

The Strategic Imperative of a Global Spatial Data Infrastructure

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Summary

The Global Spatial Data Infrastructure (GSDI) encompasses the broad policy, organisational, technical and financial arrangements necessary to support global access to geographic information. It is seen by many as central to the response to the challenge of global sustainable development. 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. The emergence of the GSDI concept can be traced through the mapping and land information system developments of the 1960's and 70's; the acceptance of the notion of information as a corporate resource in the 1980's; rapid improvements in computing, communications and positioning technologies through the 1980's and 90's; and finally, implementation of national SDI's in the 1990's. Three GSDI conferences have now been held with a fourth planned for South Africa in 2000 and a fifth foreshadowed in Columbia 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. Notwithstanding these significant challenges the potential of the GSDI to contribute to a better world in the future drives those who seek its realisation.

Introduction

In the final few years of the millennium the concept of a 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 purpose of this paper is twofold: firstly, to describe the emergence of the concept of the GSDI; and secondly, to outline the GSDI implementation activities currently underway and the challenges yet to be fully met. The paper begins with a definition of the GSDI, describes the potential benefits and beneficiaries of its implementation, summarises the outcomes of the three international GSDI conferences held to date, outlines the current work plan for its implementation, and presents some key challenges that must be confronted before the concept is fully realised. The paper draws heavily on the growing body of information about the concept, and the views of its active proponents, much of which is catalogued on the GSDI home page (<http://www.eurogi.org/gsdi/index.html>).

Definition

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 is (GSDI 1997):

'... 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.

Benefits and beneficiaries

One of the central findings of the 2nd GSDI Conference is that the GSDI is of vital importance to implementation of Agenda 21 of the Rio Summit and to multi-national environmental conventions and that it should be placed as central support for decision making before the meeting of the UN Commission on Sustainable Development in 2001. Further, the GSDI is critical to the attainment of substantial and sustainable development in both the developed and developing countries of the world.

Some of the benefits of the GSDI can be found in the concept of the Digital Earth (Gore 1998). The Digital Earth is seen as a multi-resolution, three-dimensional representation of the planet, into which we can embed vast quantities of geo-referenced data. The applications that will be possible with broad, easy to use access to global geospatial information will be, in the words of Vice-President Gore, 'limited only by the imagination'. Some current USA-based examples cited in the Digital Earth announcement are:

*'... **Fighting crime:** The City of Salinas, California has reduced youth handgun violence by using a GIS to detect crime patterns and gang activity. By collecting information on the distribution and frequency of criminal activities, the city has been able to quickly redeploy police resources.*

***Preserving biodiversity:** Planning agencies in the Camp Pendelton, California region predict that population will grow from 1.1 million in 1990 to 1.6 million in 2010. This region contains over 200 plants and animals that are listed by federal or state agencies as endangered, threatened, or rare. By collecting information on terrain, soil type, annual rainfall, vegetation, land use, and ownership, scientists modeled the impact on biodiversity of different regional growth plans.*

Predicting climate change: *One of the significant unknowns in modeling climate change is the global rate of deforestation. By analyzing satellite imagery, researchers at the University of New Hampshire, working with colleagues in Brazil, are able to monitor changes in land cover and thus determine the rate and location of deforestation in the Amazon. This technique is now being extended to other forested areas in the world.*

Increasing agricultural productivity: *Farmers are already beginning to use satellite imagery and Global Positioning Systems for early detection of diseases and pests, and to target the application of pesticides, fertilizer and water to those parts of their fields that need it most. This is known as precision farming, or "farming by the inch." ...'*

The two theme papers presented at the 2nd GSDI Conference, Coleman and McLaughlin 1997 and Rhind 1997, identify the many players potentially involved in (and regarded by the author as potential beneficiaries of) the GSDI. These include:

'... Public sector as data providers, as consumers of information and advice, and as service providers ...;

Not-for-profit organisations;

Science/social science research organisations;

International aid/development organisations;

Educational organisations;

Private sector information/content providers;

Private sector service providers;

Private sector software vendors;

Private sector hardware vendors; and

Individual citizens ...'.

