Board on Research Data and Information
Washington, DC
27-28 October 2016

CODATA: An Overview and Status Report

Bonnie C. Carroll
Secretary General, CODATA
www.codata.org

The ICSU Context

Structure

- General Assembly
- Executive Board
- **Committees**
- Interdisciplinary Bodies
- Offices & staff

- A non-governmental organisation
  - 122 Members, representing 142 countries
  - 31 International Scientific Unions

Mission:

- Strengthen international science for the benefit of society
  - Identify and address major issues of importance to science and society.
  - Facilitate interaction amongst scientists across all disciplines and countries.
  - Promote the participation of all scientists—regardless of race, citizenship, language, political stance, or gender—in the international scientific endeavour.
  - Provide independent, authoritative advice to stimulate constructive dialogue between the scientific community and governments, civil society, and the private sector.

CODATA: Committee on Data for Science and Technology

ICSU
International Council for Science

ICSU's Mission → **CODATA's Mission**

"Strengthen international science for the benefit of society

by promoting improved scientific and technical data management and use."

CODATA History and Mission

By the early **1960s** a number of scientific leaders began to realize that this deluge of data was swamping the traditional publication and retrieval mechanisms, and that there was a danger that much of it would be lost to future generations. When several of these leaders got together and agreed that an organized international effort was needed to improve the management and preservation of scientific data and to facilitate coordination among interested groups throughout the world, **the creation of CODATA was the outcome.**

CODATA @ 45 Years: the story of the ICSU Committee on Data for Science and Technology

CODATA – 50 Years of Service

Committee on Data for Science and Technology

- **Created in 1966** by the International Council of Science (ICSU)
- Initial strong focus on **reference data in physical sciences**
- Today covers data interests in **all scientific disciplines**

- Leadership in facilitating **data policies** and **data ecosystems**
- **Task and Working Groups**, Conference, Workshops and Journal.
- Promotes **data science**, especially across disciplines
- **CODATA History**: http://www.codata.org/publications/codata-history

CODATA Decade by Decade

60s-70s - basics
- Fundamental constants
- Key values for thermodynamics
- Computer use
- Compendium of numerical data projects

70s – higher level issues
- Chemical kinetics
- Numerical data by disciplines
- Data dissemination
- Handllng of experimental data
- Thermodynamic data systemization

80s – addressing disciplinary specifics
- Data in the biosciences & geosciences
- Directory of protein & nucleic acid sequencing
- Access to biological data banks
- Biodiversity international standards
- Materials database standards
- Chemical thermodynamic tables

90s – managing data
- Databases for Experimentation
- Electronic Publishing
- Data Access Commission
- Global Plant Checklist Network
- Data/Information and Visualization
- Mathematical Methodologies for Data
- Handling and Knowledge Extraction
- Data Quality and Database Compatibility

- **2000s – addressing the digital revolution**
- Data Citation: use of DOIs for data;
- International Polar Year Data
- International Symposium on Open Access and the Public Domain
- Digital Data and Information in Science;
- OECD Data Policy Recommendations.
- GEO Data Sharing Principles

2010s - open data, open science
- Policy and practice
- Frontiers of scientific use of data
- Capacity building

CODATA National Committees

- CODATA Membership is largely national, so National Committees play an important role.
- **What are the roles of a CODATA National Committee?**
  - Forum for national stakeholders (research funders, National Academies, research institutions, data centres, learned societies, research libraries, etc)
  - Forum by which national stakeholders may advance data agenda in step with international developments
    - Engagement with CODATA International and other countries.
  - Network effect of collaboration, exchanges between National Committees

US National Committee

- Membership of BRDI, plus
  - Elected International Officials
    - Secretary General Bonnie Carroll
    - Executive Committee Member Paul Uhlir
  - US TG Chairs (Below)
- Reports to BRDI
- Work through Teleconferences

CODATA TGs and US Chairs

U.S. National Committee for CODATA

BOARD ON RESEARCH DATA AND INFORMATION

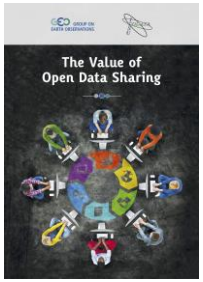
Task Group	U.S. Chair?	Chair Name(s)
Coordinating Data Standards amongst Scientific Unions	YES	Xiaogang (Marshall) Ma Department of Computer Science University of Idaho
Building Foundational Training in Research Data Science	NO	
Practice and Impact of Digital Data Citation	YES	Co-Chair, Franciel A. Linares Senior Program Manager Senior Advisor, Christine Borgman Distinguished Professor & Presidential Chair in Information Studies University of California, Los Angeles
Linked Open Data for Global Disaster Risk Research (LODGD)	YES	Carol Song CO-Chair Rosen Centre for Advance Computing, Purdue University, US cxsong@purdue.edu
Agriculture Data, Knowledge for Learning and Innovation	YES	David Nielson, Co-chair (alternate) World Bank -Lead Agriculture Economist
Citizen Science and the Validation, Curation, and Management of Crowdsourced Data (with WDS)	YES	Alex de Sherbinin, Co-Chair Associate Director for Science Applications CIESIN, Columbia University
Preservation of and Access to Scientific and Technical Data in Developing Countries (PASTD)	NO	
Earth and Space Science Data Interoperability (ESSDI)	NO	

