CODATA Strategic Plan 2013-2018

Prepared by:

Robert S. Chen, USA, former CODATA Secretary General

In consultation with the:
Executive Committee 2010-2012
Executive Committee 2012-2014
CODATA Members
Executive Director

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CODATA STRATEGIC PLAN 2013-18

Preface

This *CODATA Strategic Plan 2013-2018* has been developed at the request of the CODATA General Assembly in 2010 and in response to a recommendation from the International Council for Science (ICSU) as outlined in the *ICSU Strategic Plan II, 2012-2017.*

Created by ICSU in 1966 as an interdisciplinary body focused on scientific and technical data, CODATA is an influential voice in national and international policy regarding scientific data management and a focal point for international, cross-disciplinary collaboration and communication on key scientific data issues. CODATA has made significant contributions not only to the improvement of scientific data development, analysis, and visualization in key fields, but also to the overall advancement and application of science internationally.

In 2003-04, ICSU conducted a Priority Area Assessment (PAA) on Scientific Data and Information that included a detailed review of the ICSU bodies focused on scientific data and information. The PAA recommended that "CODATA should develop a clear long-term strategy that focuses on key international data management and policy issues, giving special attention to the needs of developing countries." (ICSU, 2004: 30). The PAA report was approved by the ICSU General Assembly in October 2005, and its main recommendation regarding CODATA was incorporated into ICSU's *Strategic Plan 2006-2011*. Specifically, ICSU decided to encourage CODATA to "develop a long-term strategy, giving special attention to the needs of developing countries" (ICSU, 2005: 40). In response, CODATA prepared a draft *CODATA Strategic Plan 2006-12,* which was reviewed at the 25th CODATA General Assembly in Beijing, China in October 2006 and formally approved at the 26th General Assembly in Kyiv, Ukraine in October 2008 (CODATA, 2009).

This *CODATA Strategic Plan 2013-18* builds on the previous plan and on the strategic priorities outlined in the new *ICSU Strategic Plan II 2012-2017*. It includes a brief overview of CODATA's strategic accomplishments under the previous plan, and sets out a new set of initiatives and targets for the period 2013-2018. Based on inputs received from a variety of sources, this new Plan provides an overarching vision for CODATA and its role in the rapidly changing world of international science, as well as detailed implementation plans for the strategic initiatives identified in the Plan.

This Plan has been developed by the CODATA Executive Committee and the CODATA Executive Director, based on inputs received from CODATA members since late 2011. The Plan was reviewed by CODATA's membership in mid-2012 and approved in principle at the 27th General Assembly in Taipei in October 2012, where several specific proposals described in this Plan were also adopted. The 27th General Assembly directed the 58th Executive Committee to ratify the final version of the Plan at its spring 2013 meeting. This version of the Plan reflects feedback from CODATA members and discussions at the General Assembly. A draft version of the Plan was an important input into the review of CODATA initiated by ICSU in the 2012-13 time frame.

1. CODATA Mission and Scientific Agenda

CODATA's mission, as adopted by the 25th General Assembly, is:

The mission of CODATA is to strengthen international science for the benefit of society by promoting improved scientific and technical data management and use.[1]

Under this broad mission statement, CODATA has developed a scientific agenda based on both "bottom up" and "top down" considerations. As an international nongovernmental scientific organization, CODATA is clearly dependent on the scientific interests and active support of its members, who bring to bear specific areas of expertise and opportunities for international and interdisciplinary collaboration. On the other hand, as a unique interdisciplinary body under the umbrella of ICSU, CODATA has both the opportunity and the responsibility to play a leadership role on scientific data issues, providing strategic guidance and expertise on critical data challenges in a rapidly evolving world. In fact, these two considerations are more often complementary than competitive, since many of the current data challenges facing science broadly started with problems identified and addressed by specific groups of scientists working on pressing scientific problems.

CODATA's scientific agenda is also affected by its historical roots and the evolving roles of other ICSU bodies as well as other data-focused organizations and institutions. For example, CODATA has had a longstanding role in international agreement on measurement of the fundamental physical and chemical constants, but it has not generally taken on the role of an international standards body like the International Organization on Standardization (ISO).

Technology has been pushing science into new frontiers for decades. These advances in science in turn have demanded advances in technology, creating a cycle of progression. At the center of all this has been data—persistent, scientific data of ever-increasing volume and complexity. Scientific data include data entities from observations, experiments, surveys, simulations, models, and higher-order assemblies, along with the associated documentation needed to describe and interpret the data. The use of digital technologies to collect and manage these data has transformed today's scientific landscape. Data that are "born digital"—available only in digital form and preserved only electronically—are increasingly becoming the primary output of science and the starting point for new research. Data-intensive science has emerged as a new paradigm of science, and there is growing recognition of the vital importance of developing and investing in "big data" approaches, methods, and infrastructure. It is clear that the need for well-developed, globally-coordinated scientific data strategies is even greater than it was at CODATA's inception.

In conjunction with the increased role of data in science, society's use of—and dependence on—digital data and information have also skyrocketed in recent decades. Economic and social decisions in both the public and private sector are becoming ever more reliant on access to, analysis, and interpretation of vast amounts of diverse data and information, including both historical and current data as well as predictions

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[1] This new mission statement was approved at the 25th CODATA General Assembly in Beijing in October 2006.

based on scientific models. Such decisions range from an individual's response to a weather forecast or a medical test to a government's choice of policies with regard to economic development, national security, or environmental management. In other words, data are an integral part of modern life. CODATA therefore has the unique opportunity to contribute to an exciting new era of interdisciplinary, global, data-intensive science aimed at helping to solve critical global challenges.

2. Overview of CODATA Strategic Accomplishments 2006-12

CODATA's *Strategic Plan 2006-12* recognized the need for CODATA to take a leadership role in several key areas of science and scientific data policy and development. The plan identified three main initiatives as well as a number of other important organizational and capacity building efforts. The three initiatives and their main accomplishments are:

1) Global Information Commons for Science Initiative (GICSI);

2) Scientific Data across the Digital Divide (SD^3) Program; and

3) Advanced Data Methods and Information technologies for Research and Education (ADMIRE).

Key GICSI Accomplishments

GICSI was launched by CODATA and several partner organizations at the second phase World Summit on the Information Society (WSIS) meeting in Tunis in 2005. CODATA has provided leadership in several science-focused "commons" efforts, including the Microbial Commons, the Polar Information Commons (PIC), and COMMUNIA, the European Thematic Network on the Public Domain in the Digital Age. In 2007, CODATA co-organized a workshop on common use licensing of scientific data in Paris with the Science Commons Project of Creative Commons and the Global Biodiversity Information Facility (GBIF), which led to development of the Protocol for Implementing Open Access Data (Science Commons, 16 December 2007). CODATA's Task Group on GICSI-European Union activities, established in 2008, organized the 2nd COMMUNIA Conference on Global Science and the Economics of Knowledge-Sharing Institutions (G-SEKSI) in June 2009 in Torino, Italy. CODATA actively contributed to the OECD Principles and Guidelines for Access to Research Data from Public Funding (OECD, 2007) and to the implementation of the Data Sharing Principles of the Group on Earth Observations (GEO) (Uhlir *et al.*, 2009; GEO, 2009, 2010). CODATA served as one of the co-chairs of the GEO Data Sharing Task Force in 2009-11, is a co-chair of the current GEO Data Sharing Working Group (2011-15), and has organized numerous side events and sessions at GEO Plenaries and other conferences. GICSI also provided a framework for open access initiatives on the part of national and union members, e.g., in Australia and on the part of the International Union of Crystallography (IUCr).[2]

Key SD^3 Accomplishments

The SD^3 initiative focused on the pressing needs of developing country scientists, students, and applied users for scientific data related to sustainable development. The Task Group on Preservation of and Access to Scientific and Technical Data in Developing Countries organized a workshop on Open Knowledge and Data

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[2] See Appendix for more details.

