The Australian Spatial Data Infrastructure:

Its current status and future directions.

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ABSTRACT

The concept of a national infrastructure is not new. The major road and telecommunications networks, and basic health and education facilities have been funded by governments around the world to ensure that consistent infrastructures are developed in the national interest. In a similar manner, spatial data requires an infrastructure to provide the availability and quality of spatial data in the application of high-benefit GIS applications.

The government and the academic and private sectors all have a role to play in the Australian Spatial Data Infrastructure (ASDI).

The Australia New Zealand Land Information Council is promoting the ASDI within Australia with support from other coordinating bodies while the Australian Surveying and Land Information Group is taking a lead role at the Commonwealth level.

Input to the debate on the nature of the ASDI is encouraged from all sectors of the spatial data community, particularly during the developmental stage of the infrastructure.

INTRODUCTION

The concept of a national infrastructure is nothing new. As a community we have created national infrastructures for health, education, transportation, communications and a wide range of other economic and social needs. Recognising that information, especially geographic information, is one of the most critical elements underpinning decision making for economic and social development, it is reasonable to consider the development of an infrastructure to serve the community's needs in this area as well.

Governments throughout the world have recognised the need to assign resources to establishing an effective information infrastructure. Readers are likely to have heard of the American initiatives in the area of information superhighways and that President Clinton issued an Executive Order in 1994, entitled *Coordinating Geographic Data Acquisition and Access; the National Spatial Data Infrastructure*. Many other countries, including the UK, the Netherlands, France, Japan, South Korea and Indonesia, have spatial data infrastructures in various stages of development.

In Australia there has been extensive debate, especially within the Australia New Zealand Land Information Council (ANZLIC), about the need to implement a spatial data infrastructure for Australia and the form that this might take.

It is worth noting that at its February 1997 meeting ANZLIC resolved to refer to the Australian implementation of a national spatial data infrastructure as the Australian Spatial Data Infrastructure (ASDI).

The main aims of this paper are to explain the current status of the ASDI and its future directions and to encourage input to the debate on the nature of the ASDI, as proposed by ANZLIC, from all members of the spatial data community.

This paper describes:

- the spatial data infrastructure model proposed by ANZLIC and the coordination that ANZLIC and other bodies are providing in supporting the development of the infrastructure;
- the objectives and benefits of developing the infrastructure;
- the roles of Commonwealth and other government bodies, the academic and research community, and the private sector in the development of the infrastructure;
- progress in bringing the infrastructure to reality;
- international aspects of spatial data infrastructures;
- trends in geographic information system (GIS) technology and the impact of this on industry, education and research, and the general community.

WHY A NATIONAL SPATIAL DATA INFRASTRUCTURE IS NEEDED

There are many situations where a consistent national dataset is required. For example:

- **Population Census**
  - The 5-yearly Australian national population census requires an up-to-date, consistent map base for delineating statistical collection units.

- **Defence**
  - National defence agencies need to build comprehensive and consistent national databases to support national security activities.

- **Native Title Administration**
  - National coverage of land tenure information is required to assist in the implementation of the Native Title legislation.

- **Emergency Services**
  - Emergencies and natural disasters have no respect for jurisdictional boundaries. It is important that all the emergency services are operating on the same, consistent data across their entire area of operation.

- **Vehicle Navigation -**
  The emergence of vehicle navigation systems is creating a demand for nationally consistent, regularly maintained digital road network data, upon which system providers can base their value-added network.

- **Environmental Management -**
  Whilst there is a great need for large-scale data for environmental management, there is also a demand for data at the regional level which often requires data to be assembled from several jurisdictions. Integration of these data are easier if the data from various sources are consistent and conform to common standards.

Under current circumstances considerable effort is generally required to create extended datasets for any of the purposes described above. This is because it is necessary to integrate a number of datasets that may have been produced by different agencies for specific purposes, to their own specifications and priorities, and with little regard to the needs of other potential users. This narrow focus, whilst understandable, leads to inefficiencies and duplication of effort.

