

The Global Spatial Data Infrastructure Initiative and Its Relationship to the Vision of a Digital Earth

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ABSTRACT In the final few years of the millennium the concept of a Global Spatial Data Infrastructure (GSDI), and its potential realisation, has captured the imagination and attention of policy-makers, administrators, industry, and the professions. Although not widely known in the general community or commonly understood by its proponents the GSDI is seen by many as a central element in the global response to the challenge of sustainable development. The GSDI encompasses the broad policy, organisational, technical and financial arrangements necessary to support global access to geographic information. It will potentially benefit many stakeholders - government and non-government organisations, education and research institutions, the commercial sector, and the general community - at the national, regional and global level. The GSDI offers the prospect of better decision-making and thus improved economic growth, social development and environmental management. Three GSDI conferences have now been held with a fourth planned for South Africa in March 2000 and a fifth foreshadowed in South America in 2001. An interim group, the GSDI Steering Committee, comprising representatives from all continents, has been tasked with establishing a permanent global umbrella organisation to take the GSDI into the future. The challenges confronting the GSDI are many - raising the level of awareness, acceptance and support; recognising and complementing related initiatives; including all stakeholders and engaging the less developed economies of the world; maintaining enthusiasm and momentum; and finally, delivering beneficial outcomes.

Indeed, the aim of the GSDI has been supported by many nations throughout the world, and are being realized in a number of national and international programs. One such program, the Digital Earth, was launched as a result of US Administration and Federal Agency focus to create "a virtual representation of our planet that enables a person to explore and interact with the vast amounts of natural and cultural information gathered about the Earth". The Digital Earth exemplifies the significant improvement in understanding and decision-making that comes through the application of spatial information, innovative technologies, and partnerships. However, the Digital Earth cannot exist and flourish without a compatible and responsive spatial data infrastructure.

The visions for the GSDI and the Digital Earth are tightly interlinked. Whereas the former places emphasis on the policy, institutional and standards environment, the latter emphasizes application of geospatial data, technology and tools to answer user queries of simple to very complex issues. All of these elements are essential to the achievement of the global vision. This paper describes the GSDI as an essential element of the Digital Earth, and identifies the challenges and opportunities for cooperation and collaboration to make the Digital Earth a reality around the globe.

1. Introduction

In the final few years of the millennium the concept of a Global Spatial Data Infrastructure (GSDI), and its potential realisation, has captured the imagination and attention of policy-makers, administrators, industry, and the professions. The GSDI offers the prospect of better decision-making and thus improved economic growth, social development and environmental management. The

GSDI is being supported by many nations and is being realised in a number of national and international programs. One such program, the Digital Earth, aims to create "a virtual representation of our planet that enables a person to explore and interact with the vast amounts of natural and cultural information gathered about the Earth".. Another program, the Global Map project, aims to establish a set of framework geospatial data

coverages for the world. These coverages will provide important information content for the GSDI.

The visions for the GSDI and the Digital Earth are tightly interlinked. Whereas the former places emphasis on the policy, institutional and standards environment, the latter emphasizes application of geospatial data, technology and tools to answer user queries of simple to very complex issues. The GSDI provides the guiding environment for the construction and operation of spatial data infrastructures that respond to national needs as well as international needs. The Digital Earth program will deliver enhanced capability to use the infrastructure to respond to a wide variety of inquiries and issues posed by community decision-makers, educators, students and others.

This paper begins with a definition of the GSDI and the Digital Earth, moves on to describe the GSDI work plan and the GSDI technical activities supporting the Digital Earth, and concludes with some observations on the challenges to the realisation of the GSDI.

2. Definition of the GSDI

The GSDI is envisaged to encompass the broad policy, organisational, technical and financial arrangements needed to support ready global access to geographic information. The definition of the GSDI adopted at the 2nd GSDI Conference (GSDI 1997) is:

"The policies, organizational remits, data, technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the global and regional scale are not impeded in meeting their objectives"

Participants at this conference also agreed that the definition needed further discussion and that the concept of the GSDI should periodically be redefined.

3. Definition of the Digital Earth

As a major program to implement capability to explore the planet by leveraging spatial information, technology, and partnerships, the Digital Earth Interagency Working Group adopted the following consensus definition on 23 September 1998:

"The Digital Earth will be a virtual representation of our planet that enables a person to explore and interact with the vast amounts of natural and cultural information gathered about the Earth."

