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Development of a new ICSU World Data System and its relationship with IODE

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1. Introduction and background

The International Council for Science (formerly the International Council of Scientific Unions), ICSU, established the World Data Centre system to serve the IGY (International Geophysical Year) of 1957-1958, and developed data management plans for each IGY scientific discipline. Multiple Centres were established to guard against catastrophic loss of data, and for the convenience of data providers and users. Three World Data Centres for Oceanography were established: Silver Spring, USA; Obninsk, Russian Federation and Tianjin, China. These centres have been collaborating with IODE as long-term permanent archives of oceanographic data since their establishment. In addition, a WDC for Marine Environmental Sciences (WDC MARE) was subsequently established.

In October 2008 a new World Data System (WDS) was created as a new ICSU interdisciplinary body through a decision of the ICSU 29th General Assembly. The WDS builds on the 50-year legacy of the ICSU World Data Centre system (WDC) and the ICSU Federation of Astronomical and Geophysical data-analysis Services (FAGS). Approximately 100 existing WDCs and Federation Services, as well as numerous other data centres, services and activities, have already expressed interest in becoming part of the new system.

The ICSU WDS concept aims at a transition from existing stand-alone WDCs and individual Services to a common globally interoperable distributed data system that incorporates emerging technologies and new scientific data activities. The new system will build on the potential offered by advanced interconnections between data management components for disciplinary and multidisciplinary scientific data applications. The WDS will enjoy a broader disciplinary and geographic base than previous ICSU bodies and will strive to become a worldwide 'community of excellence' for scientific data. To this end, WDS will work closely with ICSU's Committee on Data for Science and Technology (CODATA) and with the new ICSU Strategic Coordinating Committee for Information and Data (SCCID). In addition, a WDS Scientific Committee (WDS-SC) has been appointed by ICSU to implement and administer the activities of the WDS.

2. WDS mission and goals

The primary goals of the ICSU World Data System are to ensure the long-term stewardship of quality-assessed data for research and education, and the provision of such data and related data services to the international science community and other stakeholders. The WDS aims to incorporate scientific data activities into a common, globally interoperable, distributed data system, building on interconnections between disciplinary and interdisciplinary scientific applications. ICSU envisions a Global Data System of Systems – the World Data System – emphasizing the critical importance of successful data and science activities, enabling global science, furthering ICSU strategic scientific outcomes by addressing pressing societal needs (e.g. promoting sustainable development, mitigating digital divide), providing distinct and high visibility to data issues, enabling universal and equitable access to valuable services for data and information stewardship, facilitating long-term preservation, and providing access to data and data services, data publication and citation.

3. Early activities of the WDS

3.1 WDS Constitution

The draft WDS Constitution was approved by ICSU Executive Board in April 2010, small changes can still be incorporated into it before the full ICSU General Assembly finally approves it in September 2011. It is a basic high-level definition of the WDS, WDS Scientific Committee and the WDS International Programme Office (IPO). Bylaws are under development now that the IPO appointment has been approved. The Bylaws, which will be kept short and brief, will incorporate the details of operations of the IPO, WDS, and WDS Scientific Committee.

3.2 International Programme Office

The ICSU Executive Board, at its last meeting (29-30 October 2010), has accepted the generous offer from the Japanese National Institute of Information and Communications Technology (NICT) to host and financially support the International Programme Office for the ICSU WDS. The Office will manage and coordinate the establishment and operations of the WDS, and take responsibility for outreach and promotional activities. The International Programme Office will act under the guidance of the ICSU WDS Scientific Committee and will commence activities on 1 April 2011.

3.3 Data Policy

The ICSU WDS, recognizing the benefits and importance of contributing to the growing international efforts of data sharing, has adopted the data sharing principles of GEO/GEOSS:

- There will be full and open exchange of data, metadata and products shared within WDS, recognizing relevant international instruments and national policies and legislation;
- All shared data, metadata and products will be made available with minimum time delay and at minimum cost;
- All shared data, metadata and products being free of charge or no more than cost of reproduction will be encouraged for research and education.

