"Global Spatial Data Sharing Frameworks: the case of the Intergovernmental Oceanographic Commission (IOC)"

Roger A. Longhorn[1]

[1]Director, IDG (UK) Ltd, EC Projects Office
83 Zeedijk, B-8660 De Panne, Belgium
e-mail: ral@alum.mit.edu

Abstract

This paper examines the information infrastructure developed by the Intergovernmental Oceanographic Commission's (IOC) International Oceanographic Data and Information Exchange (IODE) group of experts. All information required by IOC member institutions in fulfilling their ocean research and monitoring mandates is spatial in nature. In order to carry out their research, these scientific users also need ready access to spatial data collected and maintained by multiple national agencies, e.g. bathymetry, coastlines, and meteorological data. They must have the right to integrate this data with their own research findings and to disseminate these results to scientific and non-scientific communities, often on a multinational basis. A high proportion of the research projects carried out by ocean research institutions under IOC auspices are multinational in composition and global in geographic coverage. Thus, IOC provides a good example of a very mature global organisation, operating under a UN mandate (UNESCO), which has confronted, examined and attempted to resolve many of the same spatial information issues and problems that are the focus of Regional SDI (RSDI) and Global SDI (GSDI) initiatives. Many of the information infrastructure issues encountered by the IODE experts relate directly to those of RSDI and GSDI planners. The solutions reached, and the compromises made, in creating a viable global (sector-specific) information infrastructure for ocean research should be of interest to participants in the GSDI implementation process at national and regional levels.

SDI versus Subject-Specific Information Infrastructure

Over the past two decades, regional and global information infrastructures have been created by many organisations and continue to be extended and updated, often in relation to fulfilling trans-national responsibilities under various international conventions. Many of these programmes focus on the research and/or monitoring needs for environmental problems, ranging from air and ocean pollution to meteorology, biodiversity loss and global climate change. Most of these organisations and information frameworks have not been specifically involved in, and many are not even aware of, initiatives of the mainstream GI/geodata community, such as the Global Spatial Data Infrastructure (GSDI) conferences, the Global Mapping project, Digital Earth or regional SDI work such as PCGIAP, PC-IDEA and INSPIRE. Yet the data used by these organisations is almost totally 'spatial information' as defined by the geodata community, comprising multiple attributes for which the spatial location component is often key to the research undertaken.

There seems to be a 'cultural' difference between the regional/global SDI initiatives and the information infrastructure solutions proposed by larger, better funded, more advanced and more highly structured subject-specific programmes, which are typically science-based. The former (SDI) are driven almost entirely by organisations for which production of geodata is their primary function. These initiatives began in the mid-1990s. By contrast, information-based programmes of the scientific geodata collectors and users have existed far longer than the regional/global SDI initiatives, extending as far back as the early 1980s, e.g. IGBP – International Geosphere-Biosphere Programme – Data and Information System (DIS) and

UNESCO's Intergovernmental Oceanographic Commission (IOC) International Oceanographic Data and Information Exchange (IODE). At the time that current regional SDI initiatives were first proposed (mid-90's), many of the scientific user-oriented data infrastructures were already mature, robust and fulfilling their roles in support of major international research programmes. However, even for the most mature such programmes, some technical, legal and policy issues still remained to be resolved, and are still being examined today.

It is important to recognise the differences between subject-specific information infrastructure programmes (e.g. oceanographic, meteorological, biodiversity, conservation, climate change) and those of the more traditional geospatial community, i.e. the SDIs which are at the heart of the GSDI initiative. One key difference is that the organisations for which the infrastructures were created, i.e. the IOC, IGBP, WMO (World Meteorological Organisation), are subject-specific, legally mandated (e.g. by the United Nations or by international conventions which member governments ratify) and with (often) significant resources at their disposal. Such resources include the financial and human resources needed to populate and operate professional secretariats, plus well resourced working groups for technical, scientific, legal, administration, education/training, conferences and similar projects or tasks within the parent organisation. Many SDI initiatives today, whether national, regional or GSDI, do not have equivalent legitimisation in national legislation or by international convention. Nor do they have access to the level of resources available to the larger international subject-specific programmes. This is especially true for the SDI initiatives in developing nations, whether at national or regional level.

