

Access to Environmental Data: Summary of an Inter-American Workshop

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Index

1. Introduction	3
2. Initiatives and Issues Related to Environmental Data Access	5
2.1. Global Initiatives	5
2.2. Regional Initiatives	6
2.3. Scientific and Technical Issues	6
2.4. World Summit on the Information Society	8
2.5. Policy and Institutional Issues	8
2.6. New Initiatives	9
3. Plenary Discussions.....	9
3.1. Scientific and Technical Issues	9
3.2. Policy and Institutional Issues	11
3.2.1. Institutional Barriers and Potential Solutions	11
3.2.2. Economic Barriers and Potential Solutions.....	12
3.2.3. Legal Barriers and Potential Solutions.....	13
3.3. Collaborating for the Future to Improve Access to and Use of Environmental Data ..	13
3.3.1. Regional Collaboration Issues	14
3.3.2. Interdisciplinary Collaboration and Application Issues.....	15
3.3.3. Improving Policy Decision Making with Environmental Data	16
4. Workshop Recommendations.....	18
Appendix A: Workshop Participants.....	19
Appendix B: Workshop Program.....	22
Appendix C: Environmental Data Initiatives and Applications: Poster Presentations and Technical Demonstrations	27

1. Introduction

Rapidly changing technological capabilities for creating, manipulating, disseminating, and using digital scientific and technical (S&T) data are producing many new opportunities and challenges at both the national and international levels. The opportunities arise primarily in data-intensive research and applications, in the integration of heterogeneous data for new results, and in making vast amounts of factual information available for a broad spectrum of users. The inherent challenges are in effectively managing these data resources for optimal access and use, and for developing rational rules and structures for that process.

At a time when S&T data and information have never been more important to the progress of science, CODATA, an interdisciplinary committee of the International Council for Science (ICSU), has worked to improve the effectiveness and impact of such activities. CODATA is concerned with all types of quantitative data resulting from experimental measurements or observations in the natural and social sciences and in the engineering disciplines. Particular emphasis is given to data management problems common to different scientific disciplines and to data used outside the field in which they were generated. The general objectives are the improvement of the quality and accessibility of data, as well as the methods by which data are acquired, managed and analyzed; the facilitation of international cooperation among those collecting, organizing and using data; and the promotion of an increased awareness in the scientific and technical community of the importance of these activities.¹

CODATA has initiated a series of bilateral and multilateral symposia and workshops that are focused on advancing these objectives by providing a forum for scientists and data managers to strengthen existing research cooperation and to initiate new collaborative activities, especially in developing countries. As part of this ongoing series of meetings, CODATA proposed the first Inter-American Workshop on Access to Environmental Data to address S&T data issues and activities of mutual benefit to scientists and data managers in the Americas.

The promotion of scientific cooperation and partnerships between researchers in North and South America is an important objective in generating new knowledge, helping to protect the regional environment, promoting sustainable economic development, and generally raising the quality of life. Improved cooperation in and coordination of scientific data activities in research areas of mutual interest will enhance the value, effectiveness and results of environmental research programs. In many cases, the issues and activities associated with data management and policy in the context of data-intensive research programs are not given adequate attention, which can lead to constraints or disruptions in cooperative research and reduce research efficiency and output. Scientists in many Latin American countries already have significant capabilities and data resources that would be of benefit to North American researchers through increased collaboration. Latin American researchers similarly would be afforded new or enhanced capacity-building opportunities and greater exposure to North American data management principles and know-how of direct relevance to their activities. The primary focus of the workshop, therefore, was on access to environmental data, which is a topic not adequately addressed from a scientific and technical data management and data policy perspective.

¹ Additional information about CODATA and its activities may be found at <http://www.codata.org>.

Environmental Science Data

Efforts to improve understanding of environmental variability and change, and their implications for human welfare and decision making, depend critically on the quality, accessibility, and usability of a range of environmental and related social science data. Latin America, along with many other regions of the world, faces pressing environmental problems and loss of biodiversity associated with urbanization, industrialization, agriculture, resource use, and other human activities. Such problems cut across national borders, scientific disciplines, and observing systems. A key scientific and technical challenge, therefore, is to improve access to existing and emerging sources of environmental, biological, and socioeconomic data and to develop better ways to integrate these data in support of a variety of disciplinary and interdisciplinary research and application efforts, and related policy making initiatives. Effective management of environmental and biodiversity data is an essential prerequisite for the goals of conserving biodiversity, enhancing knowledge of how to use natural resources on a sustainable basis over the long term, and promoting economic growth with social equity.

In collaboration with the Brazilian Reference Center on Environmental Information (CRIA), the Brazilian Academy of Science, and the U.S. National Academies, CODATA convened the Inter-American Workshop on Access to Environmental Data to provide a unique opportunity for bringing together regional scientists, data managers, and representatives of research institutions and the policy community to identify and discuss:

- Scientific, technical, and institutional aspects of data access practices and policies in the environmental sciences, biodiversity studies and related sustainable development research;
- High-priority opportunities and barriers for data access in these research areas; and
- Specific actions that can be taken to improve institutional and national policies, and regional cooperation, with regard to data access.

The workshop also provided a significant opportunity for key individuals and institutions involved in data management and the development of data systems in the environmental sciences, biodiversity and related sustainable development research in the United States and Latin America to help foster the identification of common needs and opportunities for collaboration. It brought together more than 70 selected researchers, data managers, and representatives from 48 institutions in 14 countries to address future directions in biodiversity and environmental data and information system development in the region.

The workshop, which was held on 4-6 March 2004 in Campinas, São Paulo, Brazil, was sponsored by Brazilian Academy of Sciences, Fundação de Amparo à Pesquisa do Estado de São Paulo, the International Council for Science, and the U.S. National Science Foundation.² An ad hoc planning committee consisting of U.S., Latin American, and international CODATA scientists and data experts was formed to review the objectives of the workshop, establish a program for the meeting, and identify expert invitees. The primary workshop organizers were Kathleen Cass, CODATA; Vanderlei Perez Canhos, CRIA; Reynaldo Morales, Los Alamos National Laboratory; and Paul Uhlir and Julie Esanu, U.S. National Academies.

² Additional information about the workshop, including the workshop program and speakers' presentations, can be found at <http://www.cria.org.br/eventos/iaed/>.