These theme papers expand on the potential benefits to three particular stakeholder communities:

*'... **The Military:** ... The military ... has played a significant role in developing and eventually spinning off the technology components which support global geospatial data infrastructure today. Some of the best-known examples of this - GPS, remote sensing, special-purpose computer hardware and software, and even the Internet itself, were developed to support basic mapping, surveillance, and command & control systems ... Future warfare will be "multi-dimensional", requiring the integration of information to support land, air, sea and even space-based operations in the process ...*

***Science and the Environment:** ... A number of global change initiatives have been implemented to improve quality of observations and interpretation, manage large quantities of global change data, and communicate the results of global change research to the international community. Examples of key international programs include ... Global Change Data and Information System ... World Climate Research Programme ... International Geosphere-Biosphere Program ... Human Dimensions of Global Environmental Change Programme ... Committee on Earth Observation Satellites ... Global Mapping Initiative ... Cost and availability of appropriate spatial data coverage - either on a global basis or over selected areas - remain key concerns of scientists in these programs ...'.*

The International Maritime Community: *The commercial shipping industry world-wide depends upon up-to-date information for safe and efficient navigation ... The real challenge continues to be financing the construction of the marine geospatial data infrastructure ... the use of Electronic Chart Systems and precise GPS dramatically reduces the risk of groundings, improves operational efficiency and reduces insurance costs ...'.*

Finally, the benefits from the growing number of significant SDI initiatives at national and regional level can be expected, in the view of the author, to be mirrored to a certain extent at global level through the implementation of the GSDI. Several of these initiatives were highlighted at the 3rd GSDI Conference - national developments in countries such as Malaysia, Hungary, Australia, New Zealand, USA, UK, Canada - regional developments in areas such as South America, the Baltic Sea Region, Europe, Asia and the Pacific.

History

Background

The background to the emerging interest in a GSDI is well described in Coleman and McLaughlin's theme paper.

'... The vision of a global information infrastructure (GII) is very much wrapped up with issues surrounding the development of telecommunications infrastructure. In particular, as the world becomes more interconnected and interdependent, the world of telecommunications policy has been increasing in importance.

Such policy is currently driven by the belief that communications and information infrastructures collectively represent a principal "transforming technology" serving important social goals, and that development of these infrastructures is fundamental to economic growth. As well, it reflects a strong movement towards privatisation of services and increased competition in the telecommunications sector.

... The concept of geospatial data infrastructure (GDI) was promoted from very different roots, with a much greater focus on content and concerns over the communication media treated as being largely beyond the community's control..

... In the 1960's, proponents of integrated mapping practices advocated the registration, overlay, interpretation and analysis of different "layers" or themes of spatially-related datasets- possibly originating in different organisations - to the practical solution of important problems in land use planning and resource inventory ...

... Through the 1970's, the multipurpose cadastre concept launched major topographic and cadastral "base-mapping" mega-programs to support land administration at the local, state and federal levels across North America, Australasia and in emerging nations ... By putting in place a reliable and comprehensive basic map series, these mega-programs were intended to reduce perceived duplications of effort in basic mapping by end-users and encourage greater focus on creation and maintenance of special-purpose "thematic" layers ...

... By the early 1980's, the notion of "information as a corporate resource" ... and the information resources management movement encouraged individual organisations to implement collective approaches to the collection, management and sharing of designated hardcopy and computer-based data holdings of "corporate-wide" interest....

... The manifestation of these data sharing precepts evolved from early dreams of centralised "land information databanks" through the 1960's and 1970's ... into the vision of more complex distributed land information networks in the 1980's. This vision conveyed the idea of linking together organisations responsible for the management of land-related information in a jurisdiction into a network to form a "virtual" geographic information system which could be queried in a manner similar to a single database ...

... critical mass has now been reached in a number of more recent enterprise- or jurisdiction-wide efforts. At least five important reasons account for this acceleration ... Increasing prominence of spatial data handling within organisations ... robust, easy-to-use and relatively inexpensive tools ... ubiquitous data ... ubiquitous communications ... greater availability of experienced people ... ubiquitous and inexpensive positioning, tracking and navigation capabilities of GPS ...

... By the early 1990's, the concept of spatial data infrastructure (SDI) development was being proposed in support of accelerating geographic information exchange standards efforts, selected national mapping programs and the establishment of nation-wide spatial information networks in the United States ... the United Kingdom ... Canada ... and the European Community ..."

... Finally, the Santa Barbara Statement prepared from the Interregional Seminar on Global Mapping for Implementation of Multi-National Environmental Agreements (held Santa Barbara, California, USA, in November 1996) made a strong plea for the accelerated collection, promotion and use of the output from national and global mapping programs and the coordinated development of a global spatial data infrastructure ...

The extent of activity today in implementing spatial data infrastructures around the globe is well described in Masser 1998 and Onsrud 1998. Onsrud's survey, commissioned specifically for the 3rd GSDI Conference, provides baseline information on the nature and characteristics of the SDI's currently being developed. It provides an important dataset against which to measure changes in SDI activity at national, regional and global level and will be regularly reviewed at future GSDI conferences.