By examining the information infrastructure issues faced by one such organisation, the IOC, and the solutions proposed by the IODE group of experts tasked by the IOC to examine data exchange issues, can we gain useful insights into achieving GSDI objectives in the coming years? The question is pertinent, especially in regard to data access, as indicated by the following quote from Chapter 6 of "Developing Spatial Data Infrastructures: The SDI Cookbook" (a.k.a. "The GSDI Cookbook"), version 1.1 (GSDI 2001):

> "The overlap between information managed by subject-specific communities in possibly parallel infrastructures can compound problems of data discovery and access. This can be viewed from either the consumer or supplier perspective. For example, as communities such (as) biodiversity or geoscience specialists attempt to leverage a combined spatial data infrastructure to support their own goals they introduce new factors. These could be new standards or convention that they commonly require, it could be a new attribution requirement on the data not previously realised, or it could be the need to provide common access to data not otherwise visible from a spatial data infrastructure."

We, members of the non-subject-specific (mainstream?) GI/geodata community should perhaps not be viewing our scientific (subject-specific) colleagues as the cause of "compounding problems". Rather, we should be taking their very real geospatial data needs into account from the outset when specifying the content, structure and policies of national and regional SDIs. One reason for this approach is that many of these truly global organisations and programmes will be primary consumers of the sort of geodata that is being collected in NSDI-, RSDI- and GSDI-related programmes and initiatives. They will also often be significant geodata producers, especially where remote sensing data is concerned.

IOC/IODE Overview and Information Infrastructure

The IOC was created in 1960 under the auspices of UNESCO. One of the resolutions adopted by the first IOC Assembly (Resolution 9) officially recommended that mechanisms

be put in place for the exchange of oceanographic data commencing from 1 January 1960. The IOC's earliest data policy recommendations date back to the 1961 IOC Assembly, providing the organisation now with more than 40 years experience on managing many aspects of information flow at national, regional and international level. The first official IOC Manual on International Oceanographic Data Exchange was published in 1965 and has been through numerous updates over the years to keep abreast of technology changes in both the information world as well as the ocean science research world.

Data exchange issues are handled by the IOC Committee on International Oceanographic Data Exchange (IODE), which has a Chairman, vice-Chair and permanent secretariat. IODE also has various officers, national coordinators and regional coordinators, who are supported in their work by the secretariat, based in Paris. Working Groups or Groups of Experts are convened to examine and resolve issues that arise in response to requests from IOC organisations and IODE national and global data centres. Thus, IODE acts as the coordinator for data-related activities for regional and national data centres that provide the distributed databases for ocean research information.

Technical work is carried out by the IODE Group of Experts on Technical Aspects of Data Exchange who examine topics such as (IOC 2000d):

- integrated information technology advances and their impact on marine data collection, processing and dissemination,
- data tracking, archiving and data inventory management,
- data formats and data unification,
- data management capacity building,
- creating useful data products and services (e.g. requested by users, not designed by producers),
- metadata creation and dissemination (including a new XML specifications for marine data).

The IODE is directly involved in developing the IOC information infrastructure by securing access to the required expertise to examine specific problems via Working Groups, convened normally as the result of the IOC Executive Council and by initiating specific projects at regional and global level. It hosts a Web-based information gateway, the "OceanPortal" [see http://ioc.unesco.org/oceanportal] and sponsors numerous outreach activities including training and education of users and administrators, capacity building, especially in developing nations and awareness actions at all levels.