2. Initiatives and Issues Related to Environmental Data Access

The first part of the workshop program provided background information about the status of existing initiatives and related issues to help prepare the participants for the breakout discussions that followed (see Appendix B for the workshop program). The first two sessions focused on global and regional initiatives, followed by sessions exploring the scientific and technical and policy and institutional issues related to the access of environmental data. Participants also received overviews of the World Summit on the Information Society, CODATA, and the Global Earth Observation System of Systems, a new international, intergovernmental initiative. The workshop additionally included 19 poster presentations and technical demonstrations that highlighted environmental data access initiatives and applications (see Appendix C for a complete list of presenters in this session).

2.1. Global Initiatives

There are many initiatives and programs currently under way in the areas of environmental sciences, biodiversity, and related sustainable development research that span from the global to local levels and that are particularly active in the region. Many of the specialized programs of the United Nations focus on these areas, including the U.N. Development Programme the U.N. Environment Programme (UNEP), the World Meteorological Organization (WMO), the Food and Agriculture Organization (FAO), the U.N. Educational, Scientific, and Cultural Organization (UNESCO) and the U.N. Geographic Information Working Group.

In addition to the relevant earth and environmental science scientific unions of the International Council for Science, there are several interdisciplinary committees that specifically address these issues. These include the International Geosphere-Biosphere Programme (IGBP), the Scientific Committee on Problems of the Environment (SCOPE), the Global Change System for Analysis, Research and Training (START) and the Panel on World Data Centres. ICSU also partners with various UN agencies, such as FAO, UNEP, WMO, and UNESCO, to develop joint initiatives such as Diversitas—an integrated program of biodiversity science, the International Human Dimensions Programme on Global Environmental Change, and the Global Climate Observing System, for example.

Other relevant international initiatives include the Intergovernmental Panel on Climate Change, the Global Biodiversity Information Facility, the Global Environmental Facility, the Global Spatial Data Infrastructure, the World Conservation Union, the World Resources Institute, and the Consultative Group for International Agricultural Research.

Three global initiatives were presented at the workshop:

- The Global Biodiversity Information Facility (GBIF – www.gbif.org) is an open-ended organization of countries and international organizations devoted to making primary biodiversity data freely and openly available over the Internet.
- The Global Spatial Data Infrastructure (GSDI - www.gsdi.org/) is a global and open process for coordination, awareness, and adoption of globally compatible policies and technologies for the organization, management and use of geospatial information and services, focusing on the relation between information availability, economic growth, and sustainable development.
- The International Research Institute for Climate Prediction (IRI - iri.columbia.edu/), has as its mission the enhancement of society's capability to understand, anticipate, and manage the impacts of seasonal climate fluctuations, in order to improve human welfare and the environment, especially in developing countries.

There is a clear need to establish interoperable links to initiatives that will organize geospatial data, such as the GSDI, and climate monitoring and predicting systems, such as the IRI.

2.2. Regional Initiatives

On the regional level, there are many active organizations and programs that support the environmental and related sciences, including the Organization of American States, the Inter-American Development Bank, the Inter-American Institute for Global Change Research Data and Information System, the Inter-American Geospatial Data Network, the Permanent Committee on Spatial Data Infrastructure for the Americas, the Inter-American Biodiversity Information Network, the North American Biodiversity Information Network, and the Mesoamerican Information System About Biodiversity.

Three regional initiatives were presented at the workshop.

- The Inter-American Biodiversity Information Network (IABIN – www.iabin.net) is an Internet-based forum for technical and scientific cooperation that seeks to promote greater coordination among Western Hemisphere countries in the collection, sharing, and use of biodiversity information relevant to decision-making and education.
- The Permanent Committee on Spatial Data Infrastructure for the Americas (PC-IDEA – www.cpidea.org.co/in/english.htm) aims at maximizing economic, social and environmental benefits derived from the use of geospatial information by establishing a geospatial data infrastructure in the Americas.
- The Inter-American Institute for Global Change Research Data and Information System (IAI – www.iai.int) is an Internet-based distributed database system with the main objectives of disseminating global change research information produced by the IAI and other affiliated institutions, and contributing to the standardization and exchange of scientific data between different institutions.

These complementary activities are concerned about the necessary infrastructure for conservation and sustainable development research in the areas of biodiversity, spatial, and climate data. IABIN will contribute to the development of GBIF and the Clearinghouse Mechanism of the Convention on Biological Diversity. PC-IDEA may offer the necessary map base, while IAI may improve the standardization and exchange of climate data.

2.3. Scientific and Technical Issues

Five researchers discussed scientific and technical issues. Panel members included Gilberto Câmara, Director of Earth Observations, INPE, Brazil; A. Townsend Peterson, University of Kansas, U.S.; Carlos Nobre, LBA Science Steering Group, Brazil. and Merylyn Gentry, Systems Development Institute, University of Tennessee, U.S.; William Ulate, INBio, Costa Rica; and Eric van Praag, U.S. Geological Survey, EROS Data Center, Venezuela. Each panelist gave a brief initial presentation identifying key scientific and technical issues, including, but not limited to, the following areas:

1. Technical interoperability of environmental data across software and hardware systems;
2. Semantic interoperability of environmental data across disciplines and languages;
3. Facilitating interdisciplinary and international access to environmental data resources;
4. Scientific and technical requirements for long-term preservation and accessibility of environmental data; and
5. Other issues, including those identified at the World Summit on Sustainable Development and World Summit on the Information Society.

Gilberto Câmara emphasized the need to address technical aspects concerning interoperability of environmental data across software and hardware systems. He stressed

the importance of having open access to data by sharing data formats and by developing open source tools for data conversion, visualization, analysis and Web publication.

Townsend Peterson showed some examples of predictive modeling of biodiversity phenomena. He stressed the need to work on species occurrence data—for which tools for integration are already in place (DiGIR) but that still require computerization of the holdings of scientific collections—and environmental data, where there is a need to identify key resources, prototype their use and potential, and enable access. He emphasized the need for open access to data and the development of tools for automated dataset preparation.

Carlos Nobre and Marilyn Gentry presented the Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA). All data will be made available to the public. A metadata search and data retrieval system was developed and is known as "beija-flor," which presents an Internet-based approach for sharing scientific data. Both countries have committed long-term support for the archival and distribution of the LBA data collection. The presenters indicated that the "human factor" is affecting the availability of data. That is, scientists want to hold on to their data and there are few incentives for scientists to publish data online.