Conference 1

The 1st GSDI Conference, with the theme 'The Emerging GSDI', was held in Bonn, Germany, 4 – 6 September 1996. The main goals of the conference, as described in the conference proceedings (GSDI 1996) were:

'...to minimize duplication of national efforts, the cost of Research & Development (R&D), and to identify the critical opportunities and threats inherent in creating a global spatial data infrastructure ...

... create a standardized vocabulary and the new concepts needed to facilitate an ongoing dialogue between diverse professions to design, implement and extend spatial data infrastructures needed in building and using geo-information products and service in a global spatial data infrastructure ...'

The conference generally agreed:

'... A consensus was clearly reached that now is the right time to start thinking about the GSDI concept, major issues affecting GSDI, and a possible "implementation plan", although what was to be "implemented" was still a very grey area ...

... It was proposed that this GSDI Forum should be extended to all sectors in the Spatial Data/Geographical Information communities, worldwide, and should meet again in a period of 7 to 9 months to continue the dialogue, after informal ... working groups had investigated the problems likely to surface in regards to more global use of GI ...

... It was generally accepted that there was no need to create a new "artificial" global project in order to investigate the main issues. Rather, it was suggested that existing global projects ... be examined to see if common problems were being met and could be overcome...

... it is apparent that some body or forum is needed to review and comment upon the real, practical problems being faced today by global GI projects ...

... The will for good cooperation and of sharing ideas about infrastructure architectures and solutions between the nations is clearly given. It is seen that every ground related decision has to be based on coordinates of an event including the time ...

... All people and especially the politicians have to be convinced of the importance of spatial data, which makes only sense if they are available globally and if infrastructure is functioning. It is necessary to contemplate properly the next steps in this direction and to take into consideration that not the technique itself is the problem; the ability to use the brain is the main point ...'

Conference 2

The 2nd GSDI Conference, with the theme 'Towards Sustainable Development Worldwide', was held in Chapel Hill, North Carolina, USA, 19-21 October 1997. The main goals of the conference were:

*'... clarify worldwide activity related to SDI development;
Identify specific benefits and raise awareness of GSDI within the world community;
Generate a blueprint for realizing the GSDI vision ...'*

The conference found (GSDI 1997), in addition to the central findings mentioned previously, that:

'... It is necessary to seek involvement and support of decision-makers at the highest levels of business, government, and academia in establishing the GSDI; and to generate support at the local, national, regional and international levels. In particular, it is important to involve the G7 countries, the UN Institutions, and the World Bank in the creation and use of the GSDI ...

... Numerous international activities are seeking to forward aspects of the GSDI ... It is important that all international groups working toward the development of the GSDI participate in future processes of its evolution and that they communicate, coordinate, and collaborate to the fullest extent practicable ...

... There is a need to foster education and research activities that go beyond treatment of geospatial data in solely a technical fashion. It is important that such activities include the creation of suitable tools in universities, government and the private sector to foster the use, demonstration, spread of good practice, and thoughtful application of results of this research ...'

The conference resolved that:

'... There is a need for an organizational nucleus to encourage the creation, development and linkage of local, national, regional and global geospatial data infrastructures ...

... Permanent regional committees for geographic information ... are important to the success of the GSDI. There is a need to encourage development of these permanent committees ... in regions where currently they do not exist, such as the Americas, Africa, and the Middle East ...

... It is essential to have a family of standards as the foundation for technical implementation of the GSDI, and all standards created or utilized for the GSDI should be international standards ...

... There is a need to explore the extent to which local, national and regional data sets can be translated into international ones, and how data definitions can be harmonized without losing their primary relevance or compromising the political and legal diversity amongst nations ...

... The problem solving capabilities and social and economic benefits of the GSDI should be advanced and clearly demonstrated ...

... Participants at this conference endorsed the need for a future meeting to continue activities leading to the development of the GSDI begun in Bonn and carried forward at Chapel Hill. There was consensus that the next meeting should be in the Asia/Pacific rim ... The meeting should be open to as broad a community of participants as possible ...'

One of the main outcomes of the 2nd GSDI Conference was the creation of the GSDI Steering Committee. This informal group, chaired initially by conference convenor Jane Smith-Patterson of the USA, and with broad representation from around the globe, had as its primary task the implementation of conference resolutions and delivery of the 3rd GSDI conference.

