner to move the nation into the next generation of information support systems. (9 references) (Author/DB)

NASA TM-105137
OCTOBER 1990

Data Policy and Availability Supporting Global Change Research, Development, and Decision-Making: An Information Perspective

♦ ♦ ♦

BONNIE C. CARROLL

ROBERT F. JACK

GLADYS A. COTTER

NASA TM-105137
OCTOBER 1990

Data Policy and Availability Supporting Global Change Research, Development, and Decision-Making: An Information Perspective

♦ ♦ ♦

BONNIE C. CARROLL
Commerce, Energy, NASA, NLM, Defense Information (CENDI)
Oak Ridge, Tennessee, U.S.A.

ROBERT F. JACK
NASA Center for AeroSpace Information
BWI Airport, Maryland, U.S.A.

GLADYS A. COTTER
NASA Scientific and Technical Information Program
Washington, DC, U.S.A.

INTRODUCTION

We live in an information age, in a world overloaded with data. Over the past decades, we have witnessed significant technological enhancements that have provided us the ability to store, manipulate, and retrieve information in ever-increasing quantities. Ironically, information overload—not information scarcity—is a precipitating factor creating a crisis for today's information age. The challenge is not in obtaining enough information, but rather in obtaining the right information, both in terms of comprehensiveness and specificity, in a timely manner. The following statistics help to focus the magnitude of the problem:

- Studies show that, on average, scientists spend more time handling research results than conducting new research. For example, a study of aerospace scientists and engineers found that 35 percent of the work week was spent in communicating technical information to others and about 31 percent working with technical information received from others. This finding is not surprising when one considers that more than 90,000 new technical publications are published each year that report on the results of aerospace research and development[1];
- There are over 100,000 gigabytes of federally managed earth sciences data alone and this volume is projected to increase by two orders of magnitude during the next 5 to 10 years[2]; and
- Information doubling time is 17 years. This means that when scientists and engineers graduate from college, they are exposed to only about one-sixth of the knowledge base that is created throughout their careers.

As a result, individuals must be information literate to make well-informed decisions or to solve problems effectively. They must know how to keep up with new developments. Today, this means knowing not only the field itself, but also how to use the best available information resources, tools, and technology.

This paper endeavors to provide the following:

- a background for issues of information literacy and information policy and how they relate to the specific problem addressed by the Earth Observations and Global Change Decision-Making Conference;
- critical input to the issues of data policy and availability;
- additional context in which to address problems of the "vast quantities of information (that) must be managed, safeguarded, standardized and made available..."[3]; and
- a basis upon which thinking about policy and implementation efforts can be built.

FOUR ERAS OF INFORMATION SYSTEMS

A 1978 report of the National Science Foundation (NSF), "Crossing the Threshold Into the Information Age," defined the following three eras of information systems:

Era I: *Disciplinary Systems*, where the focus was on such disciplines as chemistry, physics, and medicine. These systems were driven mainly by technical and scientific societies such as the American Chemical Society and the American Institute of Physics.

Era II: *Mission-Oriented Systems*, where the focus turned to national mission areas, paralleling those of federal agencies. This post-World War II era saw rapid development of energy and space information systems.

Era III: *Decision Support Systems*, where the need was cross-disciplinary and cross-missionary. It also saw the need to integrate scientific and technical societal information (STSI). This emphasis saw the development of systems for studying pollution and the environment. Today, the need for systems supporting global change fall into this category.[4]

One thesis of the NSF report was that there needed to be a transition from information systems to decision-support systems. The needs of our age were seen as crisis management and rapid decision-making. The driving forces were both technological push and user pull. We needed to move from passive to active systems to extend intellectual power through capitalization of the knowledge worker, just as agriculture was enhanced by mechanization and capitalization. Even though we have not fully realized the opportunities of Era III, we are already looking at an Era IV, dubbed the Era of ''*Personalized Information Systems*'' by Dr. Bearman (Dean of the University of Pittsburgh School of Information Science and Telecommunications).[5]

Era IV is highly technology-driven and has gained force with the proliferation of personal computers (PCs) and minicomputer workstations. One reason we stand between Eras III and IV is that through the late 1970s and until very recently, we have not had a focus for national leadership in scientific and technical information (STI) as we had with the NSF STI Program and mission funding during the 1960s and 1970s.