William Ulate from INBio presented relevant aspects concerning digitization, access and interoperability, electronic catalogues of names, and outreach and capacity building. Among the biodiversity information challenges, he indicated the "human factor" in data sharing, ICT capacity, standards and quality.

Eric van Praag of the U.S. Geological Survey's EROS Data Center presented some lessons learned in integrating spatial information, such as:

- A basic layer of digital, seamless, open-access core spatial data sets must be developed for each country. New data sets are built on top of these basic data sets.
- Open GIS standards facilitate data integration and interoperability.
- Major problems remain in environmental spatial data integration capabilities.
- Environmental data management efforts need to integrate better with existing national spatial data infrastructures.
- Limited internet bandwidth and technological know-how still act as barriers to better data dissemination in many countries.

Dr. van Praag also made some recommendations for making spatial data more accessible:

- Sponsor the development and strengthening of spatial data catalogs.
- Make senior politicians aware of the benefits of sharing spatial information.
- Have institutions develop clear and open data policies that deal with spatial information.
- Promote the use of OpenGIS standards.
- Facilitate access to new and free spatial data, such as the Shuttle Radar Topographic Mission, ASTER, MODIS, free Landsat databanks (i.e., MACGA).
- Evaluate the potential to use open source solutions.
- Make information available for download through Web portals and GIS Web Services.
- Work on data protection schemes that make data creators feel safe when distributing and/or selling data.
- Build capacity in the use of geospatial technologies.

2.4. World Summit on the Information Society

Paul Uhler, director of the Office of International Scientific and Technical Information Programs at the U.S. National Academies, presented an overview of the December 2003 World Summit on the Information Society (WSIS), focusing on WSIS actions that relate to issues of access to environmental data. He noted two competing trends. On the one hand, there is a trend toward open access (democratization of many governments, the Internet and open digital networks; and emerging information commons). On the other hand, there is a trend toward greater information control (national security and counter-terrorism; information security through digital technology controls; and privatization/commercialization of public data and information, and much stronger intellectual property rights).

Science-related action items from the WSIS Plan of Action³ include scientific information management, policy, and applications; ICT research and applications; and, public-private partnerships focused on developing countries.

The objectives of the WSIS Plan of Action are to: build an inclusive “Information Society;” put the potential of knowledge and ICTs at the service of development; promote the use of information and knowledge for the achievement of internationally agreed development goals, including those contained in the Millennium Declaration; and address new challenges of the Information Society at the national, regional and international levels. The plan recommends actions within a number of sectors, including environment, agriculture, and science, and the adoption of policies promoting greater access to information and knowledge, particularly in the public sector.

Paul Uhler concluded by discussing the role of the U.S. scientific and technical community in supporting the WSIS goals.

2.5. Policy and Institutional Issues

The next session focused on policy and institutional issues and included presentations from Harlan Onsrud, University of Maine, U.S.; Clemente Forero-Pineda, University of Andes and University of Rosario in Bogotá, Colombia; Jorge G. Tezón, International Cooperation, CONICET, Argentina; and Marco Túlio Cabral, Ministry of Foreign Relations, Brazil. Each panelist gave a brief initial presentation on key issues, including, but not limited to, the following:

1. Data access and management policies and laws in different disciplines/countries/institutions/programs;
2. Sustainable funding of environmental data centers/networks/archives;
3. Linking scientific data to environmental policy formation; and
4. Strategies and innovations in data provisioning.

Harlan Onsrud presented a conceptual model for meeting the needs of the government, commercial, scientific, and nonprofit sectors in sharing geographic data. He recommended that technological and legal approaches be redirected towards providing incentives for sharing data by individual researchers and enabling broader institutional and international data sharing. He recommended a peer-to-peer file sharing system that automatically supports open-access licenses, provides user friendly metadata creation, and documents

³ For more information, see the Plan of Action, dated 12 December 2003, WSIS-03/GENEVA/DOC/0005, at http://www.itu.int/dms_pub/itu-s/md/03/wsis/doc/S03-WSIS-DOC-0005!!PDF-E.pdf.

the sources of any newly submitted public commons data set. A prototype of such a system was demonstrated.

Clemente Forero-Pineda discussed access to scientific information in the context of strong intellectual property rights and the public domain. He compared situations where full enforcement of property rights and public-domain institutions were applied to scientific databases, and deducted conditions for the public domain to be feasible. He concluded his presentation stating that not all failures to exchange information can be blamed on the “culture of scientists.” Among other reasons he indicated institutional environments and the lack of incentives to share or publish digital data.

Jorge Tezón discussed the effect that environmental data have on decision making mechanisms. He stressed the fact that scientific environmental knowledge helps, but does not determine, the decision making process. To be useful, environmental knowledge should be available in both “codified” and “de-codified” forms. He concluded his presentation by indicating that it is necessary to build recognition for environmental databases possibly by changing the evaluation system of research and academic institutions.

Marco Túlio Cabral discussed the political and scientific dimension of information and its role in international efforts to address climate change. He stressed the necessity of aiming at scientific accuracy and political legitimacy when addressing inter-governmental issues.

2.6. New Initiatives

This session focused on the Global Earth Observation System of Systems (GEOSS). The idea is to develop a system that: uses ongoing initiatives of modeling/observing earth systems; enables archiving, access, and exchange of information; considers user requirements; envisages socio-economic benefits; and is designed on an international basis and is open for all.

The Earth Observation Summit held in Washington, D.C. in July 2003 affirmed the need for timely, quality, long-term, global information as a basis for sound decision making. An ad hoc Group on Earth Observations (GEO) was established to develop a 10-year strategic plan. Subgroups include architecture, capacity building, data utilization, international cooperation, and user requirements and outreach. The plan is to be completed by the end of 2005.

3. Plenary Discussions

The two plenary discussion sessions focused on scientific and technical issues and policy and institutional issues. They were each followed by a general discussion among panelists and workshop participants, guided by four basic questions:

- What are the challenges and barriers?
- What are the existing resources and realistic opportunities?
- What are some potential projects/collaborations?
- How can the identified new or improved initiatives be implemented?