The Digital Earth initiative brings together Federal, State, and Local agencies, industry, academia, and international partners to facilitate the development of the next generation technology, standards, and enhanced content necessary to realize the Digital Earth. The Digital Earth initiative focuses on providing significantly new end user capabilities for

engaging in research, education, community decision-making, environmental protection, and global change to name a few. The Digital Earth will also rely on the infrastructure provided through National and Global Spatial Data Infrastructures, and will leverage the significant work being accomplished through organizations supporting international standards, technology, and best practices.

4. GSDI Work Plan

The resolutions of the 3rd GSDI conference (GSDI 1998) form the basis of the current workplan (or business plan) of the GSDI Steering Committee. These resolutions provide the road map for generation of a SDI business case, pursuit of SDI technical activities, and implementation of a permanent organization arrangement. The GSDI work plan facilitates the growth of a global infrastructure reference environment capable of supporting a Digital Earth. Key elements of the work plan are described in the following sections.

4.1. Statement to the United Nations

One of the major resolutions from the 3rd GSDI Conference is to request the Statistics Division of the United Nations to submit the following statement to an appropriate United Nations body for consideration:

"Recognising that implementation of the objectives of Agenda 21 requires transnational understanding and analysis of environmental data the ECOSOC urges countries, to the extent possible and consistent with national priorities, to develop national spatial data information systems and cooperate to develop international spatial data standards"

At the time of writing this paper the resolution had not yet been able to be referred to an appropriate UN Commission by the Statistics Division.

4.2. Organisation Design

The organisational model recommended for the GSDI in the long run is a global umbrella organisation which brings together regional committees, national committees, and other relevant international institutions (e.g., ISO, OGC, ISCGM, ISPRS, ICA, etc.) in the context of principles of flexibility, inclusivity, simplicity and subsidiarity. The characteristics of this model are well described in the theme paper for the 3rd GSDI Conference (Brand 1998). As an interim measure, the GSDI Steering Committee will continue to serve as the guiding body for the GSDI while a permanent umbrella organisation is established.

4.3. Business Case Development

A major study into the business case for SDI development is to be commissioned. The study will identify the economic, social, environmental and disaster management benefits that can be achieved through development of compatible national and regional SDI's, and the global SDI. It is envisaged that SDI development will be facilitated through:

- Financial support and capacity building, by national governments and international agencies; and
- Policy changes to enable wider access to public sector spatial data, by national governments.

The study is expected to:

- Build on existing national and other economic, social, environmental and disaster management studies, and refer to the development policies of international bodies;
- Be undertaken by independent experts, with funding from independent sources;
- Include real multi-national and/or global case studies that illustrate SDI benefits; and
- Be suitable for submission to national governments and international funding agencies.

It was originally anticipated that the draft business case would be presented to the next GSDI Conference for approval. It is more likely that the initial stage in the development of the business case, a scoping study, will be available by the 4th GSDI Conference. The final stage of development of the business case is proposed to be completed by the time of the 5th GSDI Conference in South America in 2001. The business case will assist the global umbrella organisation in its campaign to secure organisational and funding support for national, regional and global SDI development.

4.4. Facilitation of Transitional Initiatives

The GSDI Steering Committee has also been asked to support and advocate transitional initiatives, in particular, Permanent Committees for GIS Infrastructure for the Americas, Africa, and the Middle East. Since the 3rd GSDI conference initial discussions have taken place in the Americas and Africa.

4.5. Future Conferences

Participants at the 3rd GSDI Conference endorsed the need for a future meeting to continue activities of the GSDI begun in Konigswinter, Germany and carried forward at Chapel Hill, North Carolina, USA and at Canberra, Australia. There was consensus to accept the invitation of South Africa that the next meeting is early in the year 2000 in South Africa. Further, there was consensus to accept the invitation of South America to hold the following

meeting in 2001 and Colombia was requested to accept responsibility to develop the conference site. Finally, there was consensus that the conference should rotate after 2001 to other regions of the world.

Preparations are well advanced for the 4th GSDI Conference to be held in Capetown, South Africa, 13-15 March 2000. The theme of this Conference will be "engaging emerging economies".

4.6. Management of the Work Plan

The GSDI Steering Committee comprises an Executive Committee and an Advisory Committee. The names and contact details of members of these committees are described at Attachments A and B respectively.