Environment for Innovative Research on Poverty-Free and Ecosystem Protection in Ulaanbaatar, Mongolia in July 2011. The CODATA Global Roads Data Development Task Group is developing an open access intercity roads database, useful for a wide range of applications especially in developing countries. CODATA collaborated with the ICSU World Data System (WDS) on establishing a new World Data Center on Biodiversity and Human Health in South Africa and with the Chinese Academy of Sciences on the establishment of the Global Alliance for Enhancing Access to and Application of Scientific Data in Developing Countries (e-SDDC), part of the United Nations Global Alliance for Information and Communications Technologies and Development (GAID).

CODATA collaborated with the ICSU Committee on Freedom and Responsibility in the Conduct of Science (CFRS) and the World Data System Scientific Committee on the development of the ICSU CFRS [Advisory Note on Sharing Scientific Data, with a Focus on Developing Countries](#) (ICSU CFRS, 2011). CODATA also organized prominent data sessions at the First Integrated Research on Disaster Risk (IRDR) Conference in Beijing in October 2011 and at the ICSU Forum on Science, Technology & Innovation for Sustainable Development, held in Rio de Janeiro just prior to the Rio+20 Conference in June 2012. CODATA's 22nd biennial conference in Cape Town, South Africa in 2010 included some 80 African scientists, including 50 young scientists, with support from the National Research Foundation (NRF) of South Africa. CODATA and the Chinese National Committee recently held an International Training Workshop for Developing Countries on Scientific Data Management and Sustainable Development in Beijing in July 2012, with 14 participants from developing countries in Africa and Asia. CODATA also co-sponsored a training seminar organized by the China Earthquake Administration in July 2012, which drew more than 80 provincial earthquake disaster risk managers including many early career experts. CODATA's Young Scientist Working Group (recently re-established as the Early Career Working Group) has been instrumental in involving a wide range of early career scientists in CODATA conferences, workshops, and task group activities and calling attention to their roles and needs with respect to the evolution of data science.

Key ADMIRE Accomplishments

Several CODATA task groups have taken on key challenges related to the application of new technologies to data development, management, and application. The CODATA Global Roads Data Development Task Group explored the use of Geographic Positioning System (GPS) technologies, automated road extraction methods from remote sensing data, and open crowd sourcing as alternative approaches to building an open access intercity roads database. The CODATA-ICSTI Task Group on Data Citation Standards and Practices is currently exploring the implementation of unique digital identifiers for data to enable improved provenance tracking and citation for scientific data and information. In collaboration with the US National Committee for CODATA, the Task Group held an International Symposium and Workshop on Developing Data Attribution and Citation Practices and Standards in Berkeley CA in August 2011 (Uhlir, 2012). In February 2012, CODATA led the organization of the ICSU-CODATA Workshop on the Description of Nanomaterials, which brought together key stakeholders from academia, industry, and government.

Other Strategic Accomplishments

CODATA's *Strategic Plan 2006-12* identified a number of other organizational priorities aimed at improving CODATA's effectiveness and capacity to support its goals and membership needs. CODATA has been working actively to clarify and modify its dues structure and member benefits and to address specific participation, recruitment, and retention cases. Notably, CODATA has weathered the most volatile economic period since its founding without any major financial or organizational disruption. With regard to national membership, in 2008 both Australia and the UK rejoined CODATA, the latter represented by the UK Digital Curation Centre (DCC). Unfortunately, Italy withdrew as a member in 2008, and Germany remains an Associate Member. France returned as a National Member at a reduced dues level in 2008-2011, but as of 1 January 2012 reverted to Associate Member status in accordance with a resolution of the CODATA General Assembly. CODATA has not been able to revive membership by Cameroon, Nigeria, and Senegal. At the 27th General Assembly in 2012, CODATA welcomed three new national members: Mongolia (effective October 2012), Finland (effective January 2013), and the Czech Republic (effective January 2013). The World Data System was accepted as a co-opted organization member in 2010, replacing the former World Data Center and Federation of Astronomical and Geophysical Services members. Two new groups have become Supporting Organizations, the U.S. National Archives and Records Administration (NARA) and the Computer Network Information Center (CNIC) of the Chinese Academy of Sciences.

CODATA is currently expanding its international cooperation through the "Hand in Hand" Program, which seeks to reach out to national scientific institutions, ICSU interdisciplinary bodies, and international scientific organizations dealing with data. Since CODATA addresses data and information across all scientific disciplines, its role is often that of a coordinator, involving a broad range of organizations. This enables CODATA to ensure that data issues, such as sharing, quality control, and standardization, are given due attention in research projects and scientific agendas. Direct CODATA involvement in partner research initiatives, conferences, working groups, and similar activities opens up opportunities to help improve planning and management of their data and information efforts. Involving partners in CODATA activities helps connect them with other organizations with relevant research and data, potentially leading to new, mutually beneficial alliances. In fall 2011, CODATA signed a Memorandum of Understanding (MoU) with the Integrated Research on Disaster Risk (IRDR) programme and another MoU with the International Society for Digital Earth (ISDE). Both MoUs included specific areas of cooperation and collaboration. These and future Hand-in-Hand partnerships will be crucial to CODATA's ability to achieve CODATA's mission and to support ICSU's scientific agenda.

In October 2011 in Beijing, CODATA held a high-level scientific meeting on "Data-Intensive Science and Discovery – CODATA 45 Years On" to discuss discovery and innovation in the age of data-intensive science and look back on CODATA's 45-year history (CODATA 2012). A significant component of the meeting was the integration of different aspects of data science, covering science and policy, national and international organizations, and public and private institutions. Including a broad range of stakeholders is fundamental to any successful initiative in data science.

CODATA also had significant accomplishments that fall outside of the main Strategic Plan priorities. For example, the CODATA Task Group on Fundamental Constants has become an official member of the Consultative Committee on Units (CCU) of the International Conference on Weights and Measures (CIPM) and is currently advising the CIPM on a major change in the International System of Units (SI). The Task Group issued an update to the fundamental physical and chemical constants in 2011 (http://physics.nist.gov/cuu/Constants/index.html; Mohr *et al.*, 2012). CODATA national members have organized a variety of successful national, bilateral, and regional activities, such as a series of roundtable meetings on scientific data cooperation organized by the China and US national CODATA committees in 2006-11. CODATA also commissioned a detailed 45-year history of the organization, prepared by former President and Secretary-General David Lide and former Vice President and Treasurer Gordon Wood (Lide and Wood, 2012).