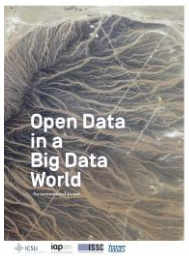
CODATA

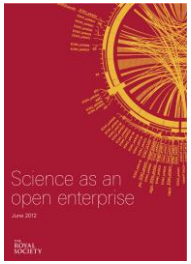
Principles, Policies and Practice

DC1 Data Citation Principles

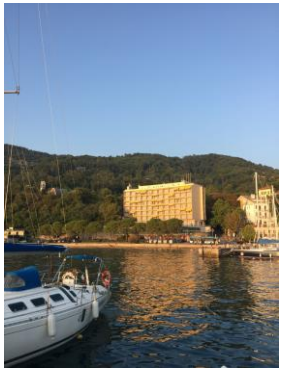
ICSU International Council for Science







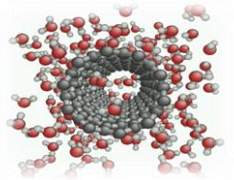
Capacity Building

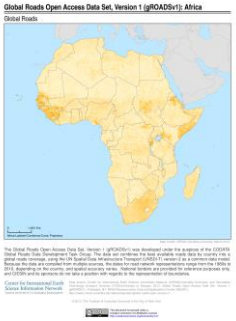


UNESCO

The Abdus Salam International Centre for Theoretical Physics

Frontiers of Data Science





ubiquity press open scholarship

Data Science Journal

SciDataCon 2016, 11-13 Sept, Denver, CO.

INTERNATIONAL DATA WEEK 2016
WWW.INTERNATIONALDATAWEEK.ORG

The Case for Open Data in a Big Data World

- **Science International Accord on Open Data in a Big Data World: http://www.science-international.org/**
- Presents a powerful case that the profound transformations mean that data should be:
  - Open by default
  - Intelligently open
- Supported by four major international science organisations.
- Lays out a framework of principles for how the vision of Open Data in a Big Data World can be achieved.
- Campaign for endorsements: over 100 organisations so far.
- **IUCr Position Paper: http://www.iucr.org/iucr/open-data**

Data Policies: Data Citation

If publications are the stars and planets of the scientific universe, data are the 'dark matter' – influential but largely unobserved in our mapping process

Task Group on Data Citation Principles and Practices

Out of Cite, Out of Mind
http://bit.ly/out_of_cite

Joint Declaration of Data Citation Principles:
https://www.force11.org/datacitation

Background and Developments:
http://bit.ly/data_citation_principles

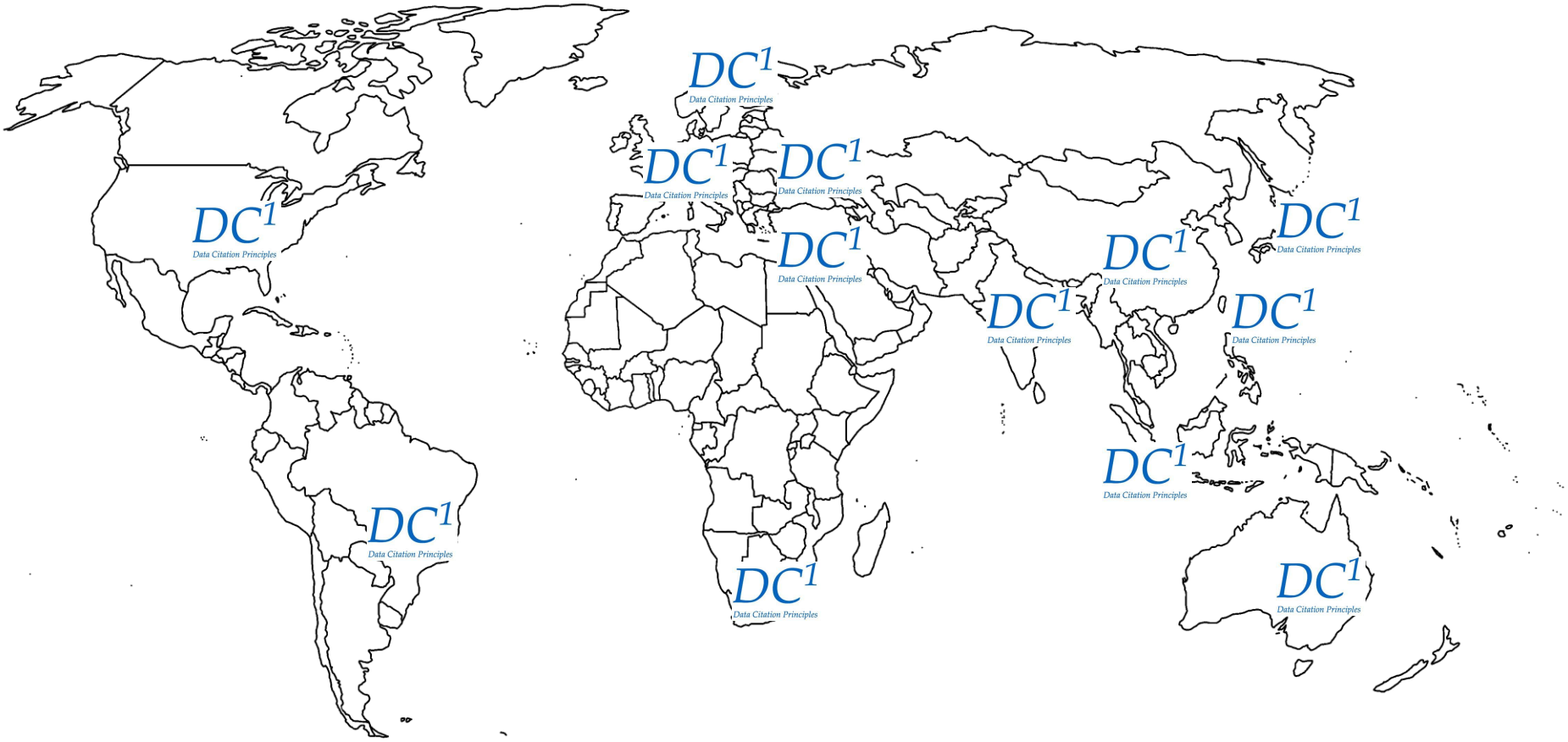
DC1
Data Citation Principles

Data Citation: From Principles to Practice

- **Organising an international series of implementation and adoption workshops.**
- Promote the implementation of data citation principles in the research policy and funding communities throughout the world.
- **Stakeholders** include: government, funders, research performing institutions, research administrators, research librarians, researchers, learned societies, publishers, data archives, journal editors …
  - What is the policy environment for data citation?
  - What are current attitudes to data citation?
  - What infrastructure currently exists to support data citation?
  - What specific plans for implementation were identified?