Australia does not have the resources to waste on such duplicated efforts. The ASDI will provide the institutional and technical framework to ensure the required national consistency, content and coverage of key spatial data to meet national needs. Within this framework, spatial data can be recognised and managed as a key national resource, and the development of common standards is facilitated for the efficient collection, storage, distribution and use of the data.

The ASDI will ensure that jurisdiction efforts contribute to the national interest wherever possible, thereby maximising the benefit from the nation’s investment in spatial data.

A spatial data infrastructure underpins economic development and wealth creation in areas such as mineral exploration and agricultural ventures. Most importantly, the ASDI will help achieve better outcomes for Australia through better economic, social and environmental decision making
.

A spatial data infrastructure provides a environment for consultation with the user community to determine specifications, standards and priorities for fundamental datasets, thus avoiding unnecessary duplication.

From a users' point of view, the primary benefit from the ASDI will be the availability of complete and consistent datasets that can be integrated with their own data to meet their specific needs, yielding efficiencies and cost savings to the whole community. This may also provide a substantial stimulus to the growth of a competitive and efficient private sector spatial data industry.

A spatial data infrastructure for Australia would be consistent with current international trends and will allow Australia to take a lead role in the *globalisation* of the spatial data community.

WHAT IS A SPATIAL DATA INFRASTRUCTURE ?

A spatial data infrastructure is much more than data and goes far beyond survey and mapping.

The ASDI model promoted by ANZLIC (ANZLIC, 1996a) comprises four core components that are linked as follows:

- An
  Institutional Framework
  that defines the policy and administrative arrangements required to implement and maintain the infrastructure.

- **Technical Standards**
  that define the technical characteristics of the fundamental data.

- **Fundamental Datasets**
  that are produced within the institutional framework and fully comply with the technical standards.
- A
  Clearinghouse
  (or distribution network)

  to provide the means by which the fundamental datasets are made accessible to the community in accordance with policy determined within the institutional framework, and to the agreed technical standards.

In the context of a spatial data infrastructure, ANZLIC identifies *fundamental datasets* as being datasets that are critical to more than one agency, thus establishing a requirement for coordination of priorities and agreement on standards and classifications and therefore indicating the need for an infrastructure.

In practice the ASDI will most likely comprise a distributed network of databases with each database managed by custodians, perhaps at the jurisdictional level, with the expertise and incentive to maintain the database to the required standard. The custodian would be obliged to undertake certain agreed responsibilities.

Of particular interest with a spatial data infrastructure is the key role of a reference system. The geographic reference system, or geodetic datum, is a fundamental standard to enable integration of spatial data. The availability of Global Positioning System (GPS) technology has greatly improved geodetic knowledge at the national, regional and global levels, enabling computation of a precise geocentric datum.

Within a spatial data infrastructure, the two key requirements are for the fundamental data to be stored on a single accurate national reference system, and for the relationship between the national and geocentric reference systems to be well defined, if they are not the same (Clarke, 1994). As well there are future benefits if the datum is internationally compatible. The work being done by member jurisdictions of the Intergovernmental Committee on Surveying and Mapping (ICSM) to implement a new geodetic datum, the Geocentric Datum of Australia (GDA), will satisfy this requirement.

OBJECTIVES IN DEVELOPING A SPATIAL DATA INFRASTRUCTURE

The principal objective in developing a national spatial data infrastructure is to achieve better outcomes for the nation through improved economic, social and environmental decision-making. The availability of standard fundamental spatial datasets is essential if the full potential of GIS technology is to be realised in supporting those decision making processes. Recognising that the cost, quality and longevity of spatial data are critical in the application of the technology, there are a number of other objectives that should be considered when developing a spatial data infrastructure:

- produce standardised fundamental spatial datasets;
- avoid unnecessary duplication of cost in developing and maintaining those data;
- facilitate access to and application of those data;
- enable integration of other application-specific data by all users (value-adding).