Comments and Evaluation

In late 2011, CODATA solicited comments from its membership on its 2006-12 Strategic Plan and suggestions for the next plan. Respondents were generally positive about the overall direction of CODATA's strategic initiatives and had constructive suggestions for the next plan. A number of members noted that the previous strategic plan did not contain many specifics on implementation of the three strategic initiatives, and did not link these closely with Task Group activities or with relevant national member activities. In some cases it was clear that there were gaps in awareness of activities that had been carried out under the auspices of the plan, highlighting the need for increased communication about CODATA's strategic activities.

Additional comments were received in mid-2012 in response to a review draft circulated to the membership prior to the 27th General Assembly. This version of the Plan reflects various suggestions and inputs as discussed at the General Assembly.

3. ICSU Strategic Guidance

As an interdisciplinary committee of ICSU, CODATA has a direct role and responsibility with respect to the scientific agenda and priorities established by ICSU. Beyond this, CODATA also must address the specific needs of its membership and the broader community of scientific data providers, managers, and users, as well as that of science and society as a whole, as expressed in its mission statement.

It is therefore vital that CODATA respond to relevant guidance from ICSU, which is articulated both in the *ICSU Strategic Plan II, 2012-17* and in the recommendations of the *ad hoc* Strategic Coordinating Committee on Information and Data (ICSU SCCID, 2011), which were endorsed by the ICSU General Assembly in 2011.

ICSU Strategic Plan II, 2012-17

The *ICSU Strategic Plan II, 2012-17* highlights a range of priorities and initiatives, a number of which appear particularly relevant to CODATA's mission and agenda. Based on its review of the plan, the CODATA Executive Committee identified the following items as essential to consider in the CODATA Strategic Plan for 2013-18:

1. The Earth System Science Initiative (recently named the "Future Earth" initiative);

2. The Belmont Challenge on delivering knowledge to support human action and adaptation to regional environmental change; and

3. The Integrated Research on Disaster Risk (IRDR) programme.

The Executive Committee also noted the importance of monitoring the progress of the ICSU Foresight Analysis on scenarios for the development of international science over the next 20 years, the strategic review on science education, and the Urban Health and Wellbeing program, and contributing to these efforts where appropriate. It also recognized the importance of the review of CODATA to be undertaken by CODATA, as well as the review of the ICSU Regional Offices.

SCCID Recommendations

The *ad hoc* Strategic Coordinating Committee on Information and Data was formed in 2009 with an initial 3-year time frame. Its terms of reference included:

- To establish and assert a visible and effective strategic leadership role, on behalf of the global scientific community, in relation to the policies, management and stewardship of scientific data and information;

- To advise on the data needs and possible solutions for existing and new ICSU programmes and other international initiatives;

- To develop a coordinated strategy for training and capacity enhancement in data and information stewardship with a particular focus on least developed countries and involving the activities of CODATA, ICSU WDS and other relevant Interdisciplinary Bodies.

- To work with relevant ICSU bodies and key partners to promote international discussions on current and evolving key data and information issues including global access.

The SCCID was chaired by Ray Harris and included an international group of experts, including CODATA Secretary General Robert Chen, serving in his personal capacity. CODATA Executive Secretary Kathleen Cass served as an *ex officio* member, as did Bernard Minster representing the WDS-Scientific Committee. The SCCID issued a report in 2011 which included 14 recommendations on a range of data related issues (ICSU SCCID, 2011). The CODATA Executive Committee has identified the following subset as most relevant to CODATA's strategic planning, recognizing that all of the recommendations have some degree of relevance:[3]

1. ICSU should ensure that National Members and Union Members adopt the guide to best practice presented in Appendix B of this report, either through their own data and information committees or commissions (where these exist), or independently. ICSU should also ensure that the guide is followed by all new ICSU projects and programmes.

2. ICSU should establish a forum for the exploration and eventual agreement in relation to science of all the terms used under the broad umbrella of Open Access.

3. ICSU should use the OECD guidelines that have already been agreed implicitly by 33 of its National Members, and have provided a general

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[3] Note: original recommendation numbers have been retained.

framework for several existing discipline-specific data access and sharing policies, as the basis for a forum to discuss and agree a set of principles among all ICSU National Members.

4. ICSU should engage actively with publishers of all kinds together with the library community and with scientific researchers to document and promote community best practice in the handling of supplemental material, publication of data and appropriate data citation.

5. CODATA should consider as the theme for its 2012 biennial conference how data science can support the delivery of the science goals of the major ICSU Earth System Research for Global Sustainability initiative and the Planet under Pressure conference organized by ICSU's Global Environmental Change programmes planned for March 2012 in London.

6. We recommend the development of education at university level in the new and vital field of data science, using the curriculum included in an appendix D of this report as a starting point.

7. Both the CODATA and the World Data System biennial conferences should include forums for data professionals to share experiences across a range of science disciplines.

10. ICSU should exploit more fully the expertise in data standards already present in CODATA, the WDS and in its Scientific Union Members to assist in the definition and maintenance of high level data standards appropriate to meet both disciplinary requirements and overall science interoperability standards.

11. ICSU should develop a better mechanism to insert a science perspective into general standards bodies such as ISO, OGC, IEEE and the World Wide Web Consortium. Suitable expertise exists in the ICSU family but it is scattered in an uncoordinated way across Scientific Unions.

12. We recommend that ICSU uses CODATA, the WDS and the National and Union Members in a coordinated way to improve access to data and information in less economically developed countries.

14. The WDS should be the natural home for science in-reach activities and should work with CODATA on raising visibility of data and information management by scientists.

It should be noted here that CODATA has already responded to recommendation 5 by participating actively in the 2012 Planet Under Pressure conference and establishing the theme of "Open Data and Information for a Changing Planet" for its 23rd International Conference in Taipei in October 2012. The CODATA-ICSTI Task Group on Data Citation Standards and Practices is also addressing a key portion of recommendation 4.

4. CODATA Strategic Initiatives 2013-18

In light of CODATA's past experience with its previous strategic plan, and the inputs from ICSU, its member organizations, and other sources, CODATA has again identified three major cross-cutting initiatives to focus its efforts and priorities in the next six years. The purpose of these initiatives is to articulate a clear vision and programme of activities in key areas where CODATA can have significant impact, drawing not only on its core organization but also the broader community it

represents. The initiatives should enable CODATA to better coordinate its activities internally and with external groups and initiatives—especially ICSU members, interdisciplinary bodies, and strategic initiatives. The initiatives should help CODATA take advantage of synergies between activities, reduce duplication among similar efforts, improve continuity over time, and increase overall visibility, both across ICSU and externally. The three initiatives build upon the previous plan's initiatives but have been recast to be responsive to evolving needs and interests.