CODATA Task Group on Data Citation 'Data Citation: From Principles to Practice, A Focus on the Research Policy and Funding Community': http://www.codata.org/task-groups/data-citation-standards-and-practices

DC1 Data Citation Principles

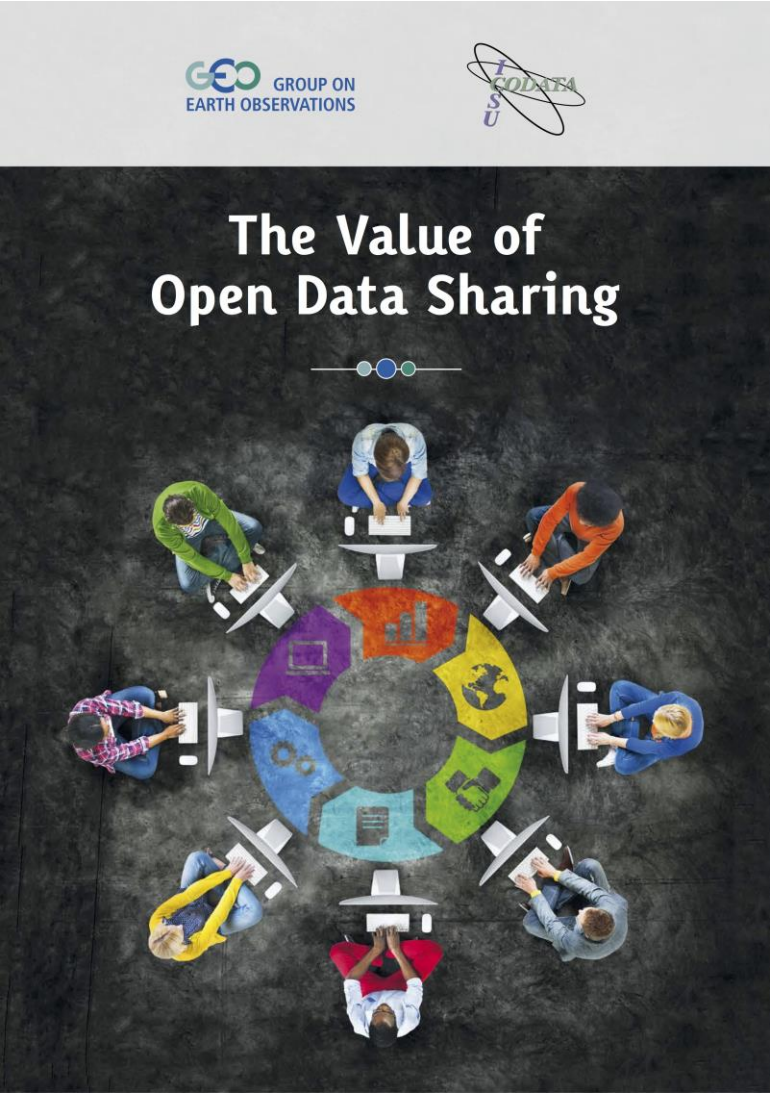


DC1
Data Citation Principles

Taking the Data Citation workshops on a world tour!

2015: China, Australia, Japan, India and South Africa.
2016: **USA**, Israel, Russia *+ Finland (Nov) and Taiwan (Dec).*
2017: France, Korea, Indonesia, Brazil…

The Value of Open Data Sharing In Earth Observation



- **Report by CODATA for GEO, the Group on Earth Observation.**
- Provides a concise, accessible, high level synthesis of key arguments and evidence of the benefits and value of open data sharing.
- Particular, but not exclusive, reference to Earth Observation data.
- Benefits in the areas of:
  - Economic Benefits
  - Social Welfare Benefits
  - Research and Innovation Opportunities
  - Education
  - Governance
- Available at http://dx.doi.org/10.5281/zenodo.33830

Implementation Guidelines for the Legal Interoperability of Research Data

1. **Facilitate the lawful access to and reuse of research data.**
2. **Determine the rights to and responsibilities for the data.**
3. **Balance the legal interests.**
4. **State the rights transparently and clearly.**
5. **Promote the harmonization of rights in research data.**
6. **Provide proper attribution and credit for research data.**

- **Joint CODATA-RDA Interest Group on Legal Interoperability.**
- Builds on work done in the context of the GEO Data Sharing Working Group.
- Set of principles to help ensure the fewest possible legal barriers relating to IP to sharing research data.
- Implementation guidelines offer high level guidance on steps to take to reduce legal barriers to data reuse.
- Result of lengthy consideration by the IG and two strenuous rounds of peer review.
- **Just published** https://doi.org/10.5281/zenodo.162241

The Challenge: Sustainable Business Models for Data Repositories

- Research funder policies mandate data stewardship.
  - OECD Principles and Guidelines, 2007
  - G8 Science Ministers Statement, 2013
  - Major funders in US, UK, EC Horizon 2020 data policy etc.
- Increasing need for data repositories and data stewardship.
  - Increasing volume presents a challenge.
  - Requirements for stewardship present a greater challenge.
- **Sustaining digital data infrastructure is a major issue for science policy!**
- Genuine concern that current funding models will prove inelastic and not meet the growing requirements – concern on the part of repositories and funders.
- Witnessing Innovation
  - Changes in funding / business models (ADS, DANS, ICPSR)
  - Innovative business models (Dryad, FigShare)

OECD Global Science Forum Project: Sustainable Business Models for Data Repositories