3.4 Membership criteria

As part of the process of developing the WDS, a transparent, objective base for the evaluating WDS candidates for membership into the WDS has been developed. This will ensure the trustworthiness of WDS facilities in terms of authenticity, integrity, confidentiality and availability of data and services. The certification process is based on a number of evaluation criteria (see Appendix 1). Candidates for WDS membership will demonstrate their capabilities through an online application form based on these criteria. Guidance is provided for each of the criteria. This application form can also be used for periodic assessment and monitoring of the WDS facilities and for the overall performance of the WDS. All steps involved are overseen by the WDS Scientific Committee, which functions as the certification authority. If necessary, the WDS Scientific Committee will engage further experts for the evaluation of specific criteria.

The evaluation criteria comprise four areas covering (i) policies, (ii) organizational framework, (iii) management of data, metadata, and services, and (iv) technical infrastructure. However, as developments are fast and the scope of WDS includes a number of special services (i.e. former FAGS) as well as new services like data publishing, the criteria and procedures described may evolve with time. Potential members first indicate their interest through completion of a short web-form and then are provided with a unique link to the application form. All of the initial group of organisations who expressed interest in becoming members of WDS have received a letter inviting them to apply for membership.

As there have been some questions about the benefits of becoming a member of the WDS, a short draft document has been produced describing some of these (see Appendix 2). This will be published when finalised.

3.5 Web-site established

The WDS web-site (www.icsu-wds.org) gives an overview of the progress so far in setting up the World Data System. It includes sections on Organisation (Introduction to WDS, Governance, International Programme Office, Partners and Events), WDS Members (with information on joining WDS), Services (prototype portal), and Outreach (Promotion, Useful Links, WDS in the News).

3.6 Collaboration with IPY-DIS

The WDS has been collaborating with the International Polar Year Data and Information System (IPY-DIS) to solve long-term data stewardship issues and will use this experience to contribute to the new CODATA- sponsored Polar Information Commons (PIC).

3.7 First WDS Scientific Conference "Global Data for Global Science"

The first international meeting of the ICSU World Data System will be held 3-6 September 2011 at Kyoto University, Japan (wdc2.kugi.kyoto-u.ac.jp/wds2011). This will provide an opportunity to receive opinions, comments and suggestions from scientific communities (data users) and other international data systems to establish the active plan of the WDS. This conference will consist of two parts; "WDS-Related Sessions" including sessions to discuss general concepts and strategy to run the WDS, and "Scientific Sessions" are allocated for presentations by data-oriented scientists in

a variety of research field, including information sciences. Presentations of activities of WDS members (e.g. data centres, data analysis centres) are welcome also. A call for papers will be announced in mid-March 2011.

4. Collaboration between WDS and IODE

As previously noted, IODE has collaborated with the World Data Centres for many years. With the announcement of the formation of the WDS, IODE has indicated its desire to continue that cooperation. In this regard, one of the IODE Co-chairs is a member of the Strategic Coordinating Committee on Information and Data (SCCID) and IODE was one of the organisations which has showed an early interest in becoming a member of the WDS.

The former WDCs for Oceanography located in Obninsk (Russian Federation), Silver Spring (USA) and Tianjin (China) have also expressed interest, as have WDC MARE (Germany) and WDC Geophysics and Marine Geophysics (USA). Some individual NODCs have also indicated their interest (e.g. VLIZ, JODC, IBSS).

At the IODE Officers meeting in March 2010, the topic of IODE membership of WDS was discussed. The Officers recommended that WDS should link to the ocean community through the Ocean Data Portal (ODP Version 2 which uses the network model). The Officers concluded that, if IODE becomes a member of WDS then all NODCs that provide data through ODP (or interoperable technology) will be accredited under WDS.

5. Questions for the IODE Committee to consider

- **Should IODE become a member of the WDS?**
  Comment: Based on earlier discussion, for example at the Officers meeting, the answer is probably yes. In anticipation of this the IODE Technical Secretary has completed a preliminary 'place-holder' version of the application form. The reasoning is that WDS should facilitate interdisciplinary research by providing a portal to data from a large number of research domains. This is an area of great interest today and it is also why IODE is linking ODP with WIS. It is of course also quite similar to GEO/GEOSS (with which the ICSU/WDS will collaborate). So for IODE the interest will be that we can contribute ocean data and information to a global system for interdisciplinary research.