3.1. Scientific and Technical Issues

The key issues raised and addressed in this discussion included:

- Interoperability (keep it simple)
- Long-term archiving is essential
- Scientific impediment: “culture” of data ownership

- Need for development of mutual trust
- Need to make information relevant to users
- Legal considerations
- Development of metadata/data catalogues to assist data discovery
- Data integration of different data
- Internet bandwidth
- Need for clear and open data policies
- Need for politician awareness and legislation
- Need for open-source solutions
- Human factors in improving data management

The following challenges and barriers were identified:

- Priority setting
- Establishing connections: the human factor
- Legislative restrictions
 - ⇒ Especially related to genetic/commercial value
 - ⇒ Could become barrier to research
 - ⇒ Need agreements between agencies for remote sensing delivery (mirror sites, etc.)
- Data sharing
 - ⇒ Need peer-reviewed on-line journals that allow publication of datasets
 - ⇒ Need review of academic work structure and promotion systems to make digital database publication of greater value
- Georeferencing of data (critical)
 - ⇒ Accuracy is also important
 - ⇒ Essential for linking to environmental/ecological data
- Better linkages between disciplines
 - ⇒ Biological/spatial
 - ⇒ Different agency types (governmental/scientific/funding/decision-makers/ environmental managers)
- Problems with delivery of data “out-of-country” where costs are involved
- Need for better discovery/search tools
- Open-source products of value in archiving
- There are practical issues in some cases for using proprietary products

The following issues related to existing resources and realistic opportunities were raised:

- Opportunity to move away from “Web-services” model (industry-driven initiatives) toward science-driven standards
 - ⇒ Not necessarily incompatible
 - ⇒ Web-services more than maps
 - ⇒ Need for both types of information (raw data and derived data products—i.e., maps)
- Need for user-driven products
 - ⇒ Two-way interaction between provider and user

- Self-perpetuating benefit
⇒ Showing benefits of data distribution encourages others to be more open and cooperative

Some issues raised with regard to the potential projects/collaborations included:

- The need for more regional collaboration
- Improving environmental outcomes with data availability

Finally, the discussion of the identification and implementation of initiatives included the development of:

- A framework for spatial data integration (SDI);
- Pilot projects; and
- Pilot proposals as a direct outgrowth of this workshop.

3.2. Policy and Institutional Issues

- Panellists and participants were encouraged to discuss the same four basic questions used to guide the plenary discussions identified in section 3 above.

3.2.1. Institutional Barriers and Potential Solutions

A. The natural environment does not have national or institutional boundaries, but political and jurisdictional divisions and competition among ministries and nations make data collection, access, and comprehensive study of the environment difficult.

Potential Solutions:

Provide budget incentives at the national level to encourage cooperation (e.g., make funding contingent on jointly managed or cooperative data collection and management projects).

Pressure public and private donor funding organizations to avoid limitations of national grants in environmental studies that require collection, access, and use of environmental data that cross national boundaries.

- Establish coordination mechanisms, such as high-level interagency committees or councils, to develop jointly approved plans and programs, especially for cross-cutting environmental research and management issues.
- Need to pay attention to sub-national political and institutional actors in the national coordination process.

B. There is a lack of incentives or mechanisms to communicate effectively across countries/institutions/sectors/disciplines, particularly in politically sensitive research areas such as geophysical (extraction industry) or biological (genetic) resources. This is related to the issues raised in item A.

Potential Solutions:

Budgetary incentives and the establishment of formal coordination bodies that involve representatives of all major stakeholders can help reduce the communication barriers and misunderstandings, and to build trust relating to environmental data activities.

Involve experts from social sciences and information management to improve communication among stakeholders to reduce friction and to assist in presenting data in the most effective and understandable manner.

- C.** Lack of authority to enforce data access requirements, both among nations and their cooperating institutions and within nations by institutions and their cooperating or funded scientists. There is a reluctance to be confrontational.

Potential Solutions:

Need to develop some formal mechanisms to enhance compliance among participating institutions (e.g., when negotiating agreements).

Establish data sharing and access requirements for grantees and contractors, as appropriate. Build on successful examples and models from other disciplines or institutions. In cases of non-compliance, withhold funding of future grants.

Apply peer pressure at both the institutional and scientific community level (unclear how). Make this issue a part of university curricula and a topic at professional society meetings.

Lead by example. Provide incentives for best practice and compliance such as prizes (e.g., the CODATA prize), formal reward systems in ministries and universities (promotion/tenure).

- D.** Explaining uncertainty to the uncertain—making environmental data useful to and used by policy makers and other decision makers beyond the environmental research community.

Potential Solutions:

Engage the policy makers and other users in the identification of the kinds of data that are needed to be collected and in how they can be most effectively presented to meet the user needs.

3.2.2. Economic Barriers and Potential Solutions

- A.** Extracting value from the investment in the data collected by public institutions and by publicly funded researchers.

Potential Solutions:

- Establish open-access policies as much as possible (make open access the default rule, rather than the exception). Avoid data cemeteries: the value of data is dependent on their use.
- Undertake empirical and analytical studies that demonstrate the value of broad access to and use of environmental data to the economy, society, and scientific progress. Some such studies already have been done in the European Union and the United States.

- B.** Finding adequate funding for environmental data collection and management at the national and international levels, particularly on a sustainable, long-term basis.

Potential Solutions:

- Part of the solution is to make the case to policy makers and funding institutions that environmental data collection and the related data management and dissemination functions are both a well-justified public good and investment and that the data access functions are an essential part of the modern research infrastructure (not a separate consideration).
- It is important to involve economists, sociologists, information experts, and others from outside the immediate research community to broaden the vision and the analysis.
- Public institutions that manage and disseminate public environmental data must seek the least restrictive means for making those information resources broadly available at the lowest cost to the users, especially to non-profit users.

- If the full funding is not available from the primary funding source, different alternative funding models exist, including national and international consortia, public and private donor agencies for developing countries, and differential pricing mechanisms.

C. Donor organizations (e.g., World Bank, U.S. Agency for International Development, Organization of American States, UN specialized agencies and private foundations) do not normally require public access to the data produced through their funding, or any related data management requirements. This leads to duplication of effort and loss of value in the investment and undermines scientific progress and development goals.