Conference 3

The 3rd GSDI Conference was hosted by the Permanent Committee on GIS Infrastructure for Asia and the Pacific and was held in Canberra, Australia, 17-19 November 1998. The conference theme was 'Policy and Organisational Framework for a GSDI'. The main goals of the conference were to:

- '.. Focus attention on the policy and organisational framework for a GSDI ...*
- .. Address specific initiatives to harmonise existing data (and other infrastructure)..*
- .. Demonstrate proven global/regional applications ...'*

The conference found (GSDI 1998), in addition to the central findings mentioned previously, that:

'... The achievement of GSDI will depend upon partnerships among many groups including industry, consumers, academia and government. GSDI must develop outreach activities to ensure that institutions and organisations that can and will benefit from an improved global spatial data infrastructure have an opportunity to participate. At this meeting it was obvious that national mapping organisations/agencies, state level mapping organisations/agencies, industry, academia and a variety of governmental agencies are very interested in GSDI development ...

... Agreement on the goals and objectives of GSDI will be vital to promoting the efforts to establish NSDI's and leverage resources at the national level ...

... It will be important for GSDI to encourage and facilitate capacity building efforts in developing countries and countries in transition so they can effectively participate ...'

The conference recommended:

'... That standards for Geomatics/Geographic Information and Services now being developed through ISO/TC 211 and the OGC be supported, and that participants actively encourage organisations in their countries to actively participate in the development, implementation and maintenance of these standards and of compatible regional and national profiles ...

... That the GSDI Steering Committee endorses the efforts of the ISCGM and participants in the VMAP programs, and encourages further contributions to and participation in the creation, maintenance and use of shareable, robust and interoperable global spatial datasets ...

... That the GSDI Steering Committee encourages organisations in individual countries to develop datasets that can be related to these global spatial specifications and datasets ...'

Work plan

The resolutions of the 3rd GSDI Conference form the basis of the current workplan of the GSDI Steering Committee.

Statement to the United Nations

One of the major resolutions from the 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 ...'

Organisation design

The organisational model recommended for the GSDI in the long run is the global umbrella organisation which brings together regional committees, national committees, and other relevant international institutions (for example, 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.

Business case

The GSDI Steering Committee is to commission a major study into the business case for SDI development. The study will identify the economic, social, environmental and disaster management benefits that can be achieved through development of 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.

The draft business case is to be presented to the next GSDI Conference for approval. It is anticipated that the document will then be used by the GSDI umbrella organisation in a major campaign to secure government and funding support for national, regional and global SDI development.

Technical matters

A Technical Working Group is tasked with development of detailed proposals by or before the next GSDI Conference that:

- 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 clearing house 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.

Management

The GSDI Steering Committee is to be modestly restructured. It will continue to comprise an Executive Committee and an Advisory Committee. The names and contact details of executive and advisory committee members, as they currently stand, 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, a representative of the Asia-Pacific region and host of the Canberra meeting. 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 in 2000. Membership on the Executive Committee will rotate with each GSDI Conference.

Each regional and national SDI and stakeholder organisation shall be encouraged to name a representative to the Advisory Group. The chair and vice chair shall propose regional representatives and stakeholder community representatives from participants of the GSDI meetings and other interested, appropriate individuals as needed to ensure balanced representation of interests from around the world.

It is agreed that a GSDI secretariat is needed to ensure and facilitate communications among members, oversee fund raising, and assist work groups. David Robertson from Australia is the current Secretary of the GSDI Steering Committee. The contact details for the secretariat are shown at attachment C.

The business of the GSDI Steering Committee will be undertaken through four initial working groups:

- **Operations Working Group** – to oversee the implementation of the umbrella organisation structure, and general administrative issues related to the GSDI.
- **Technical Working Group** – to advise the Steering Committee on technical aspects of the GSDI.
- **Communication and Awareness Working Group** – to inform the broad community about GSDI and the value of spatial data, and to promote the GSDI concept.
- **Legal and Economic Working Group** – to advise the Steering Committee on economic, legal and funding mechanisms underpinning the GSDI.

Terms of reference for each working group are now being developed for consideration by the Executive Committee.

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.

Future conferences

Finally, 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.

Challenges

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 involved in realising the GSDI will be questioned and potentially compromised.

Conclusion

In this paper I have endeavoured to briefly and faithfully describe the evolution of thinking and action on the global spatial data infrastructure. I have deliberately quoted directly, and some might say copiously, from a few of the many leaders in the SDI area in order to give the reader the opportunity to assess for themselves the importance of the GSDI concept. I have chosen what I, as present chair of the steering committee, regard as the more important challenges facing GSDI implementation. I trust that in presenting the paper in this way the reader will come to the view that, notwithstanding the challenges, the potential of the GSDI to contribute to a better world in the future is worth the effort in seeking its realisation. Finally, I would encourage the reader interested in learning more about spatial data infrastructures to seek out some of the many publications referred to in the references below.

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Attachment A

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Attachment B

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