Technical issues relating to data collection, storage, dissemination, referencing, etc., have been addressed since the earliest years of IOC's existence. The IOC "Manual on International Oceanographic Data Exchange" was first published in 1965, and has been updated four times since then, most recently in 1991. However, data exchange policy issues have only come to the fore in the past two to three years, with creation of formal working groups on data exchange policy, as described later in the paper. From IOC's inception, stated data management policy for its main data centres has been to provide data and information to any qualified requester in the scientific community. This policy includes the statement "reasonably sized requests from activities or individuals affiliated with national or regional contributors to the World Data Centres (Oceanography) will be considered as an exchange service and will be fulfilled without charge." Also, "small requests from non-contributors may be handled in a similar manner." More comment appears later in the paper on the complications now arising in regard to data exchange policy due to growth of commercial interests and certain government information charging policies.

The basic requirements for IOC's information infrastructure are much the same as those for any other spatial data infrastructure in that interoperability of data sources is a key issue. Data issues include:

- formats (standards needed for increased interoperability),
- ways to accommodate many different types of data,
- handling and integrating legacy data, as well as digitisation requirements of legacy data,
- data overload (from new remote sensing satellite-based sensors), and
- metadata issues, e.g. formats, standards, creation of metadata, dissemination via Web-based portals or clearinghouses, and interoperability with non-IOC data discovery systems.

National Oceanographic Data Centres – Backbone of the IOC/IODE Mission

Within the IOC's overall vision for a global information infrastructure for ocean research data, the National Oceanographic Data Centres (NODCs) are similar in concept to the National SDIs within a Regional SDI or GSDI vision. NSDIs will be the "backbone" for a Regional SDI and will incorporate geospatial data from many sources. Interconnected RSDIs could become the backbone for the GSDI. Similarly, NODCs are the backbone of the IOC's global oceanic data infrastructure.

As of 2001, more than 60 NODCs had been established around the globe, plus 10 "Responsible" NODCs and three World Data Centres for Oceanography (WDCs). [1] The system of global WDCs developed under the leadership of the ICSU, the International Council of Scientific Unions (ICSU 2002), beginning in 1957 in support of the International Geophysical Year (IGY).]. At first sight, an NODC might look more like a typical SDI "clearinghouse", rather than as a more critical component of a complete information infrastructure. In practice, within the oceanographic research and information exchange community, the NODC is actually a combination of clearinghouse and backbone element comprising wider regional and global systems, experiencing many of the same problems that apply to SDI formation, e.g. data policy issues, intellectual property and legal issues, awareness, training, standards development and promulgation, interaction with different types of data providers and more.

Looking more closely at the objectives, tasks and problems of creating and maintaining an NODC illustrates these parallels with the objectives and formation issues for a typical SDI. IOC's guide to setting up NODCs recommends (IOC 1997):

- Develop a mission statement in line with that of the overall IOC/IODE data exchange policy guidelines and the resources actually available to carry out the mission.
- Choose between a centralized data centre structure, i.e. holding copies of data from providers in their nation/region, or developing a distributed system, requiring greater interaction (and technological links) with the data providers – and greater understanding of, and sympathy with, their providers' own data access policies.
- If also acting as an advisory service, and not simply as a data repository or portal (gateway to other providers' data resources), then stick to data types with which they have expertise, both as to the science for interpreting that data and the peculiarities of the data itself, e.g. format, content, collection issues, quality control issues.

The NODC guide also states (IOC 1997 p 7) "…the distributed model has several potential advantages. … including savings in operating costs and in salary costs by not having to duplicate specific scientific expertise. … this sort of arrangement is only possible if the

partner organization realizes tangible benefits from the arrangement." Such benefits might include "such items as computer software, data management expertise, improved standardization, and a direct connection to other national and international oceanographic data." The responsibilities of the NODC include assisting partner organizations in formulating and implementing data management plans for national and international experiments, developing and implementing data quality control systems, setting standards for data documentation (metadata), archival, and exchange, and distributing data to the relevant national and international systems. Each new NODC should be considered "as an integral part of the national or regional system."

Comparing IOC Data Infrastructure to Regional SDIs

There are similarities and dissimilarities between the IOC information infrastructure and that proposed for Regional SDIs, at administrative, organisational and technical levels. At the organisational level, the IOC was created as a formal organisation within the UN system (UNESCO), in 1960 – more than 40 years ago. It has an Assembly of national government ministers, an Executive Council and a permanent Secretariat, based at UNESCO's Paris headquarters. IOC has international political legitimacy conferred on it by UNESCO sponsorship and access to resources to carry out major projects, including development of an extensive information infrastructure.