PARTICIPATION IN SPATIAL DATA INFRASTRUCTURE DEVELOPMENT
Government

The role of government within a spatial data infrastructure is the same as with the provision of other common, consistent national infrastructure, upon which a variety of government, private sector and community activities can take place. It is

seen to be the role of government to set up infrastructure for the community to use and for industry to provide value added services to the infrastructure.

A useful analogy would be the transport infrastructure where government develops the road networks for community use with industry contributing petrol stations, restaurants and other value adding.

The underlying philosophy supporting the role of government with spatial data is that fundamental spatial data are a national resource that must be managed in the national interest.

Commonwealth Level

A spatial data infrastructure for Australia has national importance and the Australian Surveying and Land Information Group (AUSLIG) has taken a lead role at the Commonwealth level to ensure a coordinated approach to the collection, maintenance and distribution of spatial data across the country.

A 1996 budget decision supported AUSLIG's responsibility for policy, coordination and standards for the ASDI. In line with the budget decision, consideration is being given to a Commonwealth Policy position on the ASDI.

The Commonwealth established the Commonwealth Spatial Data Committee (CSDC) which has membership from Commonwealth agencies with an interest in spatial data. The CSDC has amongst a number of activities, produced custodianship guidelines, promoted the publication of metadata by Commonwealth agencies and developed the Commonwealth Public Interest Spatial Data Transfer Policy. At present there are two working groups, the Directory working group and the Spatial Data Infrastructure working group. Additionally, the Commonwealth GPS Group is currently operating in the CSDC framework.

One of the main issues facing the Spatial Data Infrastructure working group is the determination of which national datasets are most important to the Commonwealth to meet its requirements. Additionally this working group is looking at how Commonwealth policy can best ensure that these datasets are developed, maintained and made accessible, including whether Federal funding may be required to stimulate development of the ASDI.

National Coordination

Australia has an effective model for coordination of spatial data activities that includes ANZLIC, ICSM and other related coordinating bodies.

ANZLIC is the peak intergovernmental council providing leadership for effective management of spatial data in the interests of Australia and New Zealand. ANZLIC's main objective is the establishment of the ASDI and begun fostering the concept in 1994. Additionally and in parallel, ANZLIC's objectives include the development and implementation of standards, the identification of education and training needs, and the promotion of the economic and social benefits arising from investment in and good management of the nation's spatial data resources. The Commonwealth is represented on ANZLIC by the Commonwealth Spatial Data Committee (CSDC).

ICSM is the intergovernmental forum for coordinating surveying and mapping over Australia and New Zealand within the lead coordination framework provided by ANZLIC. ICSM promotes coordination and cooperation in surveying and mapping by addressing national and international surveying, mapping and charting issues and by supporting the development and implementation of standards.

ANZLIC and ICSM jurisdictions are producers and custodians of spatial datasets (including the geodetic datum, the cadastre and topography) that form the fundamental framework of the spatial data infrastructure. The two bodies have a close and cooperative relationship. They both support the implementation of the ASDI and are promoting this concept as well as promoting the GDA to all levels of government, Commonwealth departments, State and Territory departments, the academic sector, the private sector, and the general community.

Role of the Private Sector

The role of private industry in the spatial data infrastructure is seen to be in the production and delivery of spatial data and GIS applications. Ready access to government spatial data, with clear policies on conditions of use, would be expected to stimulate the provision of value adding services by the private sector.