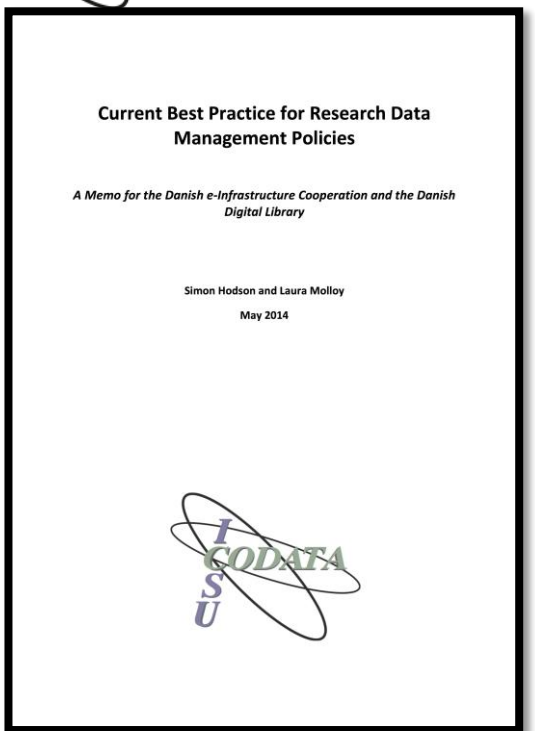
- Questions to address:
  1. How are data repositories currently funded?
  2. What innovative income streams are available?
  3. What means of restraining costs are available?
  4. How do income streams match willingness/ability to pay of various stakeholders?
  5. How do income streams/willingness to pay fit together into a **sustainable** business model?
- Builds on previous work of RDA-WDS Interest Group: http://dx.doi.org/10.5281/zenodo.46693
- Broader landscape survey of current funding models, May-Sept 2016.
- Focus group on innovative income streams and on cost restraint, workshop Nov 2016.
- Micro and macro economic analysis of business models, Nov 2016-Mar 2017.
- Test business models with stakeholder groups, workshop April 2017.
- Policy recommendations based on concrete business model options, April-June 2017.

OECD BETTER POLICIES FOR BETTER LIVES

ICSU WORLD DATA SYSTEM

RDA RESEARCH DATA ALLIANCE

CODATA and Open Data Policies


Current Best Practice for Research Data Management Policies

A Memo for the Danish e-Infrastructure Cooperation and the Danish Digital Library

Simon Hodson and Laura Molloy

May 2014

ICT Centre of Excellence and Open Data
Jomo Kenyatta University of Agriculture and Technology


Home | About Us | Open Data | Research and Innovation | Technology Transfer | Contacts Us

ICT Centre of Excellence and Open Data- iCEOD > CODATA Kenya

CODATA Kenya

The main aim of CODATA is to improve the quality, reliability, management and accessibility of data of importance to all fields of science and technology. CODATA has three main priorities as per its strateg entitled "Exploiting the Data Revolution:the CODATA strategy".

1) Data Policy- Supporting implementation of data principles and practices
2) Data Science- Addressing the frontiers of data science and its adaptation to scientific research.
3) Data Education- Capacity building (particularly in low and middle income countries (LMICs)

At the CODATA International Workshop on Open Data for Science and Sustainability in Developing Countries held at JKUAT and at UNESCO in Nairobi, it was agreed that JKUAT, would join CODATA on behalf of Kenya. Later, the CODATA General Assembly held in October, 2014 in India, accepted and welcomed Kenya warmly into the CODATA family.

- **CODATA Data Policy Committee:** key means of delivery.
  - 'The Data Agenda for International Science'
- **Register of Good Practice and Data Policy Assessment Tool**
  - Expert Report on Data Policies: http://dx.doi.org/10.5281/zenodo.27872
  - Means of assisting good practice and self-evaluation for national authorities, research institutions and data intensive programmes.
  - Commissioned by the Danish e-infrastructure Cooperation and the Danish Digital Library
- **Developing Data Strategies at regional, national and institutional levels.**
  - **Collaborating with Polish Science Ministry on Data Policy and strategy development**
  - **Collaborating with CODATA Kenya, JKUAT, on Data Policy development and data strategy.**
  - **Discussions with Finnish National Committee and with Portugal, Denmark and other countries on role CODATA can play.**

OPEN SCIENCE PLATFORM

Data at Risk

- Mission to address policy and practice issues around analogue data at risk.
- 'When are old data new data?', special issue of *Journal of Geophysical Research*: http://bit.ly/when_are_old_data_new_data
- Workshop at NCAR, Boulder, 8-9 September 2016.
- Initial preparation of policy recommendations and ***Guidelines for Rescuing Data at Risk***
- Plans include focus on metadata and catalogues for data at risk; series of regional workshops.

Alfred P. Sloan FOUNDATION

RDA RESEARCH DATA ALLIANCE

ELSEVIER

Frontiers of Data Science:

Data Science Journal

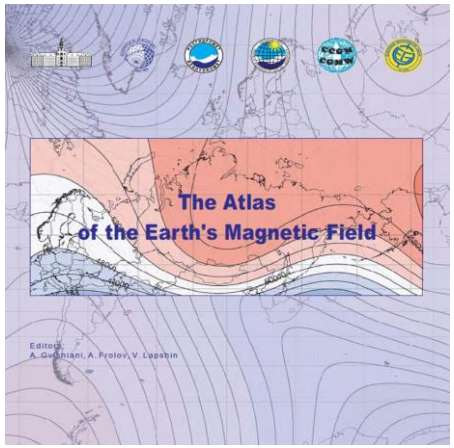
- **Relaunched Data Science Journal with Ubiquity Press: http://datascience.codata.org/**
- New Editor-in-Chief, Sarah Callaghan, data scientist with British Atmospheric Data Centre and expert on many data issues.
- *A peer-reviewed, open access, electronic journal, publishing papers on the management, dissemination, use and reuse of research data and databases across all research domains, including science, technology, the humanities and the arts.*
- Forthcoming special issues: Polar Data, Data Modeling and Knowledge Representation, Open Data and African Research, 20 Years of Persistent Identifiers.
- **Special Issue for SciDataCon papers.**
- Ubiquity are dedicated to Open Access and to innovations in researcher-led publishing.

