

The Contribution of the Global Map to a GSDI

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Summary

Ready access to spatial information is now a global concern and is reflected in the growing interest in the concept of a Global Spatial Data Infrastructure (GSDI). It was clearly recognised at the United Nations Conference on Environment and Development in Rio de Janeiro in June 1992 that geographic data is fundamental to addressing global environmental issues. It was also recognised that in many areas data of useable quality does not exist and that even where data does exist its usefulness may be reduced by access restrictions or by lack of standardisation with other data sets. Many if not most, spatial data infrastructure (SDI) initiatives around the globe, at national and regional level, recognise the importance of fundamental data in the implementation of the infrastructure. The Global Map project will deliver framework topographic and thematic spatial data sets globally. The data will be at a notional scale of 1:1 million and will include both vector (transportation, boundaries, hydrography and population centres) and raster (elevation, vegetation, landuse and land cover) data themes. These Global Map themes are expected to provide the framework on which other data sets in the GSDI can be referenced and commonly related. It is therefore essential that relevant GSDI and Global Map activities are appropriately linked. The key issues to be addressed in order to achieve strong linkages are: implementation of the GSDI umbrella organisation; interoperability of technical solutions; collaborative approaches to relevant policy issues; and support for organisations contributing to global framework spatial data sets, particularly National Mapping Agencies. This paper briefly describes the GSDI initiative; comments on the link between SDI implementation and framework data creation, with particular reference to the Asia Pacific Spatial Data Infrastructure (APSDI) being implemented by the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP); describes the specification for the Global Map product; and describes some of the key issues to be addressed. The paper concludes with the argument that ready availability of framework spatial data from the Global Map project will support effective implementation of the GSDI, which in turn will support those meeting the many global challenges such as sustainable development and climate change.

Global Spatial Data Infrastructure

Ready access to spatial information is now a global concern and is reflected in the growing interest in the concept of a GSDI. The potential realisation of a GSDI 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 (Holland 1999).

The GSDI aims to standardise national and regional spatial data infrastructures to help in the transfer of information between nations and it encompasses the broad policy, organisational, technical and financial arrangements necessary to support global access to geographic information. The definition of the GSDI adopted at the 2nd GSDI Conference is (GSDI 1997):

‘The policies, organisational 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’

The emergence of the GSDI concept can be traced through the mapping and land information system developments of the 1960s and 70s; the acceptance of the notion of information as a corporate resource in the 1980s; rapid improvements in computing, communications and positioning technologies through the 1980s and 90s; and finally, implementation of national SDI's in the 1990s. Three GSDI conferences have now been held with a fourth planned for South Africa in 2000 and a fifth foreshadowed in Colombia 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 GSDI 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 two theme papers presented at the 2nd GSDI Conference (Coleman and McLaughlin 1997 and Rhind 1997) identified the many players potentially involved in the GSDI:

- the military;
- the science and environmental communities;
- the international maritime community;
- the international development community;
- existing national data collection and dissemination bodies (e.g. National Mapping Organisations);
- commercial sector players; and
- the citizenry.

The 3rd GSDI Conference again stressed that the achievement of a GSDI will depend upon partnerships among many of the groups listed above (GSDI 1998). In particular, participants found that:

‘National Mapping Organisations/Agencies play a key role in ensuring that accurate, up-to-date geospatial framework data are developed and maintained. Such data are key to, among others, the promotion of sustainable economic development, improvement of environmental quality, resource management, upgrading public health and safety, modernisation of governments either local, national or regional, and the responses to natural and other disasters. Therefore such organisations play a vital role in facilitating the development of a GSDI.’

Moreover, the Conference endorsed:

‘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 data sets.’

‘The GSDI Steering Committee recognises that there are many challenging issues to address before the GSDI will become a reality. In particular, it is vital to recognise and complement related initiatives such as the Global Map project. The GSDI is but one of the many global, regional and national initiatives aimed at improving access to geographic information. It is, therefore, essential that these initiatives be identified and appropriately supported so that maximum benefit can be obtained from their collective outcomes’.

This brief description of the GSDI initiative clearly identifies that data; National Mapping Agencies with their role as custodians of framework data; and the Global Map project; are vital to the development of a GSDI.