PROGRESS TOWARDS THE DEVELOPMENT OF A NATIONAL SPATIAL DATA INFRASTRUCTURE FOR AUSTRALIA

While contributions to the development of the ASDI are not restricted to ANZLIC and ICSM, these coordinating bodies have made considerable progress towards the development of the ASDI through their respective coordinating mechanisms. Set out below are some of the achievements which are part of one or more of the four core components of the infrastructure. (Further information on these or other activities can be found in World Wide Web site contacts - see under BIBLIOGRAPHY at the end of this paper.)
The following initiatives have been undertaken within the ANZLIC charter:

- *Discussion Paper*. ANZLIC has developed the Discussion Paper - Spatial Data Infrastructure for Australia and New Zealand, November 1996 (ANZLIC, 1996a) on the proposed ASDI as a means of encouraging input to the debate. The Discussion Paper was presented to the spatial data community at an ANZLIC workshop during

AURISA '96 that has encouraged a significant amount of comment on the ASDI.

ANZLIC produced the Discussion Paper with the aim of arriving at an initial definition of the infrastructure so that meaningful debate and consideration of all the issues can follow. ANZLIC encourages everyone in the spatial data community to contribute to that debate in the national interest. By the time of printing of this edition of *Cartography* the Discussion Paper may have become a position paper however ANZLIC would be grateful for further comment and ideas on the nature of the ASDI.

- *Cost/Benefit Analysis.* A cost/benefit analysis of investment in spatial data was carried out by consultant Price Waterhouse for ANZLIC (ANZLIC, 1995). The results identified a benefit:cost ratio for data usage of around 4:1; that is, for every dollar invested in producing spatial data, $4 of benefit is generated within the economy.
- *Transfer Standard*s. Transfer standards provide an intermediate format for the transfer of data between different computing environments. In Australia, ANZLIC has supported the adoption of the Spatial Data Transfer Standard (SDTS) through the activities of the Australasian Spatial Data Exchange Centre (AUSDEC). SDTS has been published as the joint Australian and New Zealand standard AS/NZS 4270.
- *Metadata.* Guidelines for metadata have been published and a directory is being established by the Commonwealth.
- *Research and Development Needs.* A survey of R&D needs has been conducted by ANZLIC (ANZLIC, 1996b). The results are not a directory of R&D activities but a catalogue of where the spatial data industry thinks R&D is required.
- *Training Needs.* A training needs analysis has been conducted by ANZLIC (ANZLIC, 1996c). The outcome is a catalogue of what industry thinks it should be taught.
- *Street Addressing.* Rural street addressing guidelines have been published by ANZLIC and implemented. They have been submitted for consideration as an Australian standard.
- *Land Use Code.* A land use code draft has been published by ANZLIC and submitted for consideration as an Australian standard.
- *Promotion of the spatial data infrastructure.* Promotion of the ASDI, including GDA, is being carried out jointly with ICSM to a wide audience, including politicians.

Within the coordination environment provided by ANZLIC, ICSM has undertaken the following:

- *Input to the International GPS Geodynamics Service (IGS) 1992 Campaign.* ICSM jurisdictions provided input to IGS92 which contributed to the International Terrestrial Reference Frame 1992 (ITRF 92) that was in turn used as the framework for the GDA and the geocentric coordinates for the Australian Fiducial Network (AFN) and the Australian National Network (ANN) (Manning and Harvey, 1994).
- *The Geocentric Datum of Australia.* GDA, the foundation layer or positional framework of the spatial data infrastructure, has been established by ICSM. Geocentric coordinates for the AFN and the ANN along with State/Territory regional networks will provide the framework for spatial data applications across Australia on an internationally compatible reference frame.
- *State/Territory national geodetic adjustment.* ICSM has performed a State/Territory national geodetic adjustment with guidance from Dr John Allman under contract. GDA coordinates from this regional network adjustment are essential for the implementation of the new geocentric datum across Australia.
- *Geodesy Standards.*

  ICSM has produced Standards and Specifications for Control Surveys (SP1) and GPS Best Practice Guidelines.
- *Cadastral and Topographic Data Standards*. ICSM is developing national cadastral and topographic data standards for GIS applications and is investigating the applications and hurdles for a national approach to the use of unique identifiers.