The three new initiatives are:

1. *Policy and Institutional Frameworks for Data*

2. *Frontiers in Data Science and Technology*

3. *Data Strategies for International Science*

Policy and Institutional Frameworks for Data

One of CODATA's unique strengths and key roles to date has been its leadership in the arena of scientific data policy and the development of institutional frameworks for data science and data management. Given the broad array of stakeholders involved in the general issues surrounding digital data and information in the information society, it is vital that CODATA continue to serve as a strong voice representing the scientific community on key policies and issues and in important international initiatives affecting science. CODATA's track record in the World Summit on the Information Society and the Group on Earth Observations and its collaborations with the CFRS, WDS, Science Commons, and others groups underscore its ability to have a direct impact on data access and stewardship, promoting implementation of the ICSU Principle of Universality with respect to data and addressing key issues such as the digital divide, open access, and data ethics.

Looking ahead to the 2013-18 period, it is clear that both significant opportunities and challenges are emerging with respect to data policy and institutional development at both national and international levels. On the one hand, support appears to be growing rapidly in the scientific community and among many science agencies and funders for much more open access to and sharing of scientific data. On the other hand, increased recognition of digital resources as valuable intellectual property has in many cases reduced access to important data needed for scientific inquiry or inhibited interoperability and interdisciplinary applications of data. New scientific and technological developments, e.g., with regard to "big data," are also rapidly changing the ways in which data are gathered, managed, analyzed, preserved, and made accessible not only by scientists but also by many other stakeholders including the general public.

The overall goal of this initiative is for CODATA to take on the lead responsibility for defining a policy agenda for scientific data, working collaboratively with other relevant ICSU bodies such as the CFRS and WDS-SC and other international bodies such as the newly established Research Data Alliance to identify the key policy and institutional frameworks most relevant to the future of scientific data and to solicit inputs from the scientific community on critical policy objectives and strategies to achieve them. For example, in the arena of open access to data, CODATA will work with ICSU and others to address the SCCID recommendations 2 and 3 to establish one or more forums to explore and build consensus on terminology related to Open

Access and to develop a set of principles for ICSU and CODATA members based on the OECD Principles and Guidelines.

A critical implementation step for this initiative is the formation of a standing Data Policy Committee consisting of key experts on data policy issues from a variety of disciplines, countries, and perspectives. Analogous to the *ad hoc* SCCID, this committee would be in a position to monitor key policy developments, advise CODATA and the ICSU community more generally on issues and options, and provide the expertise and continuity needed to establish and pursue a coherent "agenda for data." An important function of this committee would be to liaise with national, union, and other members on data policy issues on an ongoing basis, providing a source of advice on best practices, making these groups aware of key policy developments and timeframes for decisions, and soliciting and reporting on feedback. This committee could also be empowered to respond to requests for advice on data policy, legal, and ethical issues coming from the ICSU family or other parts of the international scientific community. A past example of this type of activity was the third year review of the Global Biodiversity Information Facility (GBIF) organized by KPMG and CODATA in 2004-05 (KPMG & CODATA, 2005). As part of this initiative, CODATA will continue to provide strong leadership on data issues in the Group on Earth Observations (GEO) and will explore comparable roles in other international initiatives and programs such as the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES), Future Earth, and the IRDR program.

Frontiers in Data Science and Technology

As in the past decade, the pace of change in data science and data-relevant technology is likely to continue to increase, with substantial impacts not only on the conduct of science but also the application of scientific data and knowledge to practical problems facing society. CODATA is uniquely positioned to promote sharing of knowledge and experience across disciplinary and national borders, allowing the broader community to gain valuable lessons from the "early adopters," promoting bilateral and multilateral collaborations on implementation efforts, facilitating access to state-of-the-art approaches and associated capacity building by those in developing countries, and facilitating participation and leadership on the part of early career scientists.

The overall goal of this second cross-cutting initiative is to identify key frontiers in data science and data management and stewardship, as well as important interdisciplinary application areas, where CODATA is likely to have the most substantial and beneficial impacts. For example, it is clear that many different communities have begun exploring data citation approaches from different perspectives; the CODATA-ICSTI Task Force on Data Citation Standards and Practices has already assembled an international group of key stakeholders and is working to harmonize existing approaches and identify gaps and inconsistencies. The CODATA-ICSU workshop on nanomaterials held in 2012 represents an emerging application area in which early efforts to connect communities working in relative isolation—including those in industry, government, and academia—may have substantial payoffs in terms of reduced duplication, increased interoperability, and complementary human, financial, and institutional resources. Other activities such as the special sessions at the IRDR Scientific Conference, the Planet Under Pressure conference, and the Forum on Science, Technology & Innovation in Sustainable Development illustrate the potential value of highlighting these frontier areas to the international scientific and stakeholder communities.

Similarly, new approaches to data rescue and stewardship, managing "big data," improving data quality and reliability, integrating data from multiple disciplines, and promoting sound and ethical data use in research and applications—that are being developed and employed in many different fields and problem areas—could be extremely valuable if more widely shared. This is certainly one important function of the biennial CODATA Conference, but additional mechanisms are needed on a more frequent, ongoing basis.

One possibility, as in the case of the Data Citation Standards and Practices Task Group and the nanomaterials effort, is to organize *ad hoc* specialized workshops involving the key stakeholders relevant to a particular problem or community. A key implementation step for this initiative will be to embed these types of workshops, meetings, and conference sessions as part of a consistent series of CODATA events on the Frontiers of Data Science and Technology, and promoting consistent outreach and follow-up. Task Groups, the CODATA Early Career Working Group, and other CODATA and partner groups will be encouraged to participate actively in this series and to work with the CODATA Secretariat on consistent messaging and outreach. These workshops could also be excellent venues for hands-on training sessions geared to early career scientists or those from developing countries.

The theme of Frontiers in Data Science and Technology may also be valuable in thinking about how to reinvigorate the *CODATA Data Science Journal* (DSJ)*, including efforts to find new partnerships and improve the DSJ's business model. Ideally, the DSJ should serve as a leading journal for the publication of state-of-the-art work in data science and technology and their application to real-world problems.

Under this initiative, CODATA will also address the SCCID recommendation 6 on education and recommendation 11 on working with standards bodies. One of the side benefits of a series of CODATA events will be a wealth of material on the latest developments in a particular area of science and technology, which will provide useful input into educational activities. These events also provide the opportunity to involve representatives of relevant standards bodies, as was the case with the nanotechnology workshop.

Data Strategies for International Science

Although general recognition of the importance of scientific data to international science appears to be increasing, there remain significant barriers to developing and implementing sound data management programs and infrastructure in a timely manner to meet desired objectives such as open access, improved data quality and reliability, long-term stewardship, and support for both research and application needs. For example, even though data were strongly highlighted in the IPY science plans, data management efforts were not given sufficient attention, priority, and resources to meet stated objectives. Mark Parsons has noted that "with all the 'naive assumptions', the lack of planning and other unanticipated obstacles, properly managing the IPY data will require another decade of work" (quoted in Nelson, 2009: 161). The primary goal of this initiative is therefore to help the major ICSU scientific programs identified in its current strategic plan to proactively address their scientific data management needs, including infrastructure, policies, processes, and resources.