]u[ubiquity press
open scholarship

Challenges in Data Science

TG Earth-Space Science Data Interoperability

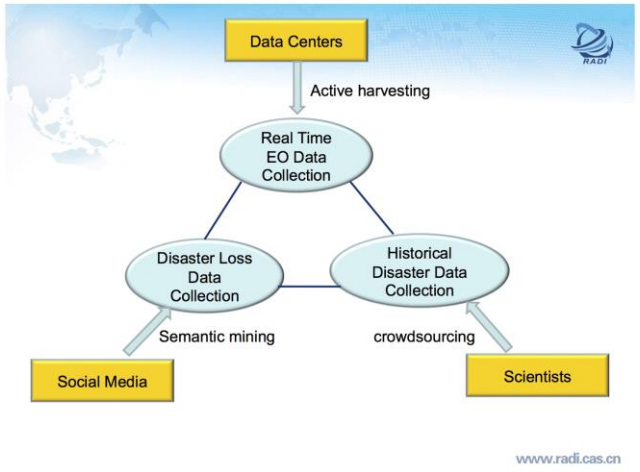
Preparing second edition of Atlas of the Earth's Magnetic Field http://bit.ly/atlas-magnetic-field



- Contribution to standards for multidisciplinary GIS for geoscience data
- **Increased focus on interoperability and standardisation issues.**
- International collaboration for conferences and training activities (Moscow and Sochi, July 2016; Peterhof, October 2017).

TG Linked Open Data for Global Disaster Risk Research

- White Paper: 'Gap Analysis on Open Data Interconnectivity for Global Disaster Risk Research' http://bit.ly/White_Paper-LOD_Disaster_Gap_Analysis



CODATA WG on Description of Nanomaterials

Convene ISUs, International Stakeholders and data experts

Form Working Group

Draft Framework for Description of Nanomaterials

Refine/validate in FP7 Future Nano Needs Project

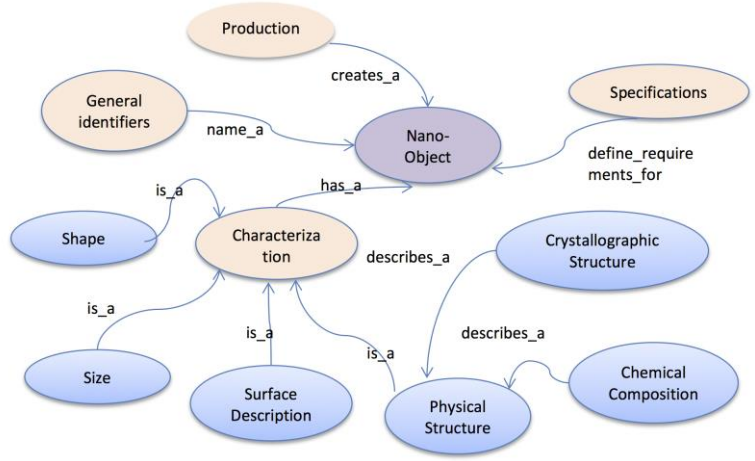


Figure 4. Information categories for describing an individual nano-object

CODATA WG on the Description of Nanomaterials:
http://www.codata.org/nanomaterials

Uniform Description System v.02, May 2016:
http://dx.doi.org/10.5281/zenodo.56720

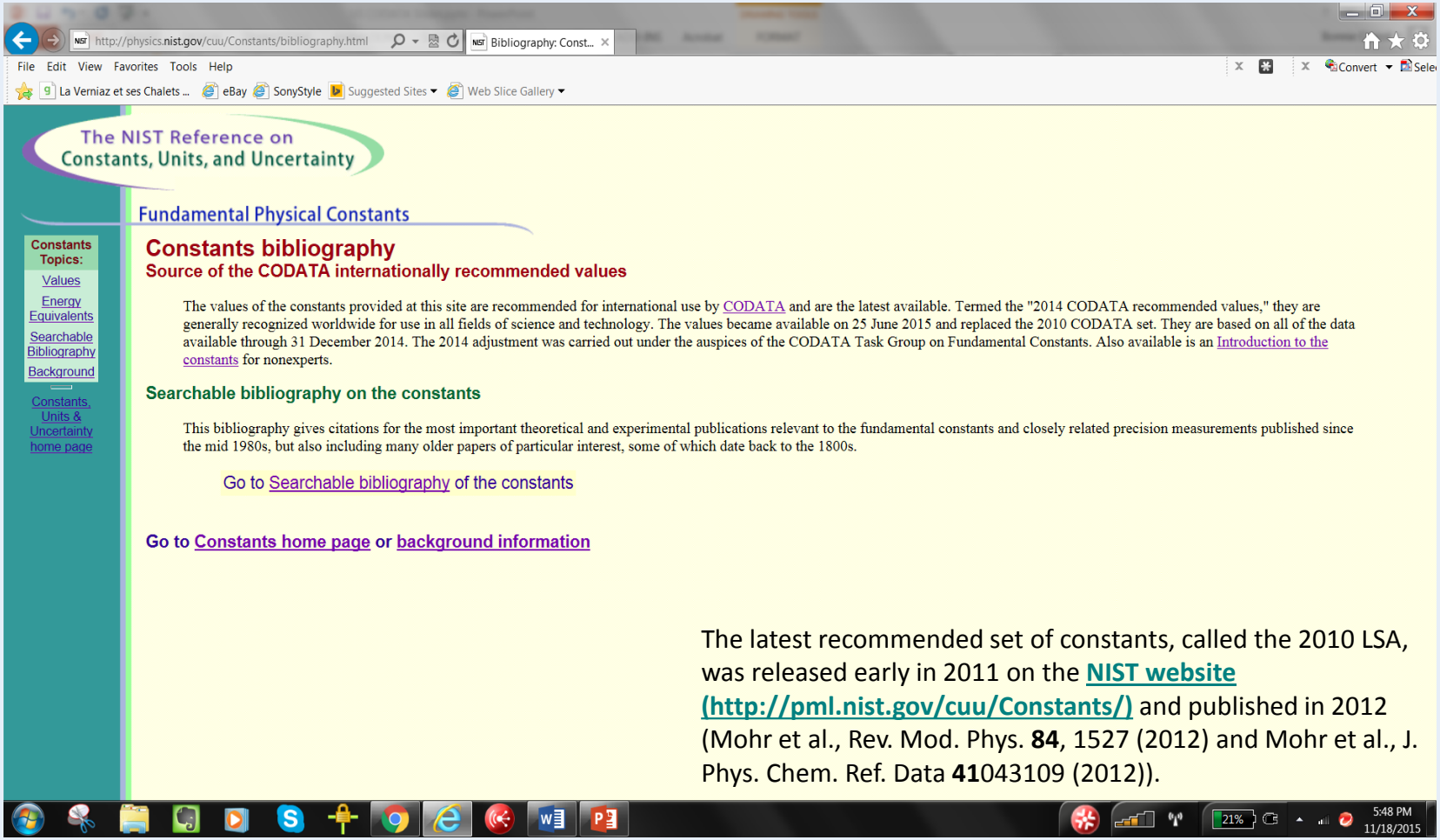
Future Nano Needs Project:
http://www.futurenanoneeds.eu/