Another national project, the *PSMA dataset for the 1996 population census* has provided a valuable contribution to the ASDI. This initiative of the Public Sector Mapping Agencies (PSMA) is very good example of national cooperation; with the dataset being a first cut at some layers of the infrastructure.

Jurisdictions are also contributing to the development of the ASDI through their various coordination forums including:

- The Commonwealth Spatial Data Committee (CSDC);
- State and Territory coordinating councils.

SPATIAL DATA INFRASTRUCTURES - THE INTERNATIONAL SCENE

The National Spatial Data Infrastructure of the USA

President Clinton's Executive Order in April 1994 on the National Spatial Data Infrastructure (NSDI) formalised USA Federal Government support for the concept.

The NSDI of the USA encompasses policies, standards and procedures for organisations to cooperatively produce and share spatial data. The Federal Geographic Data Committee (FGDC) has assumed leadership in the evolution of the NSDI in the USA in cooperation with State, local, and tribal governments, the academic sector, the private sector and professional societies.

Currently the FGDC is engaged in revising the NSDI strategy document with input from a wide variety of interested parties in Federal, State and local governments, the private sector, and the academic sector. One major impetus for this

revision followed the Mapping Sciences Committee of the National Research Council (part of the USA's National Academy of Sciences) taking a look at the evolution of the NSDI in April 1996 and noting that while much had been done particularly in the pubic sector in evolving the NSDI, more attention needed to be paid to research and educational issues. Over the latter part of 1996 and into 1997, the FGDC will be developing implementation ideas with the academic and research community.

The current situation with GIS education in the USA is that there are books and courses but not enough teachers with GIS expertise. A number of USA universities have formed a consortium with the aim of developing an agenda for common research for geographic information science. This approach could also turn out to be a method of obtaining additional education funds from government.

One of the specific objectives outlined in the Executive Order is the development of a national *clearinghouse*. This is defined as a distributed network of spatial data producers, managers, and users linked electronically. Under the *clearinghouse* various tasks have been defined, such as:

- agencies making standardised documentation of data available electronically;
- producing a plan outlining how spatial data will be made available to the public;
- agency utilisation of the *clearinghouse* to check on data availability before expending funds acquiring or producing new spatial data;
- provision of funding by the Department of Interior to assist with the development of the *clearinghouse* concept.

The *clearinghouse* is an ideal way of advertising the data an organisation has available and its intentions to undertake data acquisition projects. This knowledge of planned activities gives organisations the opportunity to pool resources rather than duplicate activities.

Progress to date with the USA NSDI is with the *clearinghouse* and the establishment of Thematic Sub-committees to develop standards for data collection and content, data presentation and data management including the development of *Framework* datasets. The *Framework* concept is based on cooperative development of *wall to wall* coverage of the nation for a particular theme to a least common denominator standard agreed by participants.

Sub-committees have been established for themes such as Base Cartographic Data, Bathymetric, Cadastral, Cultural and Demographic, Geodetic Control, Geology, Ground Transportation, International Boundaries and Sovereignty, Soils, Vegetation, Water and Wetlands. Hydrography, Vegetation, Wetlands and Transportation appear to be the most developed national *Framework* datasets at this stage.
Additionally, working groups have been set up covering archives, *clearinghouse*, facilities, standards and *Framework*.

Developments in the USA NSDI are of particular interest to Australia and the Commonwealth is investigating how the *clearinghouse* concept would work in the ASDI.

Other International Developments

The concept of a spatial data infrastructure for Australia expressed in this paper is part of a world wide move towards the implementation of national spatial data infrastructures to meet national development needs.

As well as NSDI developments in the USA that include the establishment of the FGDC and the implementation of the national *clearinghouse*, there are many other countries moving in this direction, including Japan, South Korea, Indonesia, France, The Netherlands, the United Kingdom, and more. Additionally Europe has established the European Umbrella Organisation for Geographic Information (EUROGI) for regional geographic information coordination.

The inevitable result of these activities is the establishment in time of a global spatial data infrastructure.