- **What is the best way of doing this?**
  Comment: Earlier discussions with WDS (now almost 2 years ago) focused on the possibility of having IODE collaborate as 1 member rather than have all 80 NODCs joining separately. The rationale for this was that IODE is already an existing network with its own membership, activities and dynamics. This way we could also link up the IODE ODP to the WDS directly which should be easier than WDS having to create 80 separate links from probably very different systems. The Officers meeting was in general agreement with this approach.

  This would mean that IODE would respond to some of the WDS criteria on behalf of the IODE community, but individual NODCs would need to provide evidence that they meet some of the criteria themselves, in particular those relating to

management of data products and services, and technical infrastructure. In fact this provides a good opportunity to decide on appropriate criteria for accreditation of NODCs, building on the WDS criteria which are quite generic as they have been designed to be appropriate to a wide range of facilities. Taking into account that the NODCs are at different stages of development and operation, this implies that within the IODE network there would be 'accredited NODCs' and possibly 'candidate NODCs'. The latter will then be the focus of IODE training so they can also become accredited NODCs. The accreditation then also means these NODCs can connect to ODP. This "test" would also be useful for ODP as IODE does not wish to get poor quality data into the system, nor want data providers that are hardly ever online. Accreditation of NODCs will be considered further under Agenda item 8.4.

- **Should IODE be represented at the WDS Conference in September?**
  Comment: If the Committee agrees that IODE is to become a member of WDS, then the answer should be yes. It might provide an opportunity to describe IODE to the wider ISCU data community.

Appendix 1: Certification of World Data System facilities and components (23 Oct 2010)

Introduction

A new ICSU World Data System (WDS) has been created by a decision of the 29th General Assembly of the International Council for Science (ICSU). WDS builds on the 50-year legacy of the ICSU World Data Centre system (WDC) and the ICSU Federation of Astronomical and Geophysical data-analysis Services (FAGS). Approximately 100 WDCs and Federation Services, as well as numerous other data centres, services and activities, have already expressed interest in becoming part of the new system. The WDS concept aims at a transition from existing stand-alone WDCs and individual Services to a common globally interoperable distributed data system, incorporating emerging technologies and new scientific data activities. The new system will build on the potential offered by advanced interconnections between data management components for disciplinary and multidisciplinary applications.

The WDS will enjoy a broader disciplinary and geographic base than previous ICSU bodies and will strive to become a worldwide 'community of excellence' for scientific data. To this end, WDS will work closely with ICSU's Committee on Data for Science and Technology (CODATA) and with the new ICSU Strategic Coordinating Committee for Information and Data (SCCID). Through membership of the WDS, members will contribute to ICSU program(s) and initiatives.

Evaluation Criteria

As part of the process of developing the WDS, a transparent, objective base for the evaluating WDS candidates for membership into the WDS data system has been developed. This will ensure the trustworthiness of WDS facilities in terms of authenticity, integrity, confidentiality and availability of data and services. The certification process is based on a catalogue of evaluation criteria (see Table 1). Guidance will be provided for each of the criteria. The procedure to be applied to candidates will be a demonstration of capabilities by means of a questionnaire based on the catalogue of criteria. It can also be used for periodic assessment and monitoring of the WDS facilities and for the overall performance of the WDS. All steps involved are overseen by the WDS Scientific Committee (WDS-SC), which functions as a certificate authority. If necessary, the WDS-SC will engage further experts for the evaluation of specific criteria.

The catalogue of criteria comprises four sections covering policies, organizational framework, management of data, metadata, and services, and technical infrastructure. However, as developments are fast and the scope of WDS comprises a number of special services (former FAGS) as well as new services like data publishing, the catalogue and procedures described may evolve with time. In addition, depending on the type and level of the service provided, specified criteria and procedures may be mandatory, recommended, or optional.