Potential Solutions:

- The major organizations involved in environmental research and data activities need to make the case to donor organizations that they need to be more proactive regarding data policy and management, and that they should integrate the value of those activities in their overall funding strategies.

3.2.3. Legal Barriers and Potential Solutions

A. Intellectual property (IP) and other economic proprietary protection of public environmental (and other) data is not justified because government entities funded at taxpayer expense do not need legal incentives to produce and protect the data, which are a public good.

Potential Solutions:

- National governments and their environmental and research agencies should review their IP and related legal policies and remove legal constraints as much as possible, consistent with the economic rationale and studies suggested above.

B. National security protection is frequently used to limit access to entire data collections, without adequate justification or review.

Potential Solutions:

- Agencies that assert national security restrictions on environmental data should be subject to some formal process that balances other national economic and social interests and that is subject to some appropriate review.

C. Intellectual property laws are being strengthened worldwide and there is pressure on developing countries to adopt highly protectionist regimes that are being implemented in more economically developed countries. Adequate exceptions for public research and public-interest uses are not always considered or implemented.

Potential Solutions:

- The public science and environmental research community needs to be represented and actively engaged in the discussion and formation of new IP laws and policies at the international, national, and institutional levels.

3.3. Collaborating for the Future to Improve Access to and Use of Environmental Data

The initial set of plenary sessions were followed by three breakout sessions examining future collaborations to improve access to and use of environmental data. Workshop participants were divided into three breakout sessions on regional collaboration issues, interdisciplinary collaboration and application issues, and improving policy decision making with environmental data. The three breakout sessions addressed the same four questions used to guide the general discussions in the issue sessions (see section 3 above).

3.3.1. Regional Collaboration Issues

What are the challenges and barriers?

- Digitizing of existing data and data archiving
- Language barriers: multilingual systems
- Capacity building: getting local persons to appreciate the value of data sets; providing know-how to collect, process and use data; lack of informatics tools
- Building awareness of need to have, share and have access to a wide range of data
- Open access to data
- Who pays for collaboration?
- Sustain/maintaining human/technical resources for collaborative projects
- Building the institutional framework: government, nongovernmental organizations, industry, academies
- Building trust
- Strengthening existing networks: bandwidth, interfaces and data sets handled.
- Operationalizing networks: outcomes/outputs, maintenance.

What are the existing resources and realistic opportunities?

- Identify existing organizations and institutions to collaborate and share data
- Many organizations with regional portals and links, regional networks.
- Funding available to support existing projects: challenge is how to use those funds for greater inter-regional collaboration.
- Lots of capable personnel/scientists and centers of data collection
- Support from national corporations and industry: “green globe” certification, data for operations.
- Regional problems provide opportunities for collaboration, such as global warming, disasters and watershed management. Concentrating on these may allow us to show how relevant environmental data are to societal needs.

What are some potential projects /collaborations?

Generally, there is a lack of knowledge as to needs and requirements. New projects should:

- Identify needs in order to determine projects
- Address recognized challenges
- Undertake gap analysis: where to go forward given many on-going projects.

As a possible example of a project the group indicated:

- Improving management of water resources – floods, run off, drought.
- Better manage water reserves, sustainability, predict hazards, health, water quality, pollution.

How can the identified new or improved initiatives be implemented?

- Identify stakeholders – academies, environmental agencies, government, NGOs
- Agreements to collaborate
- Identify existing stores of data, methodologies, services available
- Identify technical needs: hardware, training
- Establish data sharing methods: utilize ongoing collection activities, build databases, develop models, publish through existing portals.
- Share methodology and tools for data creation, databases
- Improve communication among all stakeholders
- Adopt protocols for collecting data on multiple variables.
- WHO PAYS? – Propose an environmental services payment (grant or levy) as part of the green certification

3.3.2. Interdisciplinary Collaboration and Application Issues

What are the challenges and barriers?

- Publishing and getting credit for data
 - ⇒ Countering the attitude that only published papers have value (those working in the field have the power to change this)
 - ⇒ Difference between research and development
 - ⇒ Younger researchers need fast turnaround in publishing
- Deposit of data a possible solution
 - ⇒ How to manage quality? Referees?
- Lack of national data policies
- Digital divide
 - ⇒ How to make data and policy information available
- Scientists' involvement in policy and in events such as WSIS is low

How can the identified new or improved initiatives be implemented?

- Need to keep projects small
- Local trends to decentralize projects
 - ⇒ Municipalities can use funding directly
- Technology costs are falling
 - ⇒ Connectivity relatively inexpensive
 - ⇒ Can give local people tools and skills
- Data Policy
 - ⇒ Individual and regional participation in ISO standards; e.g., ISO 9001
- Review WSIS plan of action for useful follow-up
 - ⇒ Circulate the action plan to participants
 - ⇒ Individuals write down relevant existing and possible projects
 - ⇒ Organize a small local group to make a proposal
 - ⇒ CODATA and ICSU can facilitate implementation

3.3.3. Improving Policy Decision Making with Environmental Data

Use of information in setting agendas

- Law
- Regulation
- Policy formulation
- Management actions
- Evaluation
- Other Decision making

Discussion about what is meant by “Environmental Data”

- Need to use a broad definition of “Environmental Data”
- It is important to understand the relationship between natural and human processes.

What are the challenges and barriers?

- The understanding of what is meant by uncertainty by different user groups
 - ⇒ Different causes of uncertainty
 - ⇒ Lack of sharing leads to the use of different data sets by different groups and thus leads to uncertainty
 - ⇒ Never enough data
 - ⇒ Statistical uncertainty
 - ⇒ Should not use uncertainty as an excuse for not acting
- Need to categorise and document the different types of uncertainty, and a framework for reporting uncertainty
- Need to develop systems to visualise information and ways to present it to users
- A lot of decision making and policy formulation has a very short time frame and “urgency,” especially compared with the time frame for scientific research
- Lack of definitions for a lot of terms
- Communicating science to policy makers and other decision makers (where do responsibilities lay for transparent communication?)
 - ⇒ Two-way street
- Determining the weight of evidence for decision-making purposes in spite of different levels of uncertainty
- How the environment is valued affects the value of the environmental information
- Linguistic, cultural and disciplinary constraints to being able to use the science that exists (or even being aware of what data exist in other languages, disciplines, etc.)
- A challenge is to build on approaches or tools that are known to work in one context and extending their use to other countries/disciplines (share lessons learned, etc.)
- Need to archive data and information products for an audit trail (in addition to preserving the data needed for research)
- Need to have open access to data required for decision making

What are the existing resources and realistic opportunities?