Until recently, the major national focus of attention in the STI community has been on large bibliographic databases as a means to identify and manage the results of the research investment that has been completed and documented in research publications. However, the technical concerns and policy issues also apply to the data and information formats that has grown because of advances in technology. The global change community focuses on data from earth observation satellites and other sources.

In global change, an engineered solution has been developed to move the traditional discipline and mission systems into decision support systems through the effort of the Interagency Working Group on Data Management for Global Change (IAWGDMGC). Although this is a start, it is a specific solution to a specific current problem area, not a more fundamental solution to moving our multi-billion dollar investment base of STI systems and resources into the next generation of information systems. In fact, the issues initially faced by the IAWGDMGC showed the magnitude of the problem when they found it a major undertaking just to develop an inventory or directory of available resources. Even today, some major sources of information on global change have not been well integrated into this program. The Arctic Data Interactive Compact Disc-Read-Only Memory (CD-ROM) produced in conjunction with the IAWGDMGC is only the most modest beginning in terms of information accessibility, although as a demonstration of an interesting personalized system user interface, it offers an excellent systems concept.

INFORMATION INFRASTRUCTURE

The needs and information-seeking behavior for scientists, engineers, managers, and policy makers are all different. A major body of information science research seeks to understand these differences. For the purpose of this paper, however, it is useful to view the types of infrastructure systems that exist to serve different needs.

Conceptually, systems have been developed to capture information by stage in the research and development (R&D) process. By "stage" we mean the chronological steps from research proposal to documentation and publication of final results of research undertaken. For example, at the front end of the R&D process, research-in-progress systems allow researchers to keep up with the latest directions in the state of the art. At the other end, systems focus on the results of completed R&D, primarily in the form of publications. Finally, other systems attempt to capture information during the process. These systems include information on conference presentations, patents and intellectual property protection, technology transfer information, and directories of experts.

The systems described above are the traditional STI systems that document aggregate, analyzed R&D results. Some data systems can capture raw data, not from controlled scientific experiments but from phenomenological observations. These data systems are an input to R&D, the results of which are then documented in the publications-oriented systems.

Information systems can also be differentiated by the following types:

- text systems that contain the full text of research publications;
- bibliographic systems, which have acted as surrogates and finding tools for the full text in the past when full text was only in printed form;
- factual systems, such as directories, research-in-progress information, or handbook-type information;
- image or graphical systems, such as Landsat data or maps; or
- numeric systems, which can be differentiated according to the type of data they contain;
  - physical experimental data, such as that from a wind funnel or chemical apparatus,
  - survey data,
  - observational data, or
  - calculated data.

Numeric systems can also be differentiated as spatial, time series, or geographic, because each type requires different software and approaches to functional manipulation.

It is important to visualize these differing types of information because their historical evolution has led to barriers (both technological and organizational) to developing Era III and IV information systems that today could best support problem-solving and decision-making on critical national priorities such as global change. In connection with this, the differences need to be understood because each type of system has different technology (computer hardware and software), standards (graphics, text, and so on), and requires different functionality at the user interface. Functionality for a text or bibliographic system means effective search and retrieval. For numerics, it might mean units conversion or mathematical or graphical manipulation.

Overlaying the type of systems, the media of systems have also created infrastructural consideration similar to the transition from copper wire to optical fiber in our telecommunications systems. Early information systems were based on ink on paper. These systems included attention to stages and types of information discussed above. As technology advanced, microforms became a popular medium, particularly for storing large amounts of data. Finally, we have digital systems, including electronic, magnetic, and optical. It is important to remember that digital STI systems have only been around for the past 30 years (only 20 years in widespread use). Online access to STI systems began in the early 1970s with bibliographic databases. It is only in the last 5 years that either full text or numeric STI systems have had any real online accessibility. That is why access and the integration across media is important from a historical resources perspective. It also helps to understand the directions that could be useful in linking across database types.

Attention given to the development of Era I and II STI systems was heavily dominated by what is referred to today as "bibliographic information systems." Historically speaking, this was appropriate because the enabling information technologies were primarily ink on paper and secondary microforms. Even numeric data information systems were contained in the paper envelopes and could be identified, managed, accessed, and controlled by a bibliographic description with the hard copy (that is, full text) backup stored in a library or information center. Handbooks are a classic example of numeric and factual information systems that were part of the classical approach to information management and accessibility. Today, handbook and backup reference data may be fully automated and available online in electronic form. The challenge is how to change traditional bibliographic or documentation methods and technology so as to be able to integrate the new media into the next generation systems.