With the launch of the IRDR program in 2011, CODATA has already begun working proactively to help IRDR address important data issues early in the program's development. This includes signing of a CODATA-IRDR MoU in October 2011,

organization of a data session at the First IRDR Scientific Symposium in October 2011, and participation in the IRDR Disaster Loss Data Working Group. CODATA helped to host a meeting of the Disaster Loss Data Working Group in conjunction with the CODATA Conference in Taipei in October 2012, and will continue working with the IRDR International Programme Office (IPO) on developing a coordinated IRDR data strategy.

A similar challenge exists with regard to the new Future Earth initiative to work proactively to identify key data needs, coordinate data development and infrastructure activities, develop data management and funding strategies, and support community outreach and participation in data-related activities. An initial step in this direction was the organization of prominent data sessions at the Planet Under Pressure conference in March 2012 and the Forum on Science, Technology & Innovation for Sustainable Development in June 2012. The 2012 CODATA Conference, which focused on "Open Data and Information for a Changing Planet," also called attention to the vital role of scientific data in sustainable development and environmental management. Over the next few years, CODATA plans to participate actively in the development of the Future Earth initiative, guided by ICSU and working as appropriate with the WDS and other relevant bodies.

Looking across and beyond specific scientific programs such as Future Earth and IRDR, CODATA is well positioned to promote coordination with key international initiatives and programs such as GEO, the European Union's Global Research Data Infrastructures (GRDI2020) project, the Eye on Earth initiative, the WSIS implementation and follow-up process, and the new Research Data Alliance (RDA). For example, there are many potential synergies between the development of the GEOSS Disaster Societal Benefit Area and IRDR data needs, and between a range of GEOSS data and services and Future Earth activities. CODATA has already established a joint initiative with the RDA on legal interoperability, building on CODATA's work on data sharing with GEO and extending this to other fields such as biodiversity, the humanities, and the social sciences. CODATA could play a lead role in harmonizing data policies, encouraging more open data access and interoperability, and supporting the development of long-term strategies for data stewardship.

Another important niche for CODATA is in the arena of developing cross-disciplinary communities and problem-focused teams aimed at key international data management needs. Examples include the Task Group on Global Roads Data Development, the Polar Year Data Policy and Management Task Group, the Data at Risk Task Group, and the CODATA-ICSTI Task Group on Data Citation Standards and Practices. Through its regular Task Group call, CODATA is able to bring together a mix of experts from academia, government, nongovernmental organizations, and industry to address specific problems or issues of common interest. CODATA will continue to give priority to task group proposals that specifically address strategic plan priorities.

5. CODATA Vision and Evolution

Expanding CODATA's Role

As an interdisciplinary committee of ICSU, CODATA has traditionally viewed itself as one of many groups within the ICSU family concerned with scientific data and information. However, over the past decade the potential roles of different ICSU bodies have become clearer, in part due to several ICSU reviews and assessments. In

particular, the consolidation of the World Data Centers and the astronomical and geophysical services into a new World Data System (WDS) is helping to support ICSU research initiatives by ensuring long-term stewardship and provision of quality-assessed scientific data services in the relevant disciplines. CODATA continues to work with a wide range of disciplines, including physics, chemistry, the material sciences, and the life and social sciences. Other bodies affiliated with ICSU such as ICSTI and CFRS have overlapping interests, but are not centrally focused on scientific data challenges. Since ICSU only established the SCCID as an *ad hoc* committee, and in fact did not renew it for a second three-year term, there appears to be an important niche for CODATA to take on a more visible leadership role related to international scientific data on an ongoing basis. This could include the key SCCID terms of references, e.g., the four listed previously. These terms of reference would clarify CODATA's role with respect to data within the ICSU family and for international science more broadly.

To successfully carry out these terms of reference, CODATA may need to consider some organizational changes to bring in appropriate expertise and provide continuity over time. The planned Data Policy Committee would be one mechanism for pulling together a group of leading international experts on data policies, who could advise CODATA, ICSU, and the scientific community in general on data policy issues and oversee the development of international forums as recommended by the SCCID.

CODATA should also consider mechanisms for ensuring ongoing, two-way interactions with key ICSU programmes and activities such as IRDR and Future Earth. Establishment of additional MoUs, like the one signed with IRDR, and appointment of liaisons and/or *ex officio* representatives on relevant committees should be worked out with the relevant governing bodies and secretariats. CODATA should continue to participate actively in relevant scientific conferences, e.g., those organized by IRDR, Future Earth, and the WDS, and to promote their involvement and visibility in the CODATA Conference. Coordination of the WDS scientific symposium with the CODATA Conference is also being planned in 2014 and beyond. The CODATA Early Career Working Group could also play a valuable role in increasing the participation of early career scientists in many of these activities.

Clarifying CODATA's Role with Respect to the WDS

A continuing question for many within the ICSU family and for external scientists and organizations is the relationship between CODATA and WDS and whether there is reason to merge the two organizations. CODATA is broadly concerned with the policies, standards, and methods that affect scientific data management across a wide range of sciences. The WDS is primarily charged with creating and operating an integrated, state-of-the-art system from a distributed set of individual data centers and data services, mostly in the geophysical and environmental sciences but beginning to expand to other related fields. CODATA and WDS grew out of different disciplinary traditions—CODATA largely from the physics and chemistry communities engaged in developing reference data (Lide and Wood, 2012), and the WDS from the International Geophysical Year (IGY), which had spawned both the original World Data Centres and the Federation of Astronomical and Geophysical Services. CODATA presently has national members and Union members from a range of disciplines, whereas the WDS consists primarily of regular members (data centers and data services) and network members (umbrella organizations and coordination

offices). CODATA's Secretariat is co-located with the ICSU Secretariat in Paris, and the WDS International Programme Office is based in Tokyo.

CODATA and the WDS share the common goal of supporting the advancement and universality of international science. Where there is an overlap in interests, such as in sharing of remote sensing and geospatial data or the development of data citation approaches, CODATA and WDS already have a strong track record of cooperation. Moreover, CODATA tends to take the lead where it has the strongest expertise, e.g., in data policy issues related to the Group on Earth Observations (GEO) or the International Polar Year (IPY). However, there are many areas in which CODATA and WDS interests do not overlap significantly, e.g., in the development of nanotechnology data standards and anthropometry data. Moving ahead, therefore, it is important that CODATA and WDS communicate clearly on their plans and activities to ensure collaboration when appropriate and avoid duplication or conflict. This Strategic Plan is one channel for achieving this goal; WDS representation as a Co-Opted Member of CODATA is another. In addition, CODATA needs to explore with WDS how it can formally liaise with the WDS, either by becoming a WDS network member or through some other mechanism. Together, CODATA and the WDS can help the scientific community in areas of common interest select high-level data standards, improve data access in less developed countries, and work together to raise the overall visibility of scientific data and information management.