The Executive Committee comprises the Chair and Vice Chair; the Past Chair of the steering committee; representatives from each of the four regions of the world (i.e. Asia-Pacific, Europe, Africa-Middle East, and the Americas); and members at large who represent nations and a cross section of the GSDI stakeholder community. The Chair is a representative of the region or nation that hosted the most recent GSDI conference. The current Chair is Peter Holland from Australia, nominee of the Permanent Committee on GIS Infrastructure for Asia and the Pacific, who hosted the 3rd GSDI Conference. The Vice Chair is selected by the host organisation of the next GSDI Conference and is responsible for conference planning. The current Vice Chair is Derek Clarke, a representative of the Africa region, and host of the 4th GSDI Conference. Membership on the Executive Committee rotates with each GSDI Conference.

Each regional and national SDI and stakeholder organisation is encouraged to name a representative to the Advisory Group. The Chair and Vice Chair are able to propose regional representatives and stakeholder community representatives as needed to ensure the Advisory Committee contains a balanced representation of interests from around the world.

A GSDI Secretariat facilitates communication among members of the Steering Committee and assists working groups. David Robertson from Australia is the current Head of the GSDI Secretariat. The contact details for the Secretariat are shown at Attachment C.

The business of the GSDI Steering Committee is currently undertaken through four working groups and a taskforce:

- Operations Working Group - to oversee the implementation of the umbrella organisation structure, and general administrative issues related to the GSDI. Co-Chairs of this Working Group are

Jane Patterson from the USA and Michael Brand from Northern Ireland.

- Technical Working Group – to advise the Steering Committee on technical aspects of the GSDI. Chair and Vice Chair of this Working Group are Doug Nebert from the USA and Steve Blake from Australia.
- Communication and Awareness Working Group - to inform the broad community about GSDI and the value of spatial data, and to promote the GSDI concept. Co-Chairs of this Working Group are Alison Davey from France and David Robertson from Australia.
- Legal and Economic Working Group - to advise the Steering Committee on economic, legal and funding mechanisms underpinning the GSDI. Co-Chairs of this Working Group are Bas Kok from the Netherlands and Ian Masser from the United Kingdom.
- Business Case Taskforce – oversight development of the SDI business case. Co-Chairs of this Taskforce are Drew Clarke from Australia and Francois Salge from France.

The activities of the Technical Working Group directly support the vision of the Digital Earth. Terms of Reference for this Working Group are at Attachment D

5. GSDI Technical Activities Supporting the Digital Earth

The Digital Earth vision is dependent on a sound and compatible technical environment for geospatial information and applications. Geospatial data must be more accessible locally, nationally, internationally, and globally to address the multitude of issues facing communities today. Additionally, applications must become more powerful and more interoperable so that costs can be minimized, processes can be focused. The following objectives of the GSDI Technical Working Group directly support the needs of the Digital Earth:

- Propose reference models or best practice recommendations for data documentation and data discovery and access;
- Define core data categories, their resolution and content for the GSDI;
- Provide a working model of this core data using metadata and clearinghouse best practices; and
- Define a single standard for spatial referencing by geodetic coordinates that may be adopted as a standard to which countries may move toward and – in the interim - to which countries relate their own respective standards.

5.1. GSDI Technical Working Group

The GSDI Technical Working Group aims to formally operationalise the GSDI principles through the implementation of some key projects and through the development and promulgation of some basic Technical Business Principles, the sharing of ideas, common applications and the development of reference implementations.

In overseeing the coordination of GSDI SDI Implementation the Technical Working Group is:

- Providing an international forum for the discussion of issues and coordination of GSDI technical activities;
- Advising the GSDI Steering Committee about technical SDI Implementation issues;
- Harmonising technical and project work undertaken by the GSDI participants;
- Building collaboration, commitment and support within the broader GI community;
- Drafting, maintaining, and implementing a technical implementation guide document for Steering Committee approval;
- Liaising with other working groups on matters of common interest; and
- Implementing selected technical recommendations to come out of the GSDI Conferences.

The main initiative currently underway is the development of a "GSDI Cookbook" to empower national SDI Implementation.

In short, the overall aim of the Technical Working Group is to apply the outputs of the ISO and OGC processes and show their application for agencies currently involved with implementing their national SDI's. Best practice and case studies are used for demonstration purposes.