It is clear that scientists, engineers, and decision-makers do not want to know the hows and whys of information systems. They do not want information about information (which has, in the past, been the limits of electronic bibliographic systems), but rather the right data or information digested and formatted for a specific use. However, these systems are not available yet, and in order to deal with a problem such as global change, there must be an understanding of the current information infrastructure—where it is, and where it can go with the new technologies. The IAWGDMGC has done much to face these problems, but has really only begun to scratch the surface of the opportunities for information support. The many facets of the global change problems call for Era III and IV information systems—they call for a new information architecture. The IAWGDMGC's current tools and resources are heavily dominated by the large numeric database systems. This has been the case because the numeric databases have been developed in closer cooperation with the scientific user. Era I and II systems have been more closely associated with the information intermediary community, including librarians and information scientists.

CENDI: A CASE STUDY

Additional resources could be integrated into the existing IAWGDMGC initiative. These resources would come from mission-oriented information systems that have been developed by federal agencies participating in R&D on global change. Five federal agencies—the Department of Commerce (DOC), Department of Energy (DOE), National Aeronautics and Space Administration (NASA), National Library of Medicine (NLM), and Department of Defense (DOD)—have an on-going cooperative information management group whose mission is to "improve the productivity of Federal research and development through efficient and responsive technical information programs and improved R&D information management systems."[6] This information management group is known as CENDI (Commerce, Energy, NASA, NLM, Defense Information). Each agency has its own STI program that has developed major databases and systems to capture, manage, and make available the results of agency-funded R&D as well as worldwide R&D results of interest to the agency mission. Table 1 below presents the names and sizes of the major bibliographic databases of each agency.

Table 1 *The Major Scientific and Technical Information Databases of the Five Federal Agency Members of CENDI (Commerce, Energy, NASA, NLM, Defense Information).*

FEDERAL AGENCY	DATABASE NAME	RECORDS (MILLIONS)	BEGINNING DATE	ONLINE SEARCH SYSTEMS
Department of Energy (DOE)	Energy Database	2.5	1974	DIALOG
Department of Defense (DOD)	Technical Reports Database	1.5	1953	DROLS
National Aeronautics and Space Administration (NASA)	STI Database	2.4	1962	NASA/RECON
National Library of Medicine (NLM)	Medline Database	6.5	1966	ELHILL and DIALOG
National Technical Information Service (NTIS)	NTIS Bibliographic Database	1.5	1964	DIALOG

The specific purposes and mechanics of STI activities vary from one agency to another, and are beyond the scope of this paper. Generally, each agency produces one or more printed announcement journal describing recently released research publications—technical reports, journal articles, conference papers, and so on, prepared by staff or contractors, or outside literature relevant to the agencies' respective missions. The data used for these announcement publications are derived from machine-readable input that is then also made available for searching online. In many cases, computer databases also contain summaries of ongoing research projects, descriptions of software packages, brief announcements concerning new technologies ready for transfer, patents, and other information. Of particular value are summaries of ongoing research. Usually these are the first indication of new investigative areas.

The resources in the CENDI databases are based on the output of the billions of dollars of R&D investment that have taken the form of publications. Their bibliographic systems play a role in the information architecture to support the national and international global change mission. The evolution of the current infrastructure and future needs of users must be tied together into a policy context for discussion so that this nation can move ahead to the next generation of information systems to better serve R&D and decision-making.

A GLOBAL CHANGE INFORMATION RESOURCE

In dealing with major interdisciplinary and intermission problems such as global change, several obstacles must be overcome so that we can state technical problems in a way that can be answered by existing information solutions. This is not unlike the situation faced by the global change modeler who must determine the variables for the model from among the world of possible variables and approaches.

In an information context, the data resources of the CENDI agencies have documentation from hundreds of millions of dollars of research investment in areas related to global change. These results can be identified and used to advance the state of the knowledge if accessed efficiently. However, how to access this store of information and integrate it with other information sources (such as large numeric databases housed in data centers) in the context of ongoing work effort becomes the challenge. First, the need must be identified. Then, the information must be extracted quickly. Finally, the extracted information must be processed into the specific decision context.