Strengthening CODATA Membership

CODATA is somewhat unique in having its own membership structure, a legal existence as a nonprofit organization incorporated in France, and its own Secretariat. In some cases, CODATA national members are no longer the same as or directly affiliated with the corresponding ICSU national member, which has traditionally been an academy of science. This in part reflects the growing diversity of institutions and stakeholders involved in data science and scientific data management.

A membership committee established in 2011 has reviewed CODATA's current membership situation and made recommendations regarding how to improve the "business model" for CODATA membership. In particular, the committee noted the need to expand membership options for the wide range of academic institutions, national and international organizations, private companies, and potentially individuals with strong data interests. Based on further strategic plan discussions, the 27th CODATA General Assembly has decided to add two new membership categories in its current Constitution. The first category is a new option for institutional membership, "Affiliate Member." Affiliate Members have the right to select at least one delegate to represent them at the General Assembly.[4] It is anticipated that this category will eventually replace the current provision for non-voting "Supporting Organizations" (Statute 11).

The 2006-12 Strategic Plan proposed establishment of an Associates Program and an International Data Academy in an effort to build a community of data scientists and professionals associated with CODATA. After extensive discussions at multiple Executive Committee meetings and General Assemblies, it became clear that such efforts would likely entail a significant investment of limited resources (e.g.,

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[4] The CODATA Executive Committee is charged with establishing membership categories and dues levels. In accordance with the CODATA Constitution, these changes in statutes must be ratified by the ICSU Executive Committee.

Secretariat time) with uncertain benefits to the organization. As an alternative, CODATA has added a new option for individual membership, the "At-Large Member." Such at-large members also have the right to select at least one delegate to represent them at the General Assembly.[5]

CODATA also needs to continue to actively recruit new national and Union members, including efforts to build constituencies within particular countries that might be most amenable to joining CODATA. Encouraging bilateral and multilateral collaboration among CODATA members can also be valuable in building constituencies and demonstrating the value of CODATA membership. Given continued economic uncertainties, CODATA also has to monitor possible retention situations closely and take action in advance if possible. CODATA should consider extending the remit of the existing Membership Committee to assist the Secretariat in this regard.

Outreach and Community Development

The SCCID report noted the need for both "inreach" to the ICSU community and "outreach" to the broad scientific data stakeholder community and suggested mechanisms appropriate to each of these functions. CODATA needs to plan its inreach and outreach activities with its overall strategic goals in mind and recognizing the evolution of methods and approaches needed in a rapidly changing information society. This should include high profile efforts such as preparation of editorials and policy pieces in prominent journals and other venues, as well as use of new social media approaches to promote CODATA visibility and impact in specific communities. The latter could be especially valuable in increasing the prominence of the biennial CODATA conference and the new set of workshops on the Frontiers of Data Science and Technology. Focused outreach to industry, developing countries, and female and early career scientists would be especially valuable. CODATA should consider establishment of an Outreach Committee or equivalent group to assist the Secretariat on an ongoing basis on outreach and community development activities.

Financial Planning and Sustainability

CODATA has made significant progress in improving its financial planning in recent years, including shifting its budget to an accrual basis, improving its annual audits, managing its funds in multiple currencies and accounts, and establishing a formal reserve fund that will be gradually increased to include at least one year's operating reserve. Despite large swings in currency markets, CODATA has been able to minimize losses and transaction fees by matching revenues with expenses in the same currency to the extent possible.

Nevertheless, CODATA does remain vulnerable to the loss of dues from a larger country and to possible major economic disruptions. Moreover, for CODATA to achieve its strategic objectives, it may need to make some upfront investments and take some risks, e.g., altering its dues and membership structure.

CODATA's highest priority in the near term should be to complete the revision of its dues structure, in close consultation with its membership. This effort should lead to greater sustainability with respect to the ability of members to pay dues, and improve the outlook for recruitment of new members.

It is also vital for CODATA to focus on strengthening its Secretariat, particularly with regard to the transition of the Executive Director. A strong Secretariat is central to CODATA's ability to implement its Strategic Plan and achieve its strategic

objectives. This may require additional investment by CODATA in order to ensure continuity and establish the foundation necessary for long-term sustainability and growth.

6. Implementation of the Strategic Plan

Table I summarizes the key actions identified in this Strategic Plan and provides a time frame and lead group with primary responsibility for the action. It is expected that additional implementation actions may be identified and added as needed.

Table I. Summary and Timeline of Major Implementation Actions

Action	Time Frame	Lead
1. Policy and Institutional Frameworks for Data		
1.1 Establish Data Policy Committee (DPC)	2013-14	GA & EC
1.2 Help organize forum on open access with ICSU	2013-14	DPC
1.3 Organize forum based on OECD guidelines and principles	2013-14	DPC
1.4 Expand data policy role in Future Earth, IRDR, and other ICSU programs and initiatives	2012-16	DPC, EC
2. Frontiers in Data Science and Technology		
2.1 Establish CODATA workshop series on Frontiers of Data Science and Technology	2013-16	EC, TGs
2.2 Expand CODATA's education and training activities including curriculum development	2013-16	EC, TGs, WGs
2.3 Develop relations with relevant standards bodies in coordination with ICSU Unions	2013-18	EC, Union Members
2.4 Reinvigorate the *CODATA Data Science Journal*	2012-14	EC
3. Data Strategies for International Science		
3.1 Help Future Earth develop and implement a coordinated data strategy	2013-18	EC, relevant TGs, DPC
3.2 Help IRDR develop and implement a coordinated data strategy	2012-14	EC, relevant TGs, DPC
3.3 Formalize relationships with key international data initiatives	2013-18	EC
4. CODATA Evolution		
4.1 Establish formal liaison with WDS	2013-14	EC, Secretariat
4.2 Add new membership category or categories	2012-14	GA, EC
4.3 Extend remit of Membership Committee and expand recruitment efforts	2013-14	EC, Secretariat
4.4 Establish Outreach Committee or equivalent and strengthen outreach efforts	2013-14	EC, Secretariat
4.5 Revise dues structure	2012-14	GA, EC

GA=General Assembly, EC=Executive Committee, TG=Task Group, WG=Working Group, DPC=Data Policy Committee

Assessing Progress and Impact

The development of a strategic plan is an important step in a long-term strategic planning process that should inform CODATA's leadership and membership on an ongoing basis and support priority setting and decision making. Establishing clear milestones and metrics and a transparent evaluation process is essential to promoting participation and support in the activities needed to accomplish the Plan's goals and objectives.

Table I provides specific time frames for the major strategic actions articulated in this Plan. It is expected that the biennial General Assemblies will serve as key deadlines in 2014, 2016, and 2018 for these actions. The Executive Committee will need to define more detailed schedules for specific milestones based on resource issues, external partnerships, and other considerations.

Metrics are important not only in assessing progress in implementing the Plan but also in determining whether Plan actions are having desired impacts. Table II contains an initial set of possible metrics for each of the Plan actions. The Executive Committee will need to select metrics based on available data and resources, as well as consideration of the utility of each metric in supporting decision making.