- The processes used by the risk assessment/risk management paradigm may be useful to review
- Visualisation tools for presenting data to improve useability (e.g., time series, maps)
- Metadata systems and tools need to be developed and utilised
 - ⇒ Need to expand expertise levels to improve the metadata and documentation of data
 - ⇒ Determine desirability for broad usability (for varied audiences) - cannot ignore the cost of doing this, however
- Search and retrieval tools
- Development of environmental and socio-economic “framework data” similar to some of the spatial framework data
- Use of open source development environment to improve the process and transparency of linking data and information to policy

What are some of the potential projects/collaborations?

- GBIF and the Group on Earth Observations of GEOSS
- IABIN and ecosystem project network communication with the Global Spatial Data Infrastructure and other environmental data producers and users
- Some ontologies are being built that will be of value (e.g., SEEK, which is building an ecological ontology) and will enable more interactive connections between database types
- Development of data cleansing tools – maybe some commonality between different disciplines
- Collaborations between data providers and decision makers, examples:
 - ⇒ Development of environmental indicators
 - ⇒ Adaptation and vulnerability to climate change

How can the identified new or improved initiatives be implemented?

- Discussions between GBIF and GEO have begun at this meeting
- The question largely relates to who is going to pay for it!
- Ideas that are perceived as necessary or useful will lead toward funding in some cases
- There are a number of initiatives just getting off the ground (e.g., the GBIF Portal and GEO). Need to think and plan 2-3 years ahead about how we can integrate with these and similar initiatives
- U.S. National Science Foundation is looking at interdisciplinary collaborations
 - ⇒ Recommendations from this workshop should go back to the funding bodies to continue and enhance collaborative projects (e.g., in support of biocomplexity)

How can the identified new or improved initiatives be implemented?

- These ideas should be promoted within the funding/granting communities (international, government, foundation, industry)

4. Workshop Recommendations

The final session of the workshop examined priorities and perspectives for future collaboration, and focused on summarizing workshop recommendations that could be presented to the CODATA Executive Committee for their consideration. Five recommendations were identified.

1. It was generally agreed by participants that one of the most successful elements of the meeting was that it succeeded in bringing together scientific representation from the biodiversity, geospatial, global change, and earth observation communities and provided an opportunity for these communities to commence possible collaboration on common data-oriented projects. Therefore, workshop participants recommended that geospatial initiatives and their applications to biodiversity should be promoted, and possible potential projects/collaborations should be encouraged between organizations such as the Global Biodiversity Information Facility (GBIF), the InterAmerican Biodiversity Information Network (IABIN), the InterAmerican Institute for Global Change Research (IAI), the International Research Institute for Climate Prediction (IRI), and the Global Spatial Data Infrastructure (GSDI), with an international organization like CODATA facilitating such collaboration through a possible workshop or Task Group.
2. The workshop participants recommend that all nations in the Americas participate in global and regional cross-boundary sharing efforts for environmental and geospatial data. Many countries of the Americas already have made commitments to such efforts and such commitments should be encouraged. To this end, initiatives such as GBIF, IABIN, and GSDI should be supported.
3. Participants recognised the importance of access to environmental data and the impact of data access policies on environmental research. The workshop participants recommended that current environmental data access policies in the Latin American region be identified and documented for distribution to interested parties, with the long-term objective of providing information to identify issues and to help develop amendments to such policies that may be needed to promote access to environmental data.
4. In preparation for the World Summit on the Information Society (WSIS) in Tunis in 2005, a willingness was expressed by participants to identify current activities in the Latin America region pertaining to environmental issues that directly or indirectly relate to the WSIS Plan of Action identified in Geneva in December 2003. CODATA could consider how to mobilize this effort.
5. The importance of preservation and archiving of environmental and spatial data was emphasised at the meeting. Participants supported a follow-on workshop in 2006 that would address these issues in the Latin American region, perhaps in the context of CODATA's Task Group on Preservation and Archiving of Scientific and Technical Data in Developing Countries.

Appendix A: Workshop Participants

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Appendix B: Workshop Program

Wednesday, 3 March	
17:00	Registration
18:00	Welcome by Workshop Co-Chairs Vanderlei Canhos , CRIA, Brazil, and Reynaldo Morales , LANL, U.S.
18:10	Welcoming Presentation Eduardo Moacyr Krieger , <i>President of the Brazilian Academy of Sciences</i> ■
18:30	Keynote: Importance of Improving Access to Environmental Data in the Americas, Gilberto Câmara , Director of Earth Observation, National Institute for Space Research - INPE, Brazil
19:30	Reception/Dinner (Bellini Restaurant at Vitoria Hotel)
Thursday, 4 March	
08:30	Registration
09:00	Introduction by Workshop Co-Chairs Vanderlei Canhos , CRIA, Brazil, and Reynaldo Morales , LANL, U.S.
09:10	SESSION 1: Global Initiatives (Room Paraty) Moderator: Bob Chen , Deputy Director, Center for International Earth Science Information Network, U.S. Panelists: <ul style="list-style-type: none"> • The Global Biodiversity Information Facility (GBIF): An Interoperable Network of Primary Biodiversity Databases, James Edwards, Director of GBIF Secretariat, Denmark • The Global Spatial Data Infrastructure: Vision, Goals, and Progress, Santiago Borrero, Former GSDI President, Secretary General, Pan American Institute for Geography and History, Colombia • The International Research Institute for Climate Prediction (IRI), Antonio Divino Moura, former Director, IRI, Columbia University, U.S. and Director of the National Institute of Meteorology - INMET, Brazil NOTE: All speakers in Sessions 1 and 2 were asked to provide a brief overview of their activities, specifically tying the focus of their presentations to the scientific, technical, institutional, and policy questions raised in Sessions 3 and 6.
10:15	General discussion
10:35	Break
11:00	SESSION 2: Regional Initiatives (Room Paraty) Moderator: Guido Gelli , Director of Geosciences, Brazilian Institute for Geography and Statistics Panelists: <ul style="list-style-type: none"> • Sharing Biodiversity Information throughout the Americas: Inter-American Biodiversity Information Network, Gladys Cotter, Executive Committee Chair, IABIN, and Associate Chief Biologist for Information, U.S. Geological Survey • PC-IDEA's Current Activities in the Americas, Mario Alberto Reyes-Ibarra, President, PC-IDEA, and Director of Geography, INEGI Mexico • Inter-American Institute for Global Change Research (IAI) Data and Information System, Gustavo Necco, Director, IAI, Brazil
12:05	General Discussion