In attempting to find existing information from the knowledge store, the words "global change" may never appear in the relevant information. In fact, only the highest order R&D models or policy thinking focus on global change as a concept. The rest of the thinking and research investment focuses on facets of the problem. Take for example how the multidisciplinary nature of global change research is evidenced by the research interests of many of the speakers at this conference. A rapid search of the NASA STI Database turns up 139 publications from the conference panelists from the last 5 years alone. A review of the publications demonstrates subject interests in such diverse topics as paleoclimatology, geophysics, oceanography, meteorology, glaciology, and other earth and atmospheric sciences; earth observing platforms (Landsat, Seasat, and balloons) and sensors (thematic mappers, multispectral scanners, coastal zone scanners, and infrared imagery) manifestations and phenomena (air pollution, atmospheric chemistry, ozone depletion, and the earth radiation budget); and possible sources of change-inducing conditions (point sources of pollution, industrial plants, and specific types of pollution, including thermal and chemical). A search of some of the technical interest areas of the panelists by subject concepts provides the potentially relevant information as indicated in Table 2 on page 9.

The challenge in making the information system serve the user is the issue of research context or research orientation. The different federal agencies see the problem of global change from their mission context and the agencies' information systems and technical vocabulary reflect these differences. It is also important to note that if one understands the information system structure, this can, in fact, lead to an understanding of the agency mission approach. For example, to the energy researcher, "global change" is less precise as a scientific expression than "greenhouse effect." A quick scan of the DOE database shows 68 publications using the former concept, but almost 2,000 on the latter. This, in part, reflects the agency's interest in fossil fuels and the results of their use. At the same time, the term "greenhouse effect" within the NASA community and its information base can refer to atmospheric conditions on Venus. (This false drop for the concept has been factored out of Table 2.)

The research represented by the body of knowledge referenced in Table 2 can be identified electronically, and short abstracts regarding the nature of the research can be read online. However, the

Table 2 *Selected Topical Coverage of Key Concepts by Number of Found Records in Three CENDI Databases.*

KEY CONCEPTS	NUMBER OF REFERENCES BY DATABASE*		
	DOE	NASA	NTIS
Antarctic Region	1,403	3,307	1,762
Acid Rain	8,531	774	2,137
Air Pollution	69,648	14,981	43,802
Greenhouse Effect	2,258	927	539
Atmospheric Trace Gases	364	430	271
Remote Sensing	6,814	51,296	14,897

* *These numbers are not additive across or down because some of the citations may be duplicated in more than one database.*

full text of the material is not currently available except in printed form and the researcher or the decision-maker must go through a process of manual access to get to the documents. With the advances in computer and communications technology, it would now be feasible to have the text online for the user to manipulate at the user's own workstation. In the next decade, this feasibility is likely to become a reality. However, this is dependent on national recognition that the resource investment in such a system is worthwhile. It also requires close cooperation between the producers and users of the information—that is, the research and policy community and the information community.

ROLE OF THE INFORMATION SCIENTIST

The previous discussion of the complexity of turning technical concepts into a controlled vocabulary for searching large information databases and then making systems to get from citations to the full documents are keys to effective access to the existing knowledge base for research and decision-making. Today, it is critical in understanding how to effectively search bibliographic and text files, particularly those that are large and complex. It is these that tend to be comprehensive and most valuable over time. As large, complex directories and directory networks of information sources develop, approaches to searching them to identify appropriate database resources will face similar problems to those addressed by the bibliographic community over the years. These will include the National Space Sciences Data Center (NSSDC) and the IAWGDMGC directories and others that are being developed and grow with the evolution of network services as part of the National Research and Education Network (NREN) initiatives.

The problem is something that researchers and decision-makers do not generally think in terms of, but information scientists spend considerable effort in addressing. This is why the "information specialists" are a valuable component of the research staff team. It is true that researchers in information engineering are attempting to use systems based on artificial intelligence (AI) techniques to help navigate through concept and terminology and automate some of the expertise now provided by information specialists, but these systems are still in the development stages. Similarly, all of the agency information programs are looking at developing full-text electronic systems. Until these systems are funded, developed, and implemented, the user will need assistance in effectively navigating through the information infrastructure.