Table II. Possible Metrics for Strategic Plan Actions

Action	Plan Metric	Impact Metric
1. Policy and Institutional Frameworks for Data		
1.1 Establish Data Policy Committee (DPC)	DPC meetings	Guidance provided by DPC
1.2 Help organize forum on open access with ICSU	Forum participation	Output & visibility of Forum
1.3 Organize forum based on OECD guidelines and principles	Forum participation	Output & visibility of Forum
1.4 Expand data policy role in Future Earth, IRDR, and other ICSU programs and initiatives	Role in FE, IRDR, etc.	Influence on FE, IRDR data policy
2. Frontiers in Data Science and Technology		
2.1 Establish CODATA workshop series on Frontiers of Data Science and Technology	Number & participation	Output & visibility of workshops
2.2 Expand CODATA's education and training activities including curriculum development	No. of activities	No. of trainees and feedback
2.3 Develop relations with relevant standards bodies in coordination with ICSU Unions	New linkages	Greater involvement in standards activities
2.4 Reinvigorate the *CODATA Data Science Journal*	New partnership(s)	No. of papers and impact factor
3. Data Strategies for International Science		
3.1 Help Future Earth develop and implement a coordinated data strategy	FE data strategy	Implementation of strategy
3.2 Help IRDR develop and implement a coordinated data strategy	IRDR data strategy	Implementation of strategy
3.3 Formalize relationships with key international data initiatives	New agreements	Activities based on new agreements
4. CODATA Evolution		
4.1 Establish formal liaison with WDS	Liaison(s) established	New collaborative activities

4.2 Add new membership category or categories	No. of new members by age, gender, region, etc.	Participation by new members
4.3 Extend remit of Membership Committee and expand recruitment efforts	Retention and recruitment activities	No. of retained and new members
4.4 Establish Outreach Committee or equivalent and strengthen outreach efforts	Outreach activities	Greater CODATA visibility in key communities
4.5 Revise dues structure	Acceptance of new dues structure	Improved financial situation

Evaluation should be an ongoing process that informs the CODATA leadership and membership about progress on a time frame that enables meaningful corrections and adjustments when needed. Internal evaluation is the primary responsibility of the Executive Committee, working closely with the Secretariat. The Executive Committee should review Plan progress at least annually, and should report on progress and challenges at the biennial General Assembly. The Executive Committee should also consider the need for a more in-depth evaluation in the 2015-16 time frame, potentially involving some external evaluators. This would provide CODATA with the objective information needed to determine if Plan goals and objectives will be met, or if changes are warranted.

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Appendix

Review of Strategic Plan 2006-12 Accomplishments

CODATA's *Strategic Plan 2006-12* recognized the need for CODATA to take a leadership role in several key areas of science and scientific data policy and development. The plan identified three main initiatives as well as a number of other important organizational and capacity building efforts. The three initiatives are:

1) Global Information Commons for Science Initiative (GICSI);

2) Scientific Data across the Digital Divide (SD^3) Program; and

3) Advanced Data Methods and Information technologies for Research and Education (ADMIRE).

GICSI

GICSI was launched by CODATA and several partner organizations at the second phase World Summit on the Information Society (WSIS) meeting in Tunis in 2005. CODATA played an important role at WSIS in helping to ensure high-level recognition of the role of scientific data and information in the "information society" (Iwata and Chen, 2005).

Subsequently, CODATA provided leadership in a range of science-focused "commons" efforts, including the Microbial Commons, the Polar Information Commons (PIC), and COMMUNIA, the European Thematic Network on the Public Domain in the Digital Age. For example, CODATA co-organized a workshop on common use licensing of scientific data in Paris in September 2007 with the Science Commons Project of Creative Commons and the Global Biodiversity Information Facility (GBIF), which led to development of the Science Commons Protocol for Implementing Open Access Data (Science Commons, 16 December 2007). CODATA's Task Group on GICSI-European Union activities, established in 2008, organized the 2nd COMMUNIA Conference on Global Science and the Economics of Knowledge-Sharing Institutions (G-SEKSI) in June 2009 in Torino, Italy.

Simultaneously, CODATA actively contributed to a number of important data policy initiatives, including the OECD Principles and Guidelines for Access to Research Data from Public Funding (OECD, 2007) and the implementation of the Data Sharing Principles of the Group on Earth Observations (GEO). In particular, CODATA has led ICSU's contribution to GEO data sharing activities, including serving as one of the co-chairs of the GEO Data Sharing Task Force in 2009-11 and the current GEO Data Sharing Working Group (2011-15), organizing numerous side events and sessions at GEO Plenaries and other conferences, and promoting open access and sharing to the maximum possible extent (e.g., Uhlir *et al.*, 2009; GEO, 2009, 2011).

Building on ICSU's strategic focus on the International Polar Year (IPY), CODATA established a Task Group on Polar Year Data Policy and Management that actively supported IPY data management activities before, during, and after the IPY field phase. In 2009, CODATA and a number of partners received an ICSU grant to develop the concept of a Polar Information Commons, utilizing the Science Commons protocol as a starting point. A prototype PIC was established (polarcommons.org) and has been recognized as a potentially valuable approach to ensuring the IPY data "legacy" (ref).

GICSI also provided a framework for a number of important open access initiatives on the part of national and union members. This includes the Integrated Marine Observing System (IMOS), the Terrestrial Ecosystem Research Network (TERN), the Atlas of Living Australia (ALA), the Australian National Data Service (ANDS), and the Research Data Storage Infrastructure (RDSI) initiatives in Australia and the open access[5] journal, *Acta Crystallographica Section E: Structure Reports Online*, of the International Union of Crystallography (IUCr) and other open access databases affiliated with IUCr.

SD³

The SD³ initiative has focused on the pressing needs of developing country scientists, students, and applied users for scientific data related to sustainable development. Several CODATA Task Groups have led a number of important activities on these issues. For example, the Task Group on Preservation of and Access to Scientific and Technical Data in Developing Countries organized a workshop on Open Knowledge and Data Environment for Innovative Research on Poverty-Free and Ecosystem Protection in Ulaanbaatar, Mongolia in July 2011. The CODATA Global Roads Data Development Task Group, established in 2010, has been working to develop an open access intercity roads database, useful for a wide range of applications especially in developing countries. CODATA also collaborated with the ICSU World Data System (WDS) on the development of a new World Data Center on Biodiversity and Human Health in South Africa and with the Chinese Academy of Sciences on the establishment of the Global Alliance for Enhancing Access to and Application of Scientific Data in Developing Countries (e-SDDC), part of the United Nations Global Alliance for Information and Communications Technologies and Development (GAID).

CODATA also collaborated with the ICSU Committee on Freedom and Responsibility in the Conduct of Science (CFRS) and the World Data System Scientific Committee on the development of the ICSU CFRS Advisory Note on Sharing Scientific Data, with a Focus on Developing Countries, released in 2011.