5.2. GSDI Technical Business Principles

Technical Business Principles provide the common understanding of "ground rules" when undertaking applications development tasks under a distributed development model across many development sites. They guide the development of an infrastructure capable of supporting the Digital Earth vision

The purpose of Technical Business Principles is to create a common environment to share information and software tools. Developments under the GSDI should take into account the needs of the whole GSDI community, both for accessing information and for publishing their own data. This community includes, but is not necessarily limited to, the four tiers of government agencies, industry and business, environmental and other community groups, education and research organisations.

Agencies and GSDI contractors who are placed on GSDI contracts need to "sign up" to the common

ground rules, or outputs from their consultancies will not be able to be incorporated into, and built on by, other GSDI initiatives.

Technical Business Principles assist with turning a common vision into closely aligned tasks and subsequent outputs. There is therefore a need to establish a set of GSDI Technical Business Principles to further coordination and common outcomes among jurisdictional SDI implementations. Technical experts from the jurisdictions and industry groups with national SDI programs currently underway, are encouraged to assist in establishing and applying these Technical Business Principles to meet national and jurisdictional SDI obligations.

The draft set of GSDI Technical Business Principles is described below. They are grouped into four categories:

- Coordination and Standards;
- Sharing and Dissemination;
- Systems Development and Architecture; and
- Content, Documentation and Acknowledgements.

5.2.1. Coordination and Standards

- Use existing software and protocols wherever possible to reduce development costs and to increase overall applicability and interoperability;
- Utilise existing national, regional, and thematic coordination mechanisms to encourage cooperation and participation;
- Support and utilise the relevant standards for Geographic Information Systems/ Geomatics now being developed through ISO TC/211;
- New developments and enhancements not covered by existing standards should be communicated to the relevant standards bodies;
- Support and utilise the emerging interoperable technologies coming out of the OpenGIS Consortium;

5.2.2. Sharing and Dissemination

- Provide base and enhanced public and commercial software and technical publications to a common GSDI resource registry;
- Advance interoperable architecture and systems development through the delivery of specific GSDI-compatible components, which in turn should be related closely to the international WWW Consortium and OpenGIS Consortium developments;
- Utilise the WWW and endorsed GSDI Internet technologies as the principal delivery mechanism for GSDI data and services, supplemented with other media for portable use off-network;
- Make available reference implementations of core GSDI software modules free-of-charge with open

licensing policies for public use and commercial enhancement;

- Enhancements to reference implementations of core GSDI software modules commissioned by non-commercial agencies and organisations should be returned/ lodged in the common GSDI resource registry for further general access and the opportunity for improvements;

5.2.3. Systems Development and Architecture

- Emphasis is placed on a distributed open systems architectural "Nodal" approach and also interoperability for search and access across multiple information communities, small and large;
- Implement a phased software life cycle approach, building mutually supportive GSDI modules/components, in software and systems design to recognise milestones, requirements and architectural review, technology refresh, and software evolution;
- Recognise and support, where feasible, transnational (GSDI) requirements when undertaking applications development as part of the GSDI distributed development model;
- Adopt and implement partially distributed "incubator" Nodes, where necessary, as the precursor to full stand-alone capability for distributed Nodes in order to minimise the barriers to entry;
- Focus on developing technologies which minimise barriers to data publishing and data access;

5.2.4. Content, Documentation and Acknowledgements

- Content providers have specified rights and responsibilities as per the (to be agreed) Custodianship Guidelines;
- Each spatially referenced dataset is to have a comprehensive ISO-compliant metadata entry which is made available publicly on the nationally endorsed data directories or associated thematic/ jurisdictional directories;
- Develop and publish comprehensive and comprehensible user and systems documentation for all software developed, including description of the communication protocols and software module interfaces used;
- Fundamental datasets should be developed using GSDI content specifications;
- Agencies must be fully acknowledged for their contributions.

5.3. SDI Cookbook

The SDI Cookbook or SDI Implementation Guide will provide geographic information providers and users with the necessary background information to

evaluate, implement, or participate within a growing digital geographic information community known as the GSDI. In order to take advantage of this growing body of geographic knowledge the SDI Cookbook describes:

- Existing and emerging standards;
- Supportive organizational strategies and policies;
- Free- or low-cost software solutions based on these standards; and
- Best practices.