NEW DIRECTIONS FOR STI COUPLING

The program management of the traditional bibliographic or publications-oriented systems have also been very active in developing information systems that help identify currently funded research or research in progress. NASA, DOE, and DOD all have systems that provide information on agency funded R&D projects. NASA and DOE information is sent to the NTIS and combined with that of nine other agencies—including the NSF, the Department of Transportation (DOT), the Department of Agriculture (DOA), and the United States Geological Survey (USGS)—to create a federal research-in-progress (FEDRIP) database. Today, the FEDRIP database contains more than 127,000 descriptions of ongoing federally funded R&D projects. A quick search of the FEDRIP database for the same technical concepts as searched in Table 2 provides project descriptions of potential interest to global change research as shown in Table 3 at right.

Table 3 *Selected Topical Coverage of Ongoing Federally Funded Research and Development Projects by Number of Found Records in the Federal Research-in-Progress (FEDRIP) Database.*

KEY CONCEPTS	NO. OF REFERENCES*
Antarctic Region	304
Acid Rain	222
Air Pollution	782
Greenhouse Effect	52
Atmospheric Trace Gases	48
Remote Sensing	588

* *These numbers are not additive across or down because some of the citations may be duplicated in more than one database.*

Some of these databases include citations to publications from the ongoing research so many linkages can be made—from determining who is doing what to what results have been achieved. Again, the full text of publications documenting these results is usually not in electronic form and is almost never online. Thus the infrastructure at this point shifts from electronic online to manual acquisition of a printed document and the assistance of information specialists.

LINKING NUMERICS, TEXT, AND BIBLIOGRAPHIES INTO NEXT-GENERATION ARCHITECTURE

In addition to the linkages among text, bibliographies, and research in progress, researchers also need to work with numeric and image databases for data input to their projects. In global change and the theme of the conference, which highlights earth observation, the need for access to large numeric data stores is particularly important. As was quickly discovered by the IAWGDMGC, the first task in accessing required data is to know what is available. This leads to the creation of a data resource directory. Once directories are created and data sources identified, the next task is to obtain access.

The trend in information infrastructure, largely enabled and spurred forward by advances in high-speed communications technologies and networking, is to provide online directories and then connections via gateways to data resources. To the extent that the databases are online, the user can be delivered to the database door. Current practice requires the user to know how to navigate through each system once the door is opened. The NASA Master Directory with its associated networks, coordinated through the NSSDC, is a leader in developing new infrastructures for information access. The IAWGDMGC has capitalized on this model. In addition, many of the CENDI agencies also have been following the directory-to-gateway approach for integrating different data sources and making accessibility to the right information easier to the user.

In addition to their own databases, CENDI agencies have all embarked on creating major directories of external databases of interest to their technical and policy communities. For example, NASA has followed the NSSDC master directory model and is developing Aeronet, which will be a directory of aerospace science and technology data resources. DOE has a master directory that contains descriptions of more than 600 databases of interest to DOE missions. All of these agencies are also looking at the next step—providing gateway services through their existing online systems to allow users to find the database of interest and then to link automatically into that database. Figure 1 at right is a schematic of the directions that new information architectures have taken in terms of types and media of information and search mechanisms that are evolving to support more state-of-the-art technology access. Due not only to technical limitations but also to administrative, policy, and economic considerations, progress in this area has been deliberate, but measured. DOD has been aggressively pursuing developments in its Gateway System, which now provides direct links to almost 900 bibliographic, numeric, and full-text databases and which allows the user to reformat (post-process) retrieved information.[7]