CODATA's 22nd biennial conference was held in Cape Town, South Africa in 2010 and, with support from the National Research Foundation (NRF) of South Africa, enabled some 80 African scientists, including 50 young scientists, to interact with about 200 members of the international CODATA community. Subsequent activities have included a CODATA International Training Workshop for Developing Countries on Scientific Data Management and Sustainable Development, organized by the Chinese National CODATA Committee and CODATA International, held in Beijing in July 2012, with 14 participants from developing countries in Africa and Asia. CODATA was also a sponsor of a Seminar on Data Processing Techniques for

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[5] As of 2008.

Enhancing Earthquake Risk Modeling and Post-Earthquake Loss Assessment organized by the China Earthquake Administration in July 2012, which drew more than 80 provincial earthquake disaster risk managers, many of them in the early stages of their careers. CODATA's Young Scientist Working Group (recently re-established as the Early Career Working Group) has been instrumental in involving a wide range of early career scientists in CODATA conferences, workshops, and task group activities and calling attention to their roles and needs with respect to the evolution of data science.

It is worth noting here that CODATA's efforts related to open data access and data policy, e.g., in the context of GEO, have important implications for addressing the digital divide. For example, CODATA was instrumental in highlighting the need for open reuse and redissemination of data from the Global Earth Observing System of Systems (GEOSS), especially for those in developing countries with limited access to the Internet (link to guidelines). CODATA also organized prominent data sessions at the First Integrated Research on Disaster Risk (IRDR) Conference in Beijing in October 2011 and at the ICSU Forum on Science, Technology & Innovation for Sustainable Development, held in Rio de Janeiro just prior to the Rio+20 United Nations Conference on Sustainable Development in June 2012. CODATA also co-organized the data session with ICSU and the WDS Scientific Committee at the ICSU Planet Under Pressure conference in London in March 2012.

ADMIRE

Rapid advances in information technology and data science methods in many different scientific disciplines underscore the need to promote greater awareness, cross-disciplinary exchange, and capacity building related to developing and applying new data processing, management, and analysis approaches in new areas of science. As science has increasingly moved from a "data poor" to a "data rich" world, new techniques have emerged for processing vast quantities of heterogeneous data, identifying and extracting relevant or desired data from large data holdings, and integrating diverse data sets in creative ways.

Several CODATA task groups have taken on key challenges related to the application of new technologies to data development, management, and application. For example, the CODATA Global Roads Data Development Task Group explored the use of Geographic Positioning System (GPS) technologies, automated road extraction methods from remote sensing data, and open crowd sourcing as alternative approaches to building an open access intercity roads database compatible with the United Nations Spatial Data Infrastructure–Transport (UNSDI-T) data model. The Task Group received external funding from both the AgCommons Initiative and the SERVIR program for some of this work. The CODATA-ICSTI Task Group on Data Citation Standards and Practices is currently exploring the implementation of unique digital identifiers for data to enable improved provenance tracking and citation for scientific data and information. In collaboration with the US National Committee for CODATA, the Task Group held an International Symposium and Workshop on Developing Data Attribution and Citation Practices and Standards in Berkeley CA in August 2011 (Uhlir, 2012).

CODATA is also playing a lead role in key areas of new technology development. In February 2012, for example, CODATA led the organization of the ICSU-CODATA Workshop on the Description of Nanomaterials, which brought together key

stakeholders from academia, industry, and government to review the present status of description systems for nanomaterials and to bring the views of their respective scientific communities to the attention of groups actively engaged in developing standardized nanomaterials descriptions.

Other Strategic Accomplishments

CODATA's *Strategic Plan 2006-12* identified a number of other organizational priorities aimed at improving CODATA's effectiveness and capacity to support its goals and membership needs. Specifically, CODATA has been working actively to address a number of membership issues, including its dues structure, member benefits and participation, and specific recruitment and retention cases. In light of the significant economic challenges facing most countries in recent years, it is not surprising that CODATA has had mixed success in some areas, and indeed it is important to recognize that CODATA has weathered the most volatile economic period since its founding without any major financial or organizational disruption. This stems in part from recent changes in the dues structure and financial management (e.g., enabling dues payment in both U.S. dollars and euros) and most certainly to the high priority given by national members to meeting their dues obligations.

With regard to national membership, CODATA has made significant progress in some areas but also continues to face a number of challenges. Australia rejoined CODATA in 2008 and has established an active national committee. The UK also rejoined CODATA in 2008, represented by the UK Digital Curation Centre (DCC), which formed a national committee in 2009. Unfortunately, Italy withdrew as a member in 2008, and Germany remains an Associate Member. France returned as a National Member at a reduced dues level in 2008-2011, but as of 1 January 2012 reverted to Associate Member status in accordance with a resolution of the CODATA General Assembly. CODATA has not been able to revive membership by three former African members (Cameroon, Nigeria, and Senegal), which had been unable to pay dues for many years. On a positive note, Mongolia became a new member at the 27th General Assembly in 2012, and Finland and the Czech Republic have joined CODATA effective in January 2013.

CODATA has also been working to improve participation by its scientific union and co-opted members. The IUGG revived its representation in 2008. CODATA jointly launched the LIN CHAO Digital Geomuseum with the International Geographical Union (IGU) and the Geographical Society of China at its 45th Anniversary event in Beijing in October 2011. The World Data System was accepted as a co-opted organization member in 2010, replacing the former World Data Center and Federation of Astronomical and Geophysical Services members. CODATA President Guo gave a keynote speech at the second Symposium of the World Data Center for Microorganisms (WDCM) in June 2012.

Given the expanded interest and role in data science and management by a wide range of stakeholders, the Supporting Organization membership category provides the opportunity to directly engage new organizations in CODATA. The recent addition of the U.S. National Archives and Records Administration (NARA) and the Computer Network Information Center (CNIC) of the Chinese Academy of Sciences as Supporting Organizations are indicative of the potential value of this approach.

It is important to recognize that, as a membership organization with a broad range of stakeholders, CODATA may also have significant accomplishments that do not necessarily fall into the priorities set by any particular strategic plan. A case in point is the CODATA Task Group on Fundamental Constants, which is now an official member of the Consultative Committee on Units (CCU) of the International Conference on Weights and Measures (CIPM). The Task Group issued an update to the fundamental physical and chemical constants in 2011 (http://physics.nist.gov/cuu/Constants/index.html; Mohr *et al.*, 2012) and is currently advising the CIPM on a major change in the International System of Units (SI) that will make many of the fundamental constants significantly more accurate and in most cases make energy conversion factors exact. The new Data at Risk task group is working to characterize the range of significant analog and digital data resources that are at risk of loss, which could set the stage for development of a new strategic initiative, should that be warranted.

CODATA national members have also organized a variety of successful national, bilateral, and regional activities. This has included a series of more than 5 roundtable meetings on scientific data cooperation organized by the China and US national CODATA committees in both the U.S. and China from 2006 to 2011. CODATA also commissioned a detailed 45-year history of the organization, prepared by former President and Secretary-General David Lide and former Vice President and Treasurer Gordon Wood (Lide and Wood, 2012), distributed at the Taipei CODATA Conference and General Assembly and available online.