Just as communication, transportation and financial infrastructures require cooperation between the nations and regions of the world, so too will the development of a global spatial data infrastructure. Indeed, a number of multi-national and international programs are already contributing elements to the global model, although a comprehensive and integrated structure does not yet exist.

Asia-Pacific Region

Globalisation will see the world move to the global spatial data infrastructure that would provide world-wide, regional and local benefit in areas such as environmental monitoring, disaster prevention and recovery, and resource management. The Australian spatial data community will be caught up in this development. It can influence it or be influenced by it. Already ANZLIC has developed a proposed model for the infrastructure and ICSM is providing Australia with an internationally compatible geodetic framework with the development of a geocentric datum, GDA.

The implementation of an integrated spatial data infrastructure for Australia will be a positive step into the future for our country and an important contribution to the international spatial data community.

There would be many practical benefits in enhanced cooperation between nations in the Asia-Pacific region in the development of both the national and global levels of the infrastructure. These include the sharing of experience and the closer integration of national infrastructures to facilitate regional development. An important move towards such cooperation is the establishment of the Permanent Committee on GIS Infrastructure for Asia and the Pacific.

At the 13th United Nations Regional Cartographic Conference for Asia and the Pacific, held in Beijing in May 1994, it

was resolved that a body comprising the heads of national surveying and mapping agencies be formed. It was planned that this body would conduct a program of activities, between the United Nations Regional Cartographic Conferences, designed to support the development of national spatial data infrastructures and the integration of national infrastructures to form an Asia Pacific regional infrastructure. Such activities may include development of detailed guidelines for infrastructure development, information and staff exchanges, and the cooperative development of regional standards and datasets.

The Commonwealth provides the Australian representative on the Permanent Committee on GIS Infrastructure for Asia and the Pacific through the Department of Administrative Services. The Committee conducted its first full meeting in Sydney at the beginning of October 1996 and met again immediately prior to the 14th United Nations Regional Cartographic Conference for Asia and the Pacific in February 1997 in Bangkok. Malaysia holds the Chair of the Permanent Committee and Australia was elected as Secretary to the Permanent Committee at the Bangkok meeting. There are four working groups on *Geographical Information Infrastructure and Institutional Framework, Issues Relating to Cadastral Infrastructure, Regional Geodetic Networks* and *Legislation on Surveying and Mapping*, chaired by Malaysia, New Zealand, Indonesia and Australia, respectively. Australia is well represented on the working groups and of particular interest are the activities of:

- The *Geographical Information Infrastructure and Institutional Framework Working Group* that is looking into institutional matters for a regional infrastructure including international liaison with many organisations, including the International Standards Organisation (ISO);
- The *Issues Relating to Cadastral Infrastructure Working Group* that has the role to assist the Executive Board (of the Permanent Committee) and the Permanent Committee determine principles and options for the development of jurisdictional cadastral infrastructure and cadastral management systems;
- The *Regional Geodetic Networks Working Group* in light of one of the Recommendations of the Cartographic Conference, at its February 1997 meeting, to the Permanent Committee for the e*stablishment of a regional geodetic infrastructure and maintenance of a regional geodetic network for GIS applications; and*
- The *Legislation on Surveying and Mapping Working Group* with the role *to assist the Executive Board to prescribe the nature of legislative and administrative procedures and orders appropriate to the acquisition and sharing of spatial data.*

Standards

Standards are an important component of spatial data infrastructures and the International Standards Organisation has established a committee structure (ISO TC/211) for *geographic information and geomatics* standardisation. This ISO work should provide the framework for both national and international spatial data standardisation. Australia takes an active role in ISO TC/211 activities through Standards Australia which provides input to the ISO work and to the institutional framework for development and support of technical standards for spatial data in Australia. Australia chairs ISO TC/211 Working Group 2: *Geospatial Data Models and Operators.*

ANZLIC and AUSLIG strongly support the work of Standards Australia and Standards New Zealand because compliance with a single set of integrated national standards should be more efficient for industry than having to comply with the divergent standards of individual agencies. The benefit of national spatial data standards being independent of system standards developed by GIS vendors is that spatial data can be utilised on any system, and that systems can be upgraded and replaced without loss of data and data integrity.