12:30	Lunch
14:00	<p>SESSION 3: Scientific and Technical Issues (Room Paraty) Moderator: Regina P. Markus, SBPC, Brazil Rapporteur: Arthur Chapman, Australia Panelists:</p> <ul style="list-style-type: none"> • Gilberto Câmara, Director of Earth Observations, INPE, Brazil • A. Townsend Peterson, University of Kansas, U.S. • Carlos Nobre, LBA Science Steering Group, Brazil • William Ulate, INBio, Costa Rica • Merilyn Gentry, Systems Development Institute, University of Tennessee, USA • Eric van Praag, U.S. Geological Survey, EROS Data Center, Venezuela <p>NOTE: Each panelist gave a brief initial presentation of 10 minutes identifying key scientific and technical issues, including but not limited to the following areas:</p> <ol style="list-style-type: none"> 1. Technical interoperability of environmental data across software and hardware systems 2. Semantic interoperability of environmental data across disciplines and languages 3. Facilitating interdisciplinary and international access to environmental data resources 4. Scientific and technical requirements for long-term preservation and accessibility of environmental data 5. [Other issues, including those identified at the World Summit on Sustainable Development and World Summit on the Information Society (WSIS)]
15:00	<p>General discussion with panelists and workshop participants Moderator: Reynaldo L. Victoria, CENA, Brazil Rapporteur: Arthur Chapman, Australia NOTE: The following questions were addressed by the panelists and workshop participants:</p> <ol style="list-style-type: none"> 1. What are the challenges and barriers? 2. What are the existing resources and realistic opportunities? 3. What are some potential projects/collaborations? 4. How can the identified new or improved initiatives be implemented?
16:30	Break
17:00	<p>SESSION 4: Initiatives on environmental data access/applications. Poster presentations and technical demonstrations</p> <p>SESSION 4A - Room Positano Moderator: Ivis Chan, Ministry of Natural Resources, Belize Panelists:</p> <ul style="list-style-type: none"> • CLARA: an advanced regional network integrating Latin American NRENs, Michael Stanton • Biodiversity Cooperation Effort in Ibero-America, Peter Mann de Toledo • WebBee - a platform for a Brazilian network on bees, Antonio Mauro Saraiva, Vera L. Imperatriz Fonseca. • BAMPETRO: Environmental Data Base Related to the Oil and Gas Industry, Cleverson Guizan Silva • iBDC: An Internet Application for Observations Retrieval, Christopher Alexander C.Castro, Helio Camargo Junior, José Roberto M. Garcia, Luciana dos Santos Machado, Marcos Barbosa Sanches • Mexico's National System of Environmental Information, Salvador Sánchez-Cólon, Arturo Flores-Martínez.

	<p>SESSION 4B - Room Capri Moderator: Vera L. Imperatriz Fonseca Panelists:</p> <ul style="list-style-type: none"> • WorldClim: a new high-resolution global climate database, Robert Hijmans, Susan Cameron, and Juan Parra • Contributions to Information Sharing in the Hemisphere by the National Biological Information Infrastructure, Tom Lahr • The Data and Information System of the Large Scale Biosphere-Atmosphere Experiment in Amazonia - LBA, Luiz M. Horta, Marilyn J. Gentry, Larry D. Voorhees, Laurindo Campos • BIOTA/FAPESP The Biodiversity Virtual Institute: a Brazilian model for biodiversity conservation and sustainable use research programmes, Carlos Alfredo Joly and Erica Speglich • Towards biodiversity information systems for decision-making in conservation and sustainable use in Costa Rica, William Ulate
20:00	Banquet (Baracat Restaurant)
Friday, 5 March	
09:00	<p>SESSION 5: World Summit on the Information Society (Room Paraty) Moderator: Antônio Mauro Saraiva Panelist:</p> <ul style="list-style-type: none"> • Overview of World Summit on the Information Society: Focus on Access to Environmental Data, Paul Uhlir, Director of the Office of International Scientific and Technical Information Programs, U.S. National Academies
09:30	<p>SESSION 6: Policy and Institutional Issues (Room Paraty) Moderator: Bonnie Carroll, IIA, USA Rapporteur: Paul Uhlir, NAS, USA Panelists:</p> <ul style="list-style-type: none"> • Harlan Onsrud, University of Maine, U.S. • Clemente Forero-Pineda, University of Bogota, Colombia • Jorge G. Tezón, International Cooperation, CONICET, Argentina • Marco Túlio Cabral, Ministry of Foreign Relations, Brazil <p>NOTE: Each panelist gave a brief initial presentation (10 minutes) on key issues, including but not limited to the following:</p> <ol style="list-style-type: none"> 1. Data access and management policies and laws in different disciplines/countries/institutions/programs 2. Sustainable funding of environmental data centers/networks/archives 3. Linking scientific data to environmental policy formation 4. Strategies and innovations in data provisioning
10:30	Break
11:00	<p>General discussion with panelists and workshop participants (Room Paraty) Moderator: Marcio de Miranda Santos, CGEE, Brazil Rapporteur: Paul Uhlir, USA</p> <p>NOTE: Questions addressed by the panelists and workshop participants:</p> <ol style="list-style-type: none"> 1. What are the challenges and barriers? 2. What are the existing resources and realistic opportunities? 3. What are some potential projects/collaborations? 4. How can the identified new or improved initiatives be implemented?