As to resource availability to achieve stated mission objectives, the IOC/IODE seems to have access to greater resources than most regional SDI (and certainly the GSDI) initiatives, most probably due to its more formalized and legitimised nature, as a UN-sanctioned organization. Convening a single meeting of the IODE Intergovernmental Working Group on Data Exchange Policy (only one of numerous working groups active on IODE affairs) is budgeted at US$ 50,000 (for translation, interpretation, secretariat and up to 40 participants) (IOC 2000a). The IOC Executive Council meeting that authorized this working group directed members to budget for at least two working group meetings, totalling US$ 100,000 in the 2001-2002 time frame "from extra-budgetary resources", as well as allowing for "additional allocations that might be necessary to support participation from developing countries."

By contrast, most regional SDI initiatives, as well as GSDI, seem to fight a continual battle to secure the resources needed to carry forward their planned programmes of activities. Of the three major regional SDI initiatives underway, i.e. in Asia-Pacific (APSDI), the Americas (PC-IDEA) and Europe (INSPIRE), access to adequate resources, both human and financial capital, is still a serious problem, especially in relation to the ambitious objectives to be achieved.

The Asia-Pacific and Americas RSDI initiatives are promoted under the auspices of the UN Regional Cartographic Conferences programme (UNRCC), with APSDI being the more advanced, having started earlier the PC-IDEA. Unfortunately, the UNRCC programme is under-resourced at UN level, reducing the level of support that can be offered to RSDI participants in very practical ways, e.g. establishing permanent secretariats, funding working group activities, sponsoring outreach, training and conference programmes. It has also undergone its own internal administrative setbacks, with responsibility for cartographic issues changing departments at the UN in recent years.

The European SDI, INSPIRE (Infrastructure for Spatial Information in Europe), although it is the newest of these three regional initiatives, enjoys the possibility for good long-term support, as it is resourced by one or more European Union programmes, in the framework of environmental protection, water management and long-term research and development programmes (the EU's Framework RTD programmes).

IOC must also cooperate and integrate its information activities with other global programmes, including the Global Ocean Observing System (GOOS) and its European sub-system EuroGOOS, with the Global Climate Observing System (GCOS), the World Climate Research Programme and the World Ocean Circulation Experiment (WOCE). Policies, especially on data access, use and reuse, must be agreed with other international organisations, such as the World Meteorological Organization (WMO).

Similarly, regional SDI initiatives must be aware of the geospatial data needs of regional (and global) environmental protection and monitoring programmes, climate change programmes, agricultural, coastal zone and ocean research programmes. Many of these programmes will predate the regional SDI initiative and have information requirements mandated by international conventions ratified by the nations involved in the regional SDI work, usually by a number of different government ministries.

One main difference is that NODCs and especially WDCs, in the IODE system, actually hold copies of information (data, metadata, research reports, etc.). This information is made available to IOC member institution researchers in each nation or region. Thus, IOC operates a formal information exchange system, where "exchange" is a key part of the mission statement. The global information infrastructure for IOC is its network of 60+ physical data holdings, which can be accessed by "authorised" users through a standardised data exchange system. This is not necessarily the case for the Regional SDIs that will comprise the GSDI.

Most SDIs, whether national, regional or global, are created to aid in geospatial data discovery and access, including access to expertise in understanding the data holdings of those organisations participating in the infrastructure. There are many technical, administrative and legal issues to be resolved, some of which also apply to data exchange in the IODE system. However, there is no plan in any SDI (yet) to hold a centralised database or to create a physical system of interconnected databases. This is perhaps best expressed in the description of the Asia - Pacific Spatial Data Infrastructure (APSDI) as described by the Permanent Committee for Geographic Information in Asia Pacific (PCGIAP 2001).