The Mother of All Task Groups (➡Committee)

U.S. National Committee for CODATA

BOARD ON RESEARCH DATA AND INFORMATION

- Dr David Newell (Chair), NIST



The latest recommended set of constants, called the 2010 LSA, was released early in 2011 on the **NIST website (http://pml.nist.gov/cuu/Constants/)** and published in 2012 (Mohr et al., Rev. Mod. Phys. **84**, 1527 (2012) and Mohr et al., J. Phys. Chem. Ref. Data **41**043109 (2012)).

CODATA Recommended Values of the Fundamental Physical Constants, 2014: http://dx.doi.org/10.5281/zenodo.22826

2014 CODATA RECOMMENDED VALUES OF THE FUNDAMENTAL CONSTANTS OF PHYSICS AND CHEMISTRY NIST SP 959 (Aug 2015)

See: P. J. Mohr, D. B. Newell, and B. N. Taylor, arxiv.org/pdf/1507.07956v1.pdf (2015). A more extensive listing of constants is available in the reference given above and on the NIST Physical Measurement Laboratory Web site: physics.nist.gov/constants.

Quantity	Symbol	Numerical value	Unit
speed of light in vacuum	c, c_0	299 792 458 (exact)	$\mathrm{m\ s^{-1}}$
magnetic constant	μ_0	$4\pi \times 10^{-7}$ (exact)	$\mathrm{N\ A^{-2}}$
electric constant $1/\mu_0 c^2$	ϵ_0	$8.854\,187\,817... \times 10^{-12}$	$\mathrm{F\ m^{-1}}$
Newtonian constant of gravitation	G	$6.674\,08(31) \times 10^{-11}$	$\mathrm{m^3\ kg^{-1}\ s^{-2}}$
Planck constant	h	$6.626\,070\,040(81) \times 10^{-34}$	J s
$h/2\pi$	$\hbar$	$1.054\,571\,800(13) \times 10^{-34}$	J s
elementary charge	e	$1.602\,176\,6208(98) \times 10^{-19}$	C
fine-structure constant $e^2/4\pi\epsilon_0\hbar c$	α	$7.297\,352\,5664(17) \times 10^{-3}$	
inverse fine-structure constant	α^{-1}	137.035 999 139(31)	
Rydberg constant $\alpha^2 m_e c/2h$	R_∞	10 973 731.568 508(65)	$\mathrm{m^{-1}}$
Bohr radius $\alpha/4\pi R_\infty$	a_0	$0.529\,177\,210\,67(12) \times 10^{-10}$	m
Bohr magneton $e\hbar/2m_e$	μ_B	$927.400\,9994(57) \times 10^{-26}$	$\mathrm{J\ T^{-1}}$

International Data Week 2016

SciDataCon 2016

- Jointly organised by CODATA, RDA and WDS: **12-16 September, Denver, Colorado, USA**
- Combines 1) two-day research conference, SciDataCon 2016, 2) an international data forum focusing on policy discussion, intersections with open public data and data science, data driven innovation, 3) RDA Plenary 8.

- 620 registrants for SciDataCon.
- Over 800 total registrations over International Data Week, plus a number of colocated events.

CODATA and Data Science Capacity Building: Training

CODATA Training in Big Data for Science
Beijing, 4-20 July 2016
http://bit.ly/CODATA-China_Training_2104-Call

中国科学院
CHINESE ACADEMY OF SCIENCES

CODATA and Data Science Capacity Building: Training

CODATA ISI Workshop on Big Data for Science, Indian Statistical Institute, Bangalore, 9-20 March 2015
http://drtc1.isibang.ac.in/bdworkshop/

CODATA LIPI Workshop on Big Data, Tools and Data Management, LIPI, Jakarta, 2-4 Sept 2015
http://www.codata.org/events/workshops/workshops-2015/training-workshop-on-big-data-jakarta

CODATA-RDA School of Research Data Science

- **First School of Research Data Science, 1-12 August 2016, ICTP, Trieste**
- Funding for students and tutors provided by ICTP, TWAS, CODATA, ACU, RDA Europe, GEO and GODAN.
- Attended by 70 students from all around the world.