12:30	<p>SESSION 7: New Initiatives (Room Paraty) Moderator: Hernan Chaimovich, Brazilian Academy of Sciences, Brazil Panelist:</p> <ul style="list-style-type: none"> • <i>Global Earth Observation System of Systems (GEOSS)</i>, Reinaldo Silveira, INMET, Brazil
13:00	Lunch
Breakout Sessions	SESSION 8: Collaborating for the Future to Improve Access to and Use of Environmental Data
14:30	<p>Breakout Sessions</p> <ol style="list-style-type: none"> 1. Regional Collaboration Issues (Room Paraty) Moderator: Cecille Blake, Ministry of Land and Environment, Jamaica Rapporteur: Tom Lahr, U.S. Geological Survey, USA 2. Interdisciplinary Collaboration and Application Issues (Room Capri) Moderator: Santiago Borrero, Secretary General, Pan American Institute for Geography and History Rapporteur: William Anderson, CODATA 3. Improving Policy Decision Making with Environmental Data (Room Positano) Moderator: Sidney Draggan, U.S. Environmental Protection Agency Rapporteur: Arthur Chapman, Australia <p>Questions addressed:</p> <ol style="list-style-type: none"> 1. What are the challenges and barriers? 2. What are the existing resources and realistic opportunities? 3. What are some potential projects/collaborations? 4. How can the identified new or improved initiatives be implemented?
15:45	Break
16:15	Breakout Sessions continued (Room Paraty)
17:30	<p>SESSION 9: Initiatives on environmental data access/applications. Poster presentations and technical demonstrations</p> <p>SESSION 9A - Room Capri Moderator: Jacob Opadeyi, Centre for Geospatial Studies, Engineering Institute, Trinidad y Tobago</p> <ul style="list-style-type: none"> • Consortium of Advancing Monitoring of Ecosystem Sustainability in the Americas (CAMESA), Sidney Draggan and Celedonio Aguirre-Bravo • International Activities of the U.S. Geological Survey - EROS Data Center and their applicability to Bioinformatics, Eric van Praag • <i>speciesLink</i>: a system for integrating distributed primary biodiversity data, Vanderlei P. Canhos, Renato De Giovanni, Sidnei de Souza • <i>geoLoc</i> and <i>spOutlier</i>: on-line tools for geocoding and validating biological data, Alexandre Marino, Fabrício Pavarin, and Sidnei de Souza, Arthur D. Chapman <p>SESSION 9B - Room Positano Moderator: Gustavo Necco, IAI, Brazil</p> <ul style="list-style-type: none"> • Understanding the Geography of Infectious Diseases Using Biodiversity Data and Informatics Tools, A Townsend Peterson • Use of biodiversity modelling in environmental conservation - a case study, Marinez Ferreira de Siqueira, Giselda Durigan, Mauro Muñoz, Fabrício Pavarin, and A. Townsend Peterson • <i>openModeller</i>: a framework for biological/environmental modelling, Mauro Muñoz, Renato De Giovanni, Sidnei de Souza • <i>BiodiversityWorld</i> - a grid enabled virtual laboratory for biodiversity analysis, Tim Sutton

Saturday, 6 March	
9:00	SESSION 10: Summaries of Breakout Sessions by Rapporteurs (Room Paraty) Plenary discussion
10:30	SESSION 11: Role of the Committee on Data for Science and Technology - CODATA (Room Paraty) Moderator: Jean Jacques Royer , CODATA Treasurer <ul style="list-style-type: none"> • Brief Overview of CODATA and its Recent Accomplishments, Bob Chen, CODATA Executive Committee Member • Task Group on Preservation and Archiving of Scientific and Technical Data in Developing Countries, William Anderson, Task Group Co-chair
11:00	Break
11:30	SESSION 12: Priorities and Perspectives for Future Collaboration (Room Paraty) Moderator: Reynaldo Morales Rapporteur: Kathleen Cass , CODATA Executive Director Representatives from invited public and private organizations
12:45	Closing Remarks by Workshop Co-Chairs
13:00	End of Workshop
14:30	Meeting of Session chairs and rapporteurs (Room Mikonos)

Appendix C: Environmental Data Initiatives and Applications: Poster Presentations and Technical Demonstrations

- CLARA: an advanced regional network integrating Latin American NRENs, Michael Stanton
- Biodiversity Cooperation Effort in Ibero-America, Peter Mann de Toledo
- WebBee - a platform for a Brazilian network on bees, Antonio Mauro Saraiva and Vera L. Imperatriz Fonseca
- BAMPETRO: Environmental Data Base Related to the Oil and Gas Industry, Cleverson Guizan Silva
- iBDC: An Internet Application for Observations Retrieval, Christopher Alexander C. Castro, Helio Camargo Junior, José Roberto M. Garcia, Luciana dos Santos Machado, and Marcos Barbosa Sanches
- Mexico's National System of Environmental Information, Salvador Sánchez-Cólon, and Arturo Flores-Martínez
- WorldClim: a new high-resolution global climate database, Robert Hijmans, Susan Cameron, and Juan Parra
- Contributions to Information Sharing in the Hemisphere by the National Biological Information Infrastructure, Tom Lahr
- The Data and Information System of the Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA), Luiz M. Horta, Marilyn J. Gentry, Larry D. Voorhees, and Laurindo Campos
- BIOTA/FAPESP The Biodiversity Virtual Institute: a Brazilian model for biodiversity conservation and sustainable use research programmes, Carlos Alfredo Joly and Erica Speglich
- Towards biodiversity information systems for decision-making in conservation and sustainable use in Costa Rica, William Ulate
- Consortium of Advancing Monitoring of Ecosystem Sustainability in the Americas (CAMESA), Sidney Draggan and Celedonio Aguirre-Bravo
- International Activities of the U.S. Geological Survey - EROS Data Center and their applicability to Bioinformatics, Eric van Praag
- speciesLink: a system for integrating distributed primary biodiversity data, Vanderlei P. Canhos, Renato De Giovanni, and Sidnei de Souza
- geoLoc and spOutlier: on-line tools for geocoding and validating biological data, Alexandre Marino, Fabrício Pavarin, Sidnei de Souza, and Arthur D. Chapman
- Understanding the Geography of Infectious Diseases Using Biodiversity Data and Informatics Tools, A Townsend Peterson
- Use of biodiversity modelling in environmental conservation - a case study, Marinez Ferreira de Siqueira, Giselda Durigan, Mauro Muñoz, Fabrício Pavarin, and A. Townsend Peterson
- openModeller: a framework for biological/environmental modelling, Mauro Muñoz, Renato De Giovanni, and Sidnei de Souza
- BiodiversityWorld - a grid enabled virtual laboratory for biodiversity analysis, Tim Sutton