Fundamental data and spatial data infrastructures

Many if not most, SDI initiatives around the globe, at national and regional level, recognise the importance of fundamental data in the implementation of the infrastructure. The global survey of SDI activities presented at the 3rd GSDI Conference (Onsrud 1998) confirms this point. A specific example is the APSDI being implemented by the PCGIAP (PCGIAP 1998).

A fundamental data set, in the context of the APSDI, is a data set for which there is a demand for consistent regional coverage. This demand for a consistent coverage implies that:

- there is a need for coordination between custodians to ensure that components of that regional data set are collected to consistent standards;
- the community of users must be adequately consulted to determine specifications and priorities;
- access to the data is provided in accordance with policies determined for the APSDI; and
- the regional data set conforms with a set of standards that ensures that it can be combined with other components of the APSDI to create value-added products.

There are three principal issues associated with the provision of regional fundamental data sets:

- identification and prioritisation;
- production and integration; and
- data maintenance.

A key activity in defining the APSDI is to identify national spatial data priorities – i.e. what are the fundamental data sets that should be produced by governments of PCGIAP member countries and what are the priorities?

It is the PCGIAP's aim to facilitate the determination of an APSDI that contributes to the achievement of common regional objectives. The Permanent Committee aims to:

- identify the fundamental data sets comprising that infrastructure,
- identify custodians of those data; and
- facilitate the development of priorities and standards for those data.

This does not mean that the PCGIAP will sponsor the collection of new data sets; rather, the APSDI will build upon existing, national data collections, supporting the development of effective national spatial data infrastructures. The PCGIAP anticipates that the technical characteristics of those data sets would include the spatial accuracy, associated attributes, attribute accuracy and currency.

The following table **Table 1** contains a draft list of fundamental data sets; the suggested resolution of these data sets is 1:1 million. Note that this table is only intended to indicate the type of data that may be required at the regional level. The PCGIAP will give further consideration to this matter.

Table 1: Draft list of fundamental data sets in the APSDI

Theme	Key components
Geodetic control network	The underpinning geo-reference framework for the APSDI. Includes geodetic control stations, geodetic parameters.
Elevation	Elevation data/DEM.
Drainage systems	Natural and constructed drainage features. Includes rivers, canals, water bodies, coastline and drainage catchments.
Transportation	Includes road, rail, seaports and airports.
Populated places	Geographic location and extent of cities and major towns.
Geographical place names	Officially recognised names of geographic and cultural features.
Vegetation	Natural vegetation, forests, cultivated crops.
Natural hazards	Earthquake zones, flood plains, volcanoes, climate history.
Administrative boundaries	National/provincial boundaries, exclusive economic zones.
Land use	Population distribution, agriculture, secondary industries, conservation reserves.

In developing this list of fundamental data sets, the PCGIAP recognises the need to collaborate with other relevant regional and global initiatives where data needs are being identified.

Global Map data sets

Concept

The Global Map project will deliver basic topographic and thematic data sets globally (ISCGM 1). It was clearly recognised at the United Nations Conference on Environment and Development in Rio de Janeiro in June 1992 that geographic data is fundamental to addressing global environmental issues. It was also recognised that in many areas data of useable quality does not exist and that even where data does exist its usefulness may be reduced by access restrictions or by lack of standardisation with other data sets.

The Japanese Ministry of Construction first proposed the concept of a Global Map product in 1992. With continuing secretariat support from the Japanese Government the International Steering Committee on Global Mapping has developed the concept. The ISCGM has acted as a driving force for the development of the product, refining the concept, maintaining liaison with the United Nations and developing specifications. It will also coordinate building the product and its distribution.

Participants

The primary data providers for the Global Map are national mapping agencies. This will make the product authoritative. It will also allow the data set to be seen as an international product rather than representing a particular national interest. It is intended that the product will be available at minimal cost and without restriction on non-commercial use.

One of the challenges for production of the Global Map is that traditionally national mapping agencies have been focused on programmes within national boundaries and they are rarely funded to participate in international programmes. However, increasingly problems are international in scope and users expect regional and global data to be readily available to assist in addressing these problems. Both the Global Map project itself and the GSDI movement reflect the growing demand for good spatial data covering the globe. Because the Global Map is tied to broad United Nations environmental initiatives it is hoped that national mapping agencies will see the worth of participating and encourage their governments to support their participation.