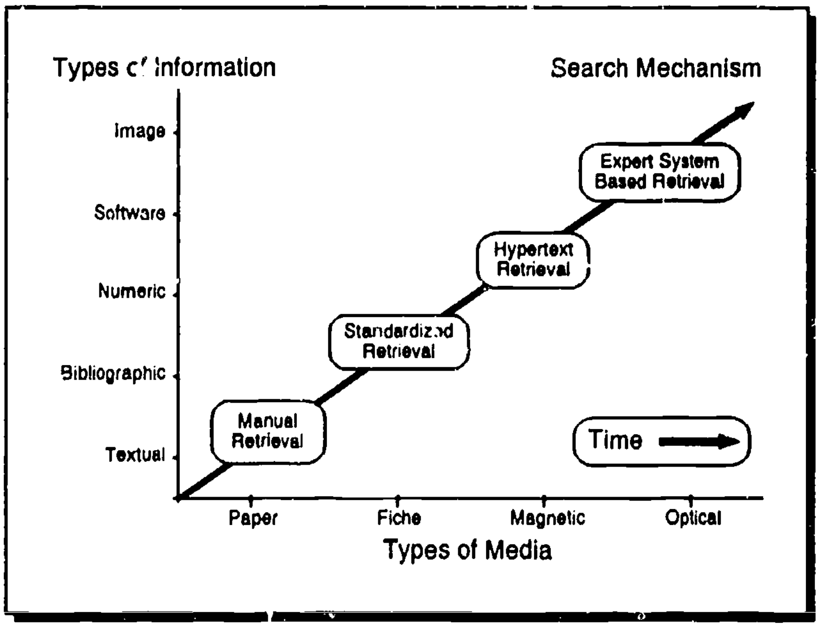

Figure 1 *Search Mechanisms that are used with Various Types of Information on Various Media over Time.*

The additional steps that are in the forefront of developments in these areas have to do with solving the problems of different and generally incompatible interface systems, command structures, and functional capabilities among the different databases as well as capabilities to make the full text available online. Interdatabase work is being done through standards activities as well as through using AI and front-end systems development. Full text is being developed using both fully searchable and bit-mapped approaches as well as a combination of the two. All agencies are working on such areas. Coordination of all the efforts on these common problems could help to move the solutions forward more quickly.

POLICY ISSUES

A number of policy issues are derived from the current status of our STI information infrastructure (and global change as a specific subset) and the recognized direction in which we must go. Four such issues are stated below.

1. Because today's problems are across disciplines and missions, we need to have leadership at the interagency level. The IAWGDMGC, under the guidance of the Office of Science and Technology Policy (OSTP) Committee on Earth and Environmental Sciences, has achieved much, but we still need to make additional linkages. Furthermore, this is a specific case study in the broader picture of moving a national information architecture from Era I and II systems to Era III and IV systems. Approximately $3 billion dollars are spent annually on STI systems in the federal government. Leadership in the broader context would help to provide tools for the specific problem of global change.

2. Because of the historical evolution of our information infrastructure, STI management, R&D management, and policy management have not been as closely coupled as they should be given the integral part that information plays in the R&D and decision process. This decoupling has been a particular problem over the last 15 years, during a time that enabling information technologies have revolutionized the ways that information can be handled. It is important to find ways to educate the users of information regarding the tools available to them. Similarly, it is incumbent upon the information community to help build tools that are more compatible with the needs of these information users. Closer cooperation and recognition of the interrelationship should open better channels of communication.

3. Related to this is the problem of information literacy in the U.S. Our graduating scientists and engineers are not given the tools to optimize their productivity. Because technology is changing so rapidly, much of the current information is no longer in textbooks, but rather in more current sources such as journals, technical reports, and databases. Yet, learning about these tools is not part of the educational curricula.

4. Information is a national resource, a public good, and an international commodity. The information industry has grown tremendously in recent years with the development of new information technologies. For the past 40 years under Era I and II systems, the U.S. has had a leadership role. In today's environment, competition from abroad is intense. How can we assure that the U.S. focuses on the importance of moving to the next generation systems to protect U.S. knowledge while keeping cooperation in areas of international concern, such as global change, opened? Has the dual nature of information as a public good and an international commodity created difficulties for global change research and decision making?

In the past 30 years, more than 50 studies and reports have been produced concerning STI systems. In the last 2 years, two extensive studies have brought forth a number of policy issues. One, entitled "Helping America Compete: The Role of Federal Scientific & Technical Information,"[2] was done by the Office of Technology Assessment based on a Congressional request. The other was a study carried out by the National Academy of Sciences, entitled "Information Technology and the Conduct of Research: A User's View."[8] Both of these studies concluded that a need exists for national leadership on an interagency basis in the field of scientific and technical information. In addition, both reports deal with the issue of information literacy—that is, the ability of scientists and engineers to use the information infrastructure effectively.

Global change is one of today's major national concerns. If one looks at the current information infrastructure and the specific steps that the community must take in order to move from traditional Era I and II systems to Era III and IV systems to help deal with this national priority, one can begin to understand how a coordinated national focus on creating a better information infrastructure can help anticipate and deal with national priorities.