The WDS is structured as a federated system integrating various facilities with different scope. Accordingly, interested parties can be certified and accredited for one or multiple roles. These could include, for example, data collection and processing (including quality assurance), long-term data repository (e.g. data library), data publisher (including

periodic compilation of data products), community related service, data analysis service. These may be national, regional or international. In other words, in applying the criteria, WDS must take into account the context of the institution, its mission, priorities, and stated commitments. Certification should be seen as an iterative process leading to stepwise improvements and reflecting the overall development of the WDS components. Feedback will be provided to the candidates as part of the process.

The criteria and procedures have been defined incorporating existing standards and best practices from other organizations and projects (OAIS[1], OCLC[2], NESTOR[3], WMO-IS[4], CRL[5], DSA[6]), whilst taking a pragmatic approach balancing proper functionalities against feasibility.

Metrics (measurability)

In principle, the goal is to have objective controls (criteria) against which candidate WDS members can be evaluated. In some cases, questions can simply be answered as yes or no. In many cases, however, evaluation will be based on non-standardized information supplied by applicants indicating the degree of trustworthiness and adequacy. In general, the information supplied for a specific criterion can be attributed to different levels of maturity (for example: not addressed, conception phase, implementation phase, operational). The decision about what is a valid concept or which service can be seen as fully operational is in the responsibility of the WDS-SC, with input from other experts, as appropriate.

Certification procedure

WDS Certification will be a five stage process:

1. Facility responds to initial WDS survey, or provides a letter of interest
2. Facility demonstrates its capabilities using the questionnaire to describe its capabilities (and possibly by practical demonstrations)
3. If necessary, an on-site review may take place (to be decided by negotiations with the candidate)
4. Accreditation as a WDS component
5. Review of accreditation should take place every 3-5 years

WDS monitoring

The WDS-SC will be responsible for designing and implementing mechanisms to monitor the overall performance of the system as well as the performance of member facilities.

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[1] Reference Model for an Open Archival Information System (OAIS) - (corresponds to ISO 14721:2003), http://public.ccsds.org/publications/archive/650x0b1.pdf

[2] Trustworthy Repositories. Audit & Certification: Criteria and Checklist, http://www.crl.edu/sites/default/files/attachments/pages/trac_0.pdf

[3] Dobratz, S et al (2009), Catalogue of Criteria for Trusted Digital Repositories, Nestor materials, Deutsche Nationalbibliothek, Frankfurt (Main), Germany, http://nbn-resolving.de/urn:nbn:de:0008-2010030806

[4] http://www.wmo.int/pages/themes/wis/index_en.html

[5] http://www.crl.edu/archiving-preservation/digital-archives/metrics-assessing-and-certifying/core-re

[6] http://www.datasealofapproval.org/

Table 1: Catalogue of Criteria for WDS Certification

1. WDS general requirements and policies (Organization specific requirements)
1.1 Signed Letter of Agreement, Intent to Cooperate or similar with ICSU
1.2 Have relevant external experts to provide advice and guidance to WDS node
1.3 Should attend WDS meetings every 2 years
1.4 Promote active communication with research community and other users
1.5 Provide full, open, timely, non-discriminatory and unrestricted access to metadata, data, products and services, no cost or at the Cost of Fulfilling User Request (COFUR)
2. Organisational framework
2.1 The facility has defined: (a) the scope of the data and/or product (services) it offers; (b) its responsibility for the long-term preservation its data, products and services; (c) its target user communities and their needs; (d) the rights of its users to access and use data; and (e) processes for responding to changing scientific requirements and to evolving technologies
2.2 The organizational form is adequate for the facility in terms of funding, sufficient numbers of qualified staff, organizational structure and long-term planning
2.3 Expertise of the host organisation offers local oversight (scientists, data specialists) of international repute
2.4 Maintenance of a continuity plan in the event of a host institution shift of interests or reaction to substantial changes
2.5 Facility is committed to formal, periodic review and assessment to ensure responsiveness to scientific and technological developments and evolving requirements
3. Management of data, products and services
3.1 The facility ensures integrity and authenticity of data sets during ingest, archival storage, data quality assessment and analysis, product generation and access and delivery
3. 2 The facility accepts data sets from its producers based on defined criteria for collection, selection and evaluation
3.3 Archival storage of the data sets is undertaken to defined specifications
3.4 The facility permits efficient usage of archived data sets, products and services based on defined criteria and preferably open standards (searchable, accessible, and usable objects and services)
4. Technical infrastructure
4.1 Facility functions on well-supported operating systems and other core infrastructural software
4.2 Facility is using hardware and software technologies appropriate to the services it provides to its designated community(ies)
4.3 Security: Technical infrastructure for protection of the facility and its users, data, products and services