THE GIS EXPLOSION

GIS Developments

The accelerating rate of development of GIS technology is beginning to impact on our everyday lives to an ever increasing extent. This is evidenced by the following:

- Currently there are 0.5 million GIS users worldwide and this figure is predicted, by the USA GIS community, to grow to over 5 million by 2000.
- GIS is valuable because it saves time and money, provides consistency, and improves problem solving and decision making.
- GIS is important because it brings together a range of disparate but spatially related elements allowing an holistic approach in spatial data applications.
- GIS not only comprises integration of various spatial datasets but supports thousands of applications using information produced from the data.
- The direct input of GPS observations into GIS applications.
- Twenty five years ago GIS provided a basic analysis of geographic information but it has moved on and now there are many types of GIS users and GIS applications.
- One trend is with *GIS for departments* moving to *GIS for enterprises*; ie common data for all organisations.
- With geographic information analysis moving into many fields there is increased user demand for spatial data, however in time, as this demand becomes satisfied, the trend will move more to data use.

Applications of GIS

GIS has developed in four main fields of application:

- Visualisation. For example with spatial data management, education and communications, GIS is used specifically in the fields of cadastral data, facilities management, spatial analysis of demography and data bases for high quality cartography (eg standard mapping).
- Scientific Technology. GIS has developed data processing and analysis approaches useful in water flow analysis, hazard modelling for fires and floods, geological analysis for mineral and petroleum exploration and demographic modelling for settlements and related physical infrastructure.
- Decision Support. GIS can be used to assist in efficient and comprehensive decision making to help avoid costly mistakes in site selection, routing and re-routing including for vehicle trips (ie. physical roads and the routes used for deliveries), planning and for policy making.
- Integration Technology. GIS was originally developed as a mapping tool however GIS is much more; it helps people and organisations cooperate in the areas of safety, emergency services, network analysis, marketing, carpooling and more. GIS maps reality and allows the viewing of models in many different ways; however it requires suitable spatial data .

GIS Revolution

As the development of GIS matures the following issues become increasingly significant:

- The GIS revolution is in cost accessibility, ease of use, institutional use, integration into other applications, technological advances and data becoming increasingly available.
- Factors affecting data acquisition for GIS applications include the availability of high resolution spatial imagery, precise positioning from satellites, faster and cheaper computing, and communication networks.
- It is not true to assume that by automating map data then all can be integrated for GIS applications. Currently there is much spatial data around the world that is not suitable for GIS use. GIS demands standards and an holistic approach and a lot of human activity, for which the four core components of the ASDI provide a framework.
- To realise the full potential of GIS technology Australia urgently needs an integrated spatial data infrastructure and an initial mass of trained people.

CONTRIBUTION BY THE ACADEMIC AND RESEARCH COMMUNITY

The academic and research community has contributed to the development of a spatial data infrastructure for Australia in the following ways:

- The work on the geoid and the Australian Height Datum (AHD) by A/Prof Bill Kearsley and others at the University of NSW.
- Professor Peter Morgan's computation of the ITRF92 (GDA) positions for the Australian Fiducial Network (AFN) and the Australian National Network (ANN) by contract.
- The Academy of Science Geodesy Sub-Committee has provided input to the ICSM Geodesy Group including during the development of the GDA and in the development of national geodesy standards.
- Assistance in the development of cadastral standards in the work being carried out by ICSM for a national cadastral data model.
- GDA implementation questionnaires and workshops by the University of Melbourne, specifically for Victoria.
- Papers by Dr Will Featherstone (Curtin University) on the effects of GDA on mapping (Featherstone, W.E., 1996).
- Input to the Committee for Geographical Names in Australia (CGNA), a Permanent Committee of ICSM that provides a focus for standardisation and consistent use of geographical names.
- Participation in ANZLIC’s research and development survey (ANZLIC, 1996b) that determined what research and development needs industry believed were required in the field of spatial data.
- Participation in ANZLIC’s training needs analysis (ANZLIC, 1996c) to determine what industry thought was required for training in the field of spatial data.
- As well there has been significant and valuable education and research over many years in the field of spatial data in which the academic and research community has assisted in shaping spatial data infrastructure thinking.