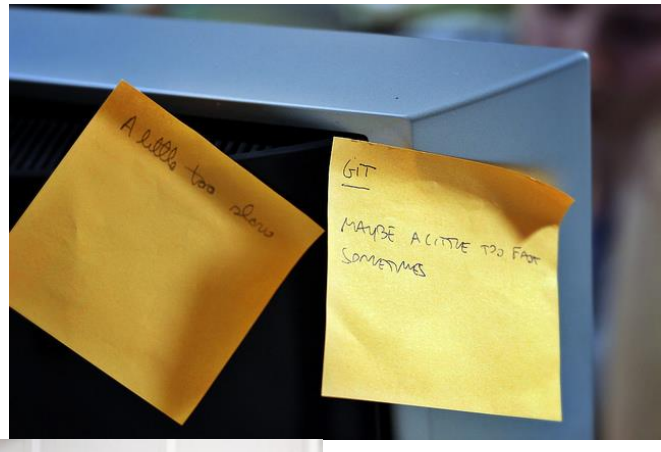
Foundational Research Data Science Curriculum

Seven components: open science, data management and curation; software carpentry; data carpentry; data infrastructures; statistics and machine learning; visualisation.

Builds on much existing courses to create something more than the sum of its parts:

- **Open Science** – reflection on ethos and requirements of sharing/openness
- **Open Research Data** – Basics of data management, DMPs, RDM life-cycle, data publishing, metadata and annotation
- **Software Carpentry** – Introduction to programming in R, the Unix shell and Git (sharing software and data)
- **Data Carpentry** – Introduction to SQL databases
- **Visualisation** – Tools, Critical Analysis of Visualisation
- **Analysis** – Statistics and Machine Learning (Clustering, supervised and unsupervised learning)
- **Computational Infrastructures** – Introduction to cloud computing, launching a Virtual Machine on an IaaS cloud

School Is Taken on the Road!



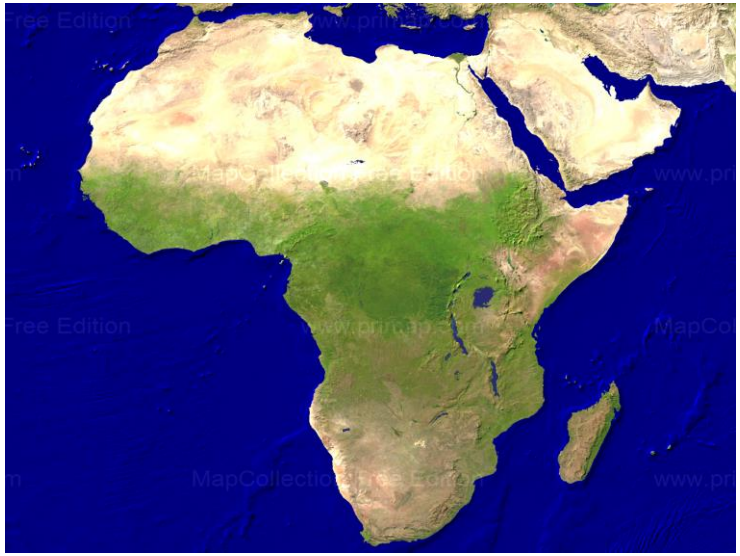
- **Programme for #datatrieste** http://bit.ly/School_of_Research_Data_Science-Programme
- **School will repeat at Trieste in 2017 and 2018, *at least…***
- Possibly with addition of one week more advanced on Big Data.
- Will run foundational two week course at ICTP INESP in Sao Paolo, Brazil, December 2017.
- Schools can be run with a greater or lesser degree of support and coordination from the international convenors.
- **Keen to encourage a network of schools, but also local schools with lower central input.**

- Discussions with possible partners in South Africa and India.
- Keen to explore opportunities with CODATA National and Union Members.

CODATA in Kenya

- International workshop on open data for science in developing countries, UNESCO, Nairobi, August 2014.
- Strong endorsement for the workshop from Kenyan Cabinet Secretary and from local universities and research institutes.
- Cabinet Secretary Dr. Fred Matiang'i: called on CODATA and other international organisations to 'become more visible in education and capacity-building, by developing science and educational programs and activities that focus on data and information' in developing countries.
- Announced data centre to be established at Jomo Kenyatta University of Agriculture and Technology.
- **'JKUAT has now established an ICT Centre of Excellence and Open Data (iCEOD) that was part of the Nairobi-CODATA conference recommendation'**
- Working with CODATA on data management policies and development of iCEOD and data system: http://www.codata.org/membership/national-members/kenya

CODATA African Open Data Platform Initiative



- **Principles**
- **Policies**
- **Incentives**

- **Hardware**
- **Software**
- **Management**

- **Data science frontiers**
- **International links**
- **Capacity building**

Operational bodies
- Researchers
- Universities
- Funders
- Governments

Supporting bodies
- ICSU-CODATA
- RDA
- Academies
- Foundations/trusts

- Proposals for Open Data Platform initiatives, Africa and Latin America and Caribbean.
- Holistic 'science systems' approach: policies, procedures, incentives, data infrastructure, scholarly communications, skills and training.
- **Keystone is to establish an Open Data Platform with a coordinating role.**
- Pilot initiative funded by Department of Science and Technology in South Africa: nearly 500K euros over three years.
- Implemented by staff from South African Academy of Sciences, under direction from CODATA.
- **Currently undertaking preparatory study to identify partners.**

Building the Initiative

Establish African Open Data Forum / Platform

Co-design African Open Data Policies

Develop Incentives Frameworks

Develop Research Data Science Training

African Research Data Infrastructure Roadmap

Activities require low funding for coordination, secondment, contributions in kind and evaluation.

Activities require higher investment for coordination, co-design implemenatation and evaluation.

Funded Research Data Infrastructure Initiatives

Funded, co-designed transdisciplinary research projects

Upcoming Activities / Events

- Launch of the African Open Data Platform, December 2016.
- OECD GSF Sustainable Business Models Workshops, Nov 2016 and April 2017.
- Data Citation Workshops, Nov (Finland) and Dec (Taiwan) 2016.
- Schools of Research Data Science, July (Trieste) and December 2017.
- CODATA Eurasia Conference, GeoData, Oct 2017.