> "The Asia and Pacific Spatial Data Infrastructure … comprises an institutional framework, technical standards, fundamental datasets and a distribution network. … it provides a network of databases, located throughout the region, that together provide the fundamental data needed to achieve the region's economic, social, human resources development and environmental objectives. Those distributed databases might include such themes as geodetic, cadastral, topographic, geographical names, hydrographic and economic data."

PCGIAP proposes that linkages between these potentially quite disparate geospatial data themes may be achieved by (PCGIAP 2001):

- an intra-regional institutional framework that provides mechanisms for sharing experience, technology transfer and coordination of the development of the fundamental datasets;
- use of common technical standards, including a common geodetic reference frame;
- adoption of harmonized data access, pricing, privacy, confidentiality, distribution and custodianship policies;
- implementation of intergovernmental agreements on data sharing;
- comprehensive and freely accessible directory of available datasets using accepted standards for metadata.

The PCGIAP vision for APSDI states that the data infrastructure is specifically "NOT a centralized database controlled by some central authority". Rather, it is "a distributed database

under the control of numerous custodians of individual datasets who retain their control over the data, but which are linked by a common set of standards and protocols." Also, APSDI is "NOT a comprehensive GIS of all things". Rather, it includes basic and essential data on which, and from which, other datasets can be built.

Just as NSDI implementers must take into account the structures that already exist in the geospatial information communities that will comprise their national SDI, NODCs are advised to plan their organization and functions to take advantage of expertise and work already being done in the ocean research realm. They are admonished "to consider all opportunities for mutually beneficial partnerships with existing organizations collecting or using oceanographic data." (IOC 1997) They need to be aware of the missions of existing organizations in the oceanographic field and the international responsibilities for data and information exchange of these organizations and their governments.

Another similarity to NSDIs, which form the cornerstones for a regional SDI, is that IOC advises NODCs to be good national centres before they try to provide good services on an international basis. "If a centre (NODC) does not provide a good quality national service, it will not receive the co-operation of its data collectors and users and will fail. An NODC should not be established to serve a perceived international need alone. The centre should generally not take on responsibilities for international datasets that are of no interest or are not collected nationally." (IOC 1997)

Comparing Information Policy at IOC/IODE and in RSDI/GSDI

A key aspect of any spatial data infrastructure is data policy, including access, use, re-use and charging elements of such policy. Regional (and global) SDI developers generally accept that their SDI initiatives must include geospatial data policy(ies) that include, or encompass, the policies inherent in the national SDI policies that comprise the regional SDI. The task for the regional or global SDI designer is to attempt to establish some degree of harmonization for data policy that is acceptable at national level to all participants in the regional SDI. It goes without saying that this is not an easy task. How much success has the IOC/IODE achieved in this regard?

As late as December 1998, the first meeting of the IOC/IODE Strategy Group of Experts addressed basic data exchange issues such as "current limitations in accessibility of data due to technology limitations and lack of uniformity". They felt that the "prescriptive approach to data and information standards had not been successful in the past and should not be attempted again." (IOC 2000b) Part of the reason for this conclusion was due to the large amount of legacy oceanographic data that already existed globally. However, the group did agree that "a common method of describing data and fields within data sets" would be useful – in other words, common metadata would be nice! Other suggestions included development of an agreed keyword list and thesaurus for the ocean realm. The final recommendation was that "a common data dictionary would be especially useful" and that the group should attempt to develop a "minimal standard for data dictionary structure and tools based on existing and evolving standards for metadata."

Note that some pretty basic issues were being discussed by this "strategy" group nearly 40 years after the formation of the IOC and IODE – and certainly within the same time frame that the same issues were the focus of numerous national, regional and global SDI initiatives! While manuals on the technical aspects of data collection, storage, formats, etc. have existed in the IOC system for decades, many policy related issues have yet to be resolved. The IOC *Ad Hoc* Working Group on Data Exchange Policy did not hold its first meeting until May, 2000 (IOC 2000c) at which a Draft Data Exchange Policy Statement was issued.