In building the specifications for the Global Map the need for widespread involvement of national mapping agencies has been kept in mind. The goal of facilitating participation in the project has been a fundamental influence on the development of the specification.

Specification

ISCGM has developed a specification for the Global Map product (ISCGM 2). The data will be at a notional scale of 1:1 million. This scale will provide useful data for analysis at global and regional levels while still giving a database of manageable size. A practical consideration was that data at 1:1 million scale is generally available and is usually not restricted for reasons of national security whereas access to larger scale data is often restricted.

The data chosen for initial inclusion is based on existing data sets. As a result participating organisations have options in producing the Global Map data; it can be derived from other sources or the existing data can be updated. There is also the practical consideration that should some national mapping agencies choose not to participate in the project the existing data will provide a 'fall back position' to ensure complete global coverage.

While the specification for the Global Map is based on existing data sets, the Global Map will be an improvement in that it will be structured to allow the data sets to be used together. Regardless of the improvements that will be made in the quality of the data this will be a significant improvement in the usefulness of these data sets. Currently the differences in coordinate systems and formats mean that the data sets must be reprocessed to be able to be used together.

With the goal of producing data useful for assessing environmental impacts, it is planned that the Global Map will be an on-going project. The data will be updated at regular intervals producing a time series of data to consistent specifications that will allow uses to monitor changes.

Some data layers in the product will be in vector form and some in raster. This mix of formats was determined by the nature of the layers chosen for inclusion and also by the available data sets with global coverage. Overlaying the data sets and analysis of the data will be facilitated by the use of a common coordinate system and datum between all layers.

The specification for vector layers is based on the VMAP level 0 product (VMAPO). Features in the vector layers are described in **Table 2**. These features provide basic topographic framework information. This framework provides a structure to give a spatial context for thematic layers and the output of analysis. It will also provide valuable thematic information in its own right.

Table 2: Features in the Global Map vector layers

Layer	Feature class	Feature name	Feature type	Inclusion	
Transportation	Airport	Airport/airfield	point	optional	
	Rail yard	Railroad yard/ marshalling yard	point	optional	
	Railroad	Railroad	edge	mandatory	
	Road	Road	edge	mandatory	
	Trails and tracks line	Trail (vehicle tracks)	edge	mandatory	
	Structures	Bridge / overpass / viaduct	edge	optional	
		Ferry route	edge	optional	
		Tunnel	edge	optional	
		Transportation text	text	text	optional
	Boundaries	Political boundary	Administrative area	point	mandatory
Coast line		Coastline / shoreline	edge	mandatory	
Political boundary line		Administrative boundary	edge	mandatory	
Ocean/sea		Water (except inland)	face	mandatory	
Political boundary		Administrative area	face	mandatory	
		Political entity text	text	text	optional
Drainage (hydrography)		Miscellaneous	Dam / weir	point	optional
		Island	point	optional	
		Spring / water-hole	point	optional	
		Aqueduct / canal / flume / penstock	edge	optional	
		Miscellaneous	Dam / weir	edge	optional

Layer	Feature class	Feature name	Feature type	Inclusion
	Water course	River / stream	edge	mandatory
	Inland water	Inland water	face	mandatory
	Water text	text	text	optional
Population	Built-up area	Built-up area	point	optional
Centres	Miscellaneous population	Settlement	point	optional
	Built-up area	Built-up area	face	optional
	Population text	text	text	optional

The vector component will be partially topologically structured. The specification requires linear networks to be formed and polygons to be complete. However, it does not enforce the relationships between layers. For example, the railway network will be formed but there is not a requirement that structures such as bridges will be nodes on the network or that they will even be spatially coincident with the network. This will allow users to conduct simple analysis within networks. While it limits the use of the data for higher level analysis it significantly reduces the effort required to produce the data.

Selected attribute information will be stored against features. For example, railroads will have 'existence category' (operational, under construction etc.) and 'feature configuration' (multiple or single track) as attributes.