- **Executive Committee Meeting, December 2016, Pretoria, South Africa**
- **Immediate planning for SciDataCon 2018**

CODATA – Emergent issues

Principles, Policies and Practice

- Standards for data discovery, use & interchange (TG proposal – possible Commission)
- Citizen science & crowd-sourced data (TG proposal)
- Citing and managing digital objects
- A data system ecology for decision makers

Frontiers of Data Science

- Machine learning
- Internet of things
- Standards for reproducibility
- Linked semantic data

Capacity Building

Open Data Platforms

- Africa
- Latin America & Caribbean

Governance

Focus on:

- Relations with National Committees
- Relations with Scientific Unions
- Individual & Corporate Membership
- Serving the whole research enterprise

For Consideration of BRDI

- Topics of interest from the US to consider internationally
- International topics of particular interest to the US
- Participation of BRDI members
- US National Representative to the General Assembly (2018)

Thank you for your attention!

Credits for slides: inc. Simon Hodson, Geoffrey Boulton, Joseph Muliaro Wafula
Credit for photos: Andjani Gatzweiler

www.codata.org
http://lists.codata.org/mailman/listinfo/codata-international_lists.codata.org
Email: simon@codata.org
Twitter: @simonhodson99
Tel (Office): +33 1 45 25 04 96 | Tel (Cell): +33 6 86 30 42 59

CODATA (ICSU Committee on Data for Science and Technology), 5 rue Auguste Vacquerie, 75016 Paris, FRANCE

International Research Data Organizations

Collaboration among CODATA, Research Data Alliance and World Data System

Core activities

- ***CODATA***: strategic approach to data policies, data science and data capacity building
- ***RDA***: bottom-up community activity to promote interoperability and sharing
- ***WDS***: development and coordination of international network of trusted repositories

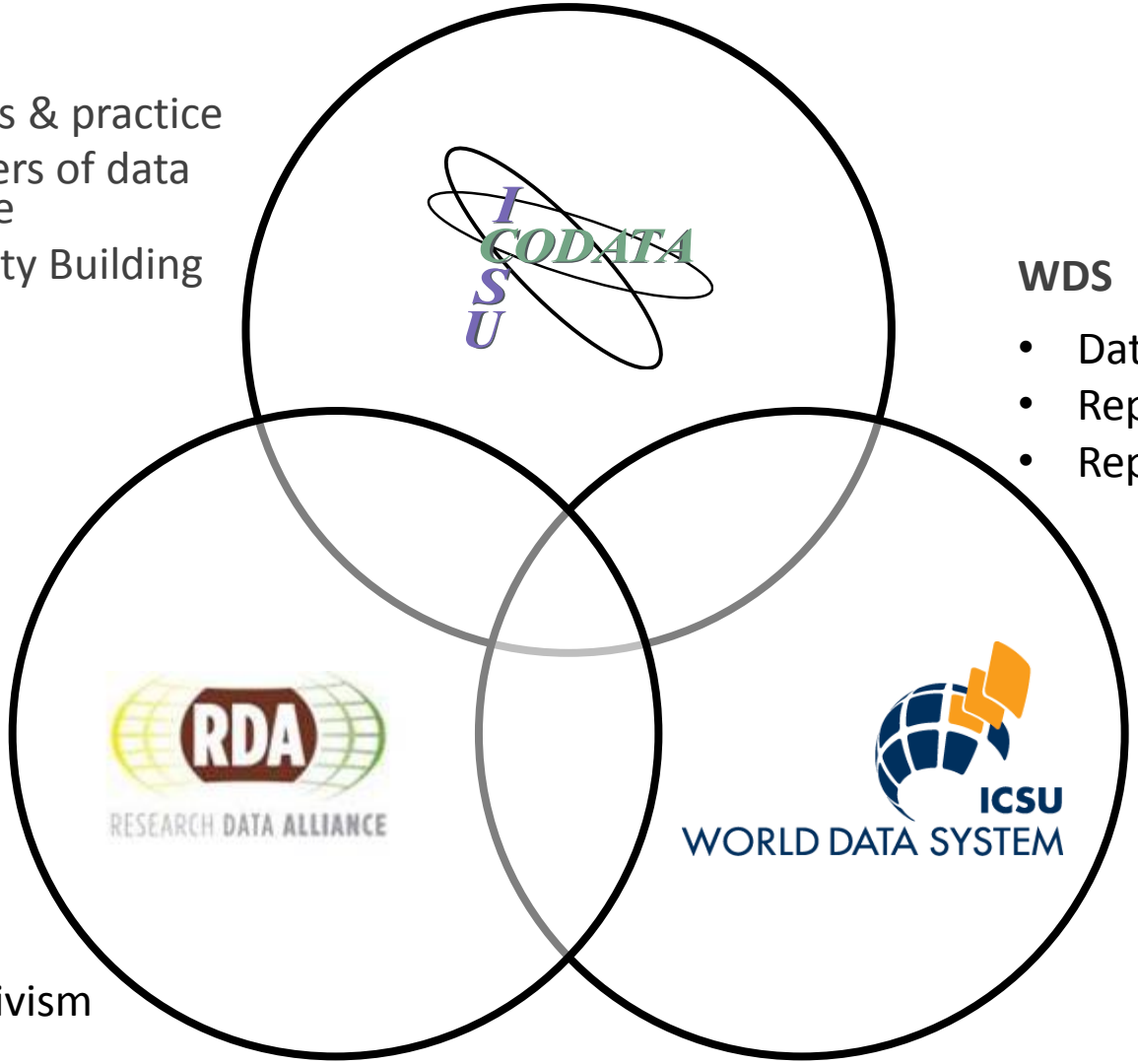
Collaborative activities

- Joint WGs on Legal Interoperability
- Income Streams for Data Repositories

International Research Data Collaboration

CODATA

- Policies & practice
- Frontiers of data science
- Capacity Building



WDS

- Data stewardship
- Repository Standards
- Repository Access

RDA

- Data sharing
- Interoperability
- Community activism