Although proprietary or project-based solutions for information sharing might exist, the adoption of consistent geospatial data sharing principles will provide a better solution for publishing geospatial data using the Internet and computer media. In an increasing "global community" there is a need to ensure that transnational implementations and common knowledge bases are available. The ultimate aim of these SDI collaborations is to facilitate the geospatial data industry to become mainstream and a component of every day life.

The SDI Cookbook will be internationally authored, will be accessible on the Internet, and will also be distributed on CD-ROM and in paper format. It will consist of an introduction and nine chapters covering the following SDI topics:

- Geospatial Data Development: authors France and Japan;
- Metadata: authors Finland and the Nordic States;
- Geospatial Data Catalog: authors USA;
- Geospatial Data Visualisation: authors Australia and Germany (official Digital Earth representation on behalf of the GSDI Technical Working Group);
- Geospatial Data Access & Delivery: authors Canada;
- Other Services: authors NASA;
- Outreach & Capacity Building: authors Ghana and the United Kingdom;
- Case Studies (national, regional, and global): authors Colombia, Zimbabwe and a representative from the Digital Earth initiative; and
- Terminology: authors South Africa and Botswana.

A chapter editors meeting will be held in early December 1999 in Los Angeles immediately following the OGC meeting.

6. Conclusion

There are many challenging issues to address before the GSDI will become a reality:

- Raising the level of awareness, acceptance and support. The GSDI concept is not widely known, let alone well accepted and supported. Given the requirement for a broad group of stakeholder interests to be satisfied this presents a significant communication challenge. Perhaps the most important task at this present juncture is to gain the

support of the senior-most members of government, non-government, business and community groups, and in doing so influence legislative, policy and financial decisions that are critical to effective GSDI implementation;

- Recognising and complementing related initiatives. The GSDI is but one of many global, regional and national initiatives aimed at improving access to geographic information. It is essential that these initiatives are identified, recognised and appropriately supported so that the maximum synergy can be obtained from their collective outcomes. This requires a continuous scan of the external environment and effective communication networks amongst those involved.

- Including all stakeholders. For the GSDI to be seen to be truly successful by its stakeholders they must be appropriately involved in, and contribute to its design and realisation. Given the breadth of the GSDI stakeholder group - government and non-government organisations, education and research institutions, the commercial sector, and the general community - it is not surprising that many, if not a majority of stakeholders are not yet included.

- Engaging the less developed economies of the world. Much of the thought, discussion and effort thus far in defining, designing and implementing the GSDI has been from the perspective of the more developed economies of the world - Europe, North America, parts of Asia and Australasia. Most of the globe - generally the less developed economies of Africa, Asia, the Middle East and Oceania - has played only a minor role, if any role at all. If the GSDI is to be a truly global initiative and confer its benefits to all global citizens then a way must be found to bring these nations on-board.

- Maintaining enthusiasm and momentum. Having made the previous point it would be unfair and misleading not to recognise the many individuals and groups who have contributed to the GSDI thus far. This enthusiastic and committed global group must be encouraged to expand their efforts and bring others on-board, thus increasing the momentum of the GSDI initiative.

- Delivering beneficial outcomes. The final, and arguably the most important, issue of all to be addressed is ensuring that the GSDI delivers benefits that can be described and measured in some way, and are regarded as important by the relevant stakeholder group. If this does not occur for some time, or not at all, then the significant effort in involved in realising the GSDI will be questioned and potentially compromised.

This International Symposium on the Digital Earth provides an ideal opportunity to address these GSDI implementation issues, by:

- Facilitating the dissemination of information on GSDI activities to the Digital Earth stakeholder group, and vice-versa;
- Allowing discussion of ways in which complementary GSDI and Digital Earth activities can be better coordinated;
- Identifying potential activities where GSDI and Digital Earth proponents can work together to resolve problems. An area of Digital Earth activity that has already been identified by the GSDI Technical Working Group as important to achieving its goals is the work being done on the Digital Earth Reference Model (DERM). The DERM will provide a definition of the Digital Earth environment at each stage of its development. It will address standards, practices, and business cases relevant to the Digital Earth program as it develops. It is proposed that the DERM will be a key ingredient of the SDI Cookbook; and
- Providing an opportunity for those not previously involved in the GSDI initiative to contribute to achieving its objectives.

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