Appendix 2: Why join ICSU's World Data System? (Draft, February 2011)

NGO Membership

- A WDS member is part of ICSU, one of the largest Non-Governmental Organization (NGO) globally. Since ICSU is inherently non-governmental, the WDS member can interact with outside organizations as an NGO, even if the WDS member is hosted by a government affiliated organization.
- In some disciplines, international data exchanges might still be characterized as "one-way": Some countries are still reluctant to make their data available to the international community, but are nonetheless anxious to receive data from others. Since the WDS is an NGO, WDS provides a mean to improve that situation. Historically, this has been one of the major advantages of the WDC system when it came to exchanging data.

International and Local Recognition

- ICSU (and its member Unions) provide prestigious auspices under which to operate. This is because ICSU members are the main scientific academies in each country, and the Unions (and their Associations) provide the main forum for international collaborative exchange of information in each major area of science.
- WDS membership heightens the profile of the organization without compromising its own identity, gaining worldwide exposure to potential users of the data, products and services offered.
- Improved visibility and engagement in international activities, programs, and projects will improve the facility's reputation and peer recognition and in turn might also improve its standing within the host organization which will in many cases enhance funding opportunities. WDS membership will be an effective means of bringing international recognition of the data facility to the attention of decision-making people within the host institution (i.e. "WDS" is a "good name").

Data Sharing Principles

- A WDS member adheres to the WDS Data Sharing Principles which are built around the concepts of full and open access, and of data sharing provided at no cost or for the cost of reproduction (i.e. "COFUR": Cost of Fulfilling User Request).
- The full benefits of data sharing are only realized if someone initiates the sharing process as a matter of principle. In this way WDS members initiate a "win-win" process that benefits not only themselves but also their partners in the scientific community.

Data Quality and Long-Term Data Curation

- WDS data holdings, WDS services output, and WDS-provided information will be easily searchable, rapidly accessible, and satisfy national and international standards for data and data services. Enhanced interoperability through

international standards could in turn be implemented at other levels, internally within the host organization and externally with its partners.

- WDS data and data products will be quality-assessed, thereby earning the trust of WDS users.
- Joining the WDS is becoming part of a community recognized to have met accreditation criteria on scientific relevance, governance, data management, technical infrastructure and security, and open and equitable access to quality-assured scientific data, data services, products and information.
- In many fields (e.g. climate change), accumulation of carefully maintained long-term data series is essential. However, critical observing stations (e.g. geomagnetic) are commonly facing closure because lack of resources. As the curator of long time series, WDS can weigh in with local and national host institutions to continue their observations for the benefit of international scientific community.

Global, Multi-Disciplinary Data Facilities

- WDS members are part of a interoperable global network of data activities with searchable common data directories and catalogues, a worldwide 'community of excellence' for scientific data which ensures the long-term stewardship and provision of quality-assessed data and data services to the international science community
- WDS opens worldwide prospects for collaborations that enhance products, services, or performance (e.g. easier sharing data and information with other systems). This is especially the case when members of existing disciplinary groupings of services/centres join collectively (e.g. geophysics, oceanography, astronomy), thereby extending the scope of whole fields of science to others.
- WDS membership opens an opportunity for enhanced data management within the host organization thereby increasing the value of its data, products and services. It will provide fertile ground onto which new, emerging international data exchange and management standards and activities could naturally graft themselves.

Data Publication

- Data facilities frequently find that their data are used in scientific papers without any citation or acknowledgement of the source. Data publishing services of WDS will be very important to highlight their contributions to the scientific community.