CONCLUSION

The U.S. government alone spends billions of dollars annually on STI systems. It has been estimated that about 4 percent of every research dollar is spent on information organizations supporting R&D. In the interagency global change environment, planning for information activities accounts for well above that percentage. In fact, it was estimated that 20 percent of the billion-dollar budget plan for global change deals with data and information management.[9] The global change community has become a leader in bringing effective information support to bear on the technical and policy problems. However, the work to date is only a start in making information the productive tool that it can be to the processes of research and decision-making. It is most important to ensure that all national resources are mobilized in a coordinated manner to move us into the next generation of information support systems.

REFERENCES

[1] "Technical Communications in Aeronautics: Results of an Exploratory Study," T. E. Pinelli, M. Glassman, W. E. Oliu, and R. O. Barclay, NASA Technical Memorandum 101534, Part 1, NASA Langley Research Center, Hampton, VA, February, 1989.

[2] *Helping American Compete: The Role of Federal Scientific & Technical Information.* Government Printing Office, Washington, DC, OTA-CIT-454, July 1990.

[3] "Earth Observations & Global Change Decision Making: A National Partnership." Fall Conference, October 1990. Program announcement and call for papers. Environmental Research Institute of Michigan.

[4] *Passing the Threshold into the Information Age: Perspective for Federal Action on Information Volume II, Research Report.* Prepared for the National Science Foundation, Arthur D. Little, Inc. Cambridge, Mass. January 1978.

[5] Bearman, Toni Carbo, Executive Director, National commission on Libraries and Information Science. "Is the Past Really a Prologue? One Perspective on Scientific and Technical Information and Public Policies." Presented to the Chemical Abstracts Service 75th Anniversary on 14 September 1982.

[6] "Improving Productivity of Federal Research and Development Through Cooperative CENDI Programs." Memorandum of Understanding No. 599-50085, dated by signatures July 1984 through October 1986 and amended February 1987.

[7] *DGIS Workbook.* BBN Laboratories, Inc. Arlington, VA. BBN Report No. 6533. May 1987.

[8] *Information Technology and the Conduct of Research: A User's View.* Report on the panel on Information Technology and the Conduct of Research. National Academy Press, Washington, D.C. 1989.

[9] "Arctic Data Interactive." Presentation by Douglas Posson to the 13 October 1990 CENDI meeting, Crystal City, VA.

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TM-105137		

4. Title and Subtitle	5. Report Date
Data Policy and Availability Supporting Global Change Research, Development, and Decision-Making: An Information Perspective	October 1990
	6. Performing Organization Code: NTT
7. Author(s): Bonnie C. Carroll, Robert F. Jack, Gladys A. Cotter	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address: NASA Scientific and Technical Information Program	11. Contract or Grant No.
	13. Type of Report and Period Covered: Technical Memorandum
12. Sponsoring Agency Name and Address: National Aeronautics and Space Administration, Washington, DC 20546	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

An explosion of information has created a crisis for today's information age. We must determine how to use the best available information resources, tools, and technology. To do this, we need to have leadership at the interagency level to promote a coherent information policy. It is also important to find ways to educate the users of information regarding the tools available to them. Advances in technology have resulted in efforts to shift from Disciplinary and Mission-oriented Systems to Decision Support Systems and Personalized Information Systems. One such effort is being made by the Interagency Working Group on Data Management for Global Change (IAWGDMGC). Five Federal agencies—the Department of Commerce (DOC), Department of Energy (DOE), National Aeronautics and Space Administration (NASA), National Library of Medicine (NLM), and Department of Defense (DOD)—have an on-going cooperative information management group, CENDI (Commerce, Energy, NASA, NLM, and Defense Information), that is meeting the challenge of coordinating and integrating their information management systems. Although it is beginning to be technically feasible to have a system with text, bibliographic, and numeric data online for the user to manipulate at the user's own workstation, it will require national recognition that the resource investment in such a system is worthwhile, in order to promote its full development. It also requires close cooperation between the producers and users of the information—that is, the research and policy community, and the information community. National resources need to be mobilized in a coordinated manner to move us into the next generation of information support systems.

17. Key Words (Suggested by Author(s))		18. Distribution Statement
Databases	Information Retrieval	Unclassified - Unlimited
Decision Making	Online Systems	Subject Category - 43
Global Warming	Policies	
Greenhouse Effect		
Information Management		

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price *
Unclassified	Unclassified	16	A03/HC

*For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA-Langley, 1991

National Aeronautics and Space Administration
Code NTT-4

Washington, D.C.
20546-0001

NASA