Preparatory to the first meeting of the new Intergovernmental Working Group on Data Exchange Policy, the appointed chairman produced a background document (McEwan 2001) looking at the many issues and tracing the history of data policy from the inception of IOC and IODE in 1961 with IOC Resolution 1.9. Originally, data exchange was the responsibility of the World Data Centres, covering (generally) exchange between qualifying contributors at no charge. In the four subsequent revisions of the IODE Data Exchange manuals from 1965 to 1991, cost and logistics of exchange were addressed, but not inclusions or exclusions to what could be exchanged.

An IODE Draft Statement adopted in 1993 stated "full and open sharing of a wide spectrum of global international data is a fundamental objective". This draft statement covered cost of exchange issues, data preservation and archiving, metadata and maintenance of standards. It proposed time limits that all ocean management data should be available after one year or, in certain cases, after a maximum of two years.

For a comparison of spatial information access policies across a range of regional and international organizations and programmes, see Longhorn (2002), which includes a comparison of policies of IGBP (International Geosphere-Biosphere Programme), CEOS (Committee on Earth Observation Satellites), WMO and ECOMET, IOC/IODE, GOOS and EuroGOOS, GSDI, the Global Map Project, plus the European Space Agency (ESA) and European Environment Agency (EEA).

At the May 2001 meeting of the Intergovernmental Working Group on IOC Oceanographic Data Exchange Policy, the following draft policy statements were adopted (IOC 2001) for consideration by the 21st Session of the IOC Assembly. These would then be considered further at the second working group meeting scheduled for June 2002 (for which public reports are not yet available at time of submission of this paper).

> The Intergovernmental Working Group on IOC Oceanographic Data Exchange Policy, at its First Session (May 2001), noted the needs of Member States to:
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> (i) Provide free and open access to data (observation data, derived data and gridded fields) that are collected, produced or exchanged as part of programmes conducted in association with IOC;
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> (ii) Freely contribute data and metadata from all sources to the IOC/IODE system to gain maximum benefit from the coordination of observing systems and the integration of data gathered, creating a truly global observing network in order to contribute to monitoring and forecasting the present and future state of the planet;
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> (iii) Submit to the appropriate IOC/IODE data centres or suitable national archive linked to the IOC/IODE system, all publicly funded data and encourage the submission of data that may have a withholding period or other restrictions, with minimal delay;
>
> (iv) Where restrictions need to be applied on access to nationally acquired data relevant to IOC programmes, submit all metadata to the appropriate IOC/IODE data centre or suitable national archive linked to the IOC system, to facilitate the exchange of metadata and to expedite its rapid inclusion in international inventories;
>
> (v) Assist in building national capacity to manage oceanographic data and information and to develop relevant products and services.

The Working Group further recommended (IOC 2001) "the following 'elements' be adopted as a basis on which oceanographic data exchange and archival policy of the IOC will be formulated":

(i) All oceanographic data and their metadata which are capable of contributing to the beneficial public use and protection of the ocean environment, resources, protection of life and property and for the prediction of weather and climate shall be freely and openly accessible (i.e. made at available without restriction at a charge no more than the cost of reproduction and delivery);

(ii) The IOC should promote, through its programmes and Member States, the reciprocal value and benefits of free and unrestricted exchange of data and metadata;

(iii) Data available from IOC programmes should have no re-export restrictions;

(iv) Data and metadata should not be delayed or withheld deliberately and arrangements for their timely transmission should be implemented using the most appropriate technology;

(v) The IOC/IODE system of data centres should be developed as the main repository for the long term preservation of data, metadata and related information. Data collected by IOC programmes should be preserved by IOC/IODE data centres and are provided with the understanding that (i) will apply;

(vi) Member States shall work to enhance the capacity in developing countries to participate and benefit fully from the exchange of oceanographic data and products through IOC's Training Education and Mutual Assistance (TEMA) programme and other mechanisms;

(vii) IODE, GOOS and (other) programmes of IOC will work with data contributors to ensure that data can be accepted into their systems and meet quality requirements;

(viii) IOC Programmes will, where appropriate, identify their requirements for data on which no conditions of access apply (in conformity with (i)) and also identify further data and products to be made available to which the originator may attach conditions.