A number of the features, attributes and even layers are optional. This was done to allow the data to be included if it was readily available but to give individual countries the chance to minimise the data they need to capture for the project. Countries may not include the optional data should there be problems with availability of source information, with the ability to capture the data or with its inclusion for reasons of national security but will still be able to participate in the product.

The specifications define minimum requirements. However, national mapping agencies will be able to supply their data with higher levels of structuring.

The specifications allow both those with little or no existing data and those with high quality data to participate, the one by setting minimum standards for structuring and the other by not forcing highly structured data to be degraded.

The raster layers contain elevation, vegetation, land cover and land use data. All have a 30 second x 30 second cell size to conform to the notional scale of 1:1 million for the product.

The elevation layer will be gridded digital elevation model data. The specification for this component of is based on the GTOPO product produced by USGS (USGS 2).

The land cover classification is the International Geosphere/Biosphere Programme classification. Data using this classification has been produced by USGS as part of their Global Land Characterisation database (USGS 1). This data has recently undergone a validation exercise but the source data is now somewhat dated.

The Vegetation and Land Use classifications were both developed specially for the Global Map project. Vegetation is a 20 part classification that incorporates the influence of climatic zones on vegetation types. The Land Use classification is a 9 part classification giving a simplified picture of Land Use.

Issues

At present the GSDI initiative and Global Map projects are loosely linked through common membership of steering committees and mutual recognition of objectives and work programmes. A recent development has been the convening of GSDI conferences and ISCGM meetings at the same time so as to encourage participation at both forums. Given that the Global Map project aims to create framework spatial data sets for the globe, and given that the GSDI definition recognises the central role of data the implementation of the infrastructure, it is arguable that much stronger links could be forged between the two activities. Stronger links might help in better defining user needs and obtaining greater support for the Global Map project; and conversely, might help in raising the level of awareness and support for the key role of fundamental spatial data within the GSDI initiative. Once the GSDI umbrella organisation is established it will provide an organisational focus for the Global Map and ISCGM and other GSDI stakeholders.

The spatial data sets from the Global Map project aim to provide a global framework to which other data sets in the GSDI can be referenced and commonly related. This implies that appropriate standards will have been used in generating the framework data; that the framework data are reasonably up to date and properly documented; that users are aware of the existence of, and conditions of access to, the framework data; and, most importantly of all, that users can readily access these data. These issues are currently being addressed by both the Global Map and GSDI communities. The challenge will be to ensure that there is interoperability of solutions.

The objective of ready access to global framework spatial data implies that national data access policies will be able to support such an objective. Given the point we are at today, where there are a wide range of national policy positions, ranging from free and open access on the one hand, to restricted and expensive access on the other, there is still some way to go before global users will have ready access to more than relatively low resolution spatial data coverages. Data access policy presents politically sensitive and legally complex challenge. It requires action at the national, regional and global level. The Global Map and GSDI communities can play a central role in meeting this challenge.

The Global Map project proposes an innovative and demanding programme for delivery of the initial global framework spatial data set. Innovative in terms of the recognition of different capabilities within countries and the opportunity for countries to have different levels of participation (that is, provision of data for one's own, and other countries; provision of data for one's own country only; or agreement that another country may make your contribution). Demanding in terms of the target of the year 2000. The Global Map and GSDI communities should, in their own ways, facilitate the achievement of the delivery programme outcomes.

Conclusion

In this paper the authors have endeavoured to argue that the ready availability of framework spatial data at the global level is central to the effective implementation of the GSDI. An effectively implemented GSDI will in turn provide a strong support to those involved in resolving the significant global challenges of sustainable development and climate change. The Global Map project has the potential to deliver these fundamental spatial data sets in a timeframe and in a manner that is likely to well meet the needs of a broad range of global users. It is therefore essential that relevant GSDI and Global Map activities are appropriately linked.

The key issues to be addressed are:

- implementation of the GSDI umbrella organisation which will provide an organisational focus for Global Map, ISCGM and other GSDI stakeholders;
- interoperability of the technical solutions being developed in the GSDI and Global Map communities;
- collaborative approaches to relevant policy issues such as access to spatial data; and
- support for organisations contributing to global framework spatial data sets, particularly National Mapping Agencies.

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