AREAS IDENTIFIED AS REQUIRING FURTHER RESEARCH

There has been significant and valuable education and research over many years in the field of spatial data and this has helped in shaping spatial data infrastructure thinking. Australia is now moving into a new era with the development and implementation of the ASDI and with the global aspects of spatial data such as the regional spatial data infrastructure proposed by the Permanent Committee on GIS Infrastructure for Asia and the Pacific and with the development of the internationally compatible geodetic datum, GDA.

The development of GIS technology is accelerating and in the near future it is expected that GIS applications will be a common component in many applications and in decision making processes such as in the fields of environmental management and emergency services.

Software and hardware technology and developments are well in hand; it is in the areas of policy, data acquisition, data management, and the integration of GIS into other applications where more needs to be achieved.

Management and accountability of spatial data are a key element of the ASDI

The explosion in GIS technology and applications of GIS, and the implementation of the ASDI provide a demand for trained people in the spatial data community. The academic and research community has an important role to provide the best, most up-to-date education and research; in this case concerning GIS and the ASDI. In other words Australia will need trained people in the areas of GIS technology who fully understand spatial data infrastructures and the potential benefits they can bring to the nation, the Asia Pacific Region, and globally.

Teaching on and research into spatial data infrastructure matters would be multi-faculty and multi-institutional. They would cut across many disciplines and institutions, for example geomatic engineering, geography, environmental sciences, space sciences, computing, communications, media, political sciences, legal, and more. Teaching in regard to spatial data infrastructures and GIS technology demands a coherent approach across faculties and institutions within Australia and around the world.

The general public is developing specific needs for GIS and relevant authorities and educators need to provide a lead. It is worth noting here that the USA is currently experiencing too few GIS educators.

For those students across all disciplines and in all countries whose training and future vocations comprise a component of spatial data activity, including decision making even for example at the political or legal level, it is vital that they receive consistent, common and appropriate education regarding spatial data infrastructure technology and policy matters.

This approach will result in students developing consistent and common understanding of all components of the infrastructure so that into the future in their chosen vocations there will be consistent and common input to, and decisions on, all components of the ASDI.

The academic and research community has a vital role with the ASDI and its input to the debate on ANZLIC's proposed model will help mould and support the infrastructure's development. The ASDI will be enhanced by the interaction of the academic and research community within the national coordination and policy forum provided by ANZLIC.

CONCLUSION

The objective in implementing a spatial data infrastructure is to efficiently provide the fundamental spatial data needed to support sound economic, social and environmental decision making.

ANZLIC, ICSM and other coordinating bodies, as well as various organisations in Australia, are cooperating in the development and promotion of a spatial data infrastructure for Australia particularly in the important areas of policy and standards for spatial data. Following a budget decision that supported AUSLIG's responsibility for a spatial data infrastructure, AUSLIG has taken a lead role at the Commonwealth level to ensure a coordinated approach to the collection, maintenance and distribution of spatial data.

AUSLIG recognises the benefits the ASDI will bring to Australia and the benefits internationally with the development of regional spatial data infrastructures and a global spatial data infrastructure.

The spatial data community has a vital role to play in the ASDI, particularly in its developmental stage. One main aim of this paper is to encourage the views of members of the spatial data community including the government sector, the private sector and the academic and research community to be heard in the development of the ASDI, in the national interest.

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