Readers familiar with the current debates surrounding access to topographic data in global projects such as the Global Map, as well as policy statements of the GSDI legal and policy working group, will see many parallels with the issues the IOC/IODE now face. The "GSDI Cookbook" on "Geospatial Data Access and Delivery - Open Access to Data" (GSDI 2001 chapter 6) highlights similar issues and concerns:

> Access to geospatial data from the consumers point of view … goes from discovery to evaluation, to access and finally to exploitation. Discovery (find, locate) involves the use of services such as metadata catalogs … Evaluation involves detailed reports, sample data and visualization … Access involves the order, packaging and delivery, offline or online, of the data … Exploitation … is what the consumer does with the data for their own purpose.
>
> Typically … the focus of geospatial data access was supplier side with a strong emphasis on technology and community based standards and specifications. With the growth of the Internet, in particular Web based technologies, access has become a demand driven operation. Consumers expect simple discovery and access to cheap (or free) data in simple standard formats that can be used in desktop applications. Increasingly non-traditional suppliers are offering geospatial services. The ability to leverage off other major developments such as the World Wide Web, and in some cases

electronic commerce, has allowed broader participation in the Industry. The further democratisation of access to geospatial data thus enables value-added suppliers to create new data products and services. … Issues appear and grow more complicated as the groups become broader and, generally, revolve around copyright, licenses (end user versus reseller), cost, privacy, data formats and standards.

Conclusion

Based on the above comparisons, it is likely that participants in IOC-sponsored research programmes, which create, use and disseminate geospatial data, would feel very much at home working with any of the groups now implementing national, regional or global SDIs. Although they have achieved much in regard to data exchange in their 40+ years of existence, as regards technical and organizational issues, they face the same data policy problems as are common in SDI developments around the globe.

References

Note: For IOC/IODE documentation, visit http://ioc.unesco.org/iode/.

GSDI. 2001. "Developing Spatial Data Infrastructures: The SDI Cookbook", D. D. Nebert (TWG Chair and editor), version 1.1, GSDI Technical Working Group, 15 May 2001. http://www.gsdi.org/pubs/cookbook/cookbook0515.pdf

ICSU. 2002. The World Data Centre System. http://www.ngdc.noaa.gov/wdc/wdcmain.html

IOC. 2001. First Session of the Intergovernmental Working Group on IOC Oceanographic Data Exchange Policy - Meeting Report, IOC/INF-1163, UNESCO 15 June 2001.

IOC. 2000a. IOC Executive Council Resolution XXXIII.4 – IOC Oceanographic Data Exchange Policy - and Annex, UNESCO, June 2000.

IOC. 2000b. First Consultative Meeting of the IOC/IODE Strategy Group of Experts. Meeting Report, 1-2 December 1998. UNESCO HQ, Paris. IOC/INF-1145 20 July 2000.

IOC. 2000c. IOC Meeting of the Ad Hoc Working Group on Oceanographic Data Exchange Policy: Meeting Report IOC/INF-1144rev, UNESCO, 15-17 May 2000.

IOC. 2000d. IODE Group of Experts on Technical Aspects of Data Change – Eight Session report, 13-17 March 2000. UNESCO, IOC/IODE-TADE-VIII/3.

IOC. 1997. Guide for Establishing a National Oceanographic Data Centre (revised edition). Manuals and Guides No. 5 (revised). UNESCO, Paris.

Longhorn, R. 2002. "A Comparison of Spatial Information Access Policies of Transnational Environmental Modeling and Global Climate Change Programmes" in Proceedings of the 22nd EARSeL (European Association for Remote Sensing Laboratories) Symposium, Prague, Czech Republic, 3-6 June, 2002, to be published October 2002.

McEwan, A. 2001. Issues in the Formulation of a Policy for the Public Exchange of Oceanographic Data and Data Products. IOC/IWG-ODP-I/6, UNESCO, 17 April 2001.

PCGIAP. 2001. "What is the APSDI?". http://www.pcgiap.org/