SDI Development and Capacity Building

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ABSTRACT

The growing need to organise data across different disciplines and organisations has resulted in the concept of spatial data infrastructure (SDI). SDI is an evolving concept about facilitation and coordination of the exchange and sharing of spatial data between stakeholders from different jurisdictional levels in the spatial data community. In order to develop and maintain such an infrastructure, the international community needs to pay more attention to capacity building.

Capacity building is an essential component of any institutional reform such as building land administration infrastructures and SDI. However the capacity building concept is often used within a narrow meaning such as focusing on staff development through formal education and training programmes to meet the lack of qualified personnel in a project in the short term. This paper argues that capacity building measures should be addressed in the wider context of developing and maintaining institutional infrastructures in a sustainable way, even if the key focus may be on education and training to meet short and medium term needs.

This paper reviews the capacity building concept and looks at capacity assessment and capacity development as the two key components. The paper then discusses the evolving nature of SDIs, including the SDI hierarchy, which has helped to build understanding about the importance of the relationships within different levels of SDI, and to support the interactions and dynamic nature of partnerships between spatial data communities. It then discusses different generations of SDI development followed by a discussion of their characteristics to facilitate the important roles of capacity building. It is argued that consideration of capacity building for SDIs and the adoption of its wider concepts and levels can assist SDI coordinating agencies to speed up the progress in the development of SDI initiatives.

In order to resolve the difficulty of applying the complex and often unclear nature of capacity building to the evolving and similarly unclear nature of SDI, capacity building for SDI in Australia is used as a case study.

INTRODUCTION

Spatial Data Infrastructure (SDI) is an evolving concept about facilitation and coordination of the exchange and sharing of spatial data between stakeholders from different jurisdictional levels in the spatial data community. In order to develop and maintain such an infrastructure, the international community needs to pay more attention to capacity building.

SDI is a dynamic and multi-disciplinary concept that includes, institutional, policy, technical, standards and human resources dimensions. In most developing and transition countries there is a lack of institutional capacity to plan and develop SDI in an adequate and sustainable way. SDI development in developing countries is usually undertaken by the international development community as part of a larger project which is responding to economic, social or environmental concerns. However, incorporating an SDI component in a project such as for land titling, irrigation or forestry is not simple. This is partly due to SDIs being removed from development issues such as poverty reduction or promotion of economic growth, because of the complex and theoretical

nature of the SDI concept, and partly due to the lack of emphasis on long-term capacity building measures aimed at developing sustainable institutional infrastructures. In order to measure the capacity needs and capacity building for such an infrastructure, it should be addressed in the wider context of developing and maintaining institutional infrastructures in a sustainable way, even if the key focus may be on education and training to meet short and medium term needs. The consideration of capacity building for SDIs and the adoption of its wider concepts and levels can assist SDI coordinating agencies to speed up the progress in the development of SDI initiatives.

With this in mind, this paper reviews the capacity building concept and looks at capacity assessment and capacity development as the two key components. The paper then discusses the evolving nature of SDIs, including the SDI hierarchy, which has helped to build understanding about the importance of the relationships within different levels of SDI, and to support the interactions and dynamic nature of partnerships between spatial data communities. It then discusses different generations of SDI development followed by a discussion of their characteristics to facilitate the important roles of capacity building. It is argued that consideration of capacity building for SDIs and the adoption of its wider concepts and levels can assist SDI coordinating agencies to speed up the progress in the development of SDI initiatives. In order to resolve the difficulty of applying the complex and often unclear nature of capacity building to the evolving and similarly unclear.

CAPACITY BUILDING

Capacity building may refer to improvements in the ability of institutions and (government and non-government) organisations to carry out their functions and achieve desired results over time (Georgiadou 2001). It may also refer to the provision of foundation data, metadata standards, clearinghouse functionalities and a facilitating environment for decentralising GIS application in manageable application domains within the SDI concept. Along this line, as highlighted by Williamson *et al.* (2003) the term capacity has many different meanings and interpretations depending on who uses it and in what context it is used. It is generally accepted that capacity building as a concept is closely related to education, training and human resource development (HRD). This conventional concept has changed over recent years towards a broader and more holistic view, covering both institutional and country specific initiatives.

According to the Workshop on Capacity Building in Land Administration for Developing Countries, held at the ITC, The Netherlands, November 2000 (Groot and van der Molen 2000) adopted the following definition for capacity building: “The development of knowledge, skills and attitudes in individuals and groups of people relevant in design, development, management and maintenance of institutional and operational infrastructures and processes that are locally meaningful”. This is a broader approach while still focusing mainly on education, training and HRD. Therefore, based on this definition, capacity building for an SDI in a broad sense may refer to improvements in the ability of all involved parties to perform appropriate tasks within the broad set of principles of that particular SDI initiative.

According to the UNDP (1998) “Capacity can be defined as the ability of individuals and organizations or organizational units to perform functions effectively, efficiently and sustainably.” This definition has three important aspects: (i) it indicates that capacity is not a passive state but is part of a continuing process; (ii) it ensures that human resources and the way in which they are utilized are central to capacity development; and (iii) it requires that the overall context within which organizations undertake their functions will also be a key consideration in strategies for capacity development. Capacity is the power of something – a system, an organisation or a person to perform and produce properly. As summarised by Williamson *et al.* (2003), capacity is seen as two-dimensional: capacity assessment and capacity development.

Capacity Assessment or diagnosis is an essential basis for the formulation of coherent strategies for capacity development. This is a structured and analytical process whereby the various dimensions of capacity are assessed within a broader systems context, as well as being evaluated for specific entities and individuals within the system.

Capacity Development is a concept which is broader than institutional development since it includes an emphasis on the overall system, environment and context within which individuals,

organisations and societies operate and interact. Even if the focus of concern is a specific capacity of an organization to perform a particular function, there must nevertheless always be a consideration of the overall policy environment and the coherence of specific actions with macro-level conditions. Capacity development does not, of course, imply that there is no capacity in existence; it also includes retaining and strengthening existing capacities of people and organisations to perform their tasks.

Levels and Dimensions of Capacity Building

Capacity building is a much more complex activity than defined above and it can be undertaken in various ways and be viewed at different levels, with these levels including different dimensions (UNDP, 1998). But the important issue which needs to be considered is to conduct both institutional as well as individual level capacity building. In this regard, the importance of training in creating a successful environment for SDI development needs to be realised. Training should be of the largest possible breadth and depth. It is not simply a matter of learning a particular concept. It goes much further than that, to a whole new way of thinking about sharing and exchanging spatial data assets, and about optimum solutions. So this is an essential and important issue to be considered for the success of an SDI initiative. According to Rajabifard (2002), there are different capacity factors that are important for the success of SDI initiatives. These capacity factors are technological capacity, human capacity, and financial capacity.

Some examples of capacity factors are: the level of awareness of values of SDIs; the state of infrastructure and communications; technology pressures; the economic and financial stability of each member nation (including the ability to cover participation expenses); the necessity for long-term investment plans; regional market pressures (the state of regional markets and proximity to other markets); the availability of resources (lack of funding can be a stimulus for building partnerships, however, there should be a stable source of funding); and the continued building of business processes.

The view on the capacity comes from United Nations Development Program (UNDP, 1998) in which they define capacity as the power/ability of something – a system, an organisation or a person to perform and produce properly. According to this definition, capacity issues can be addressed at these three levels: the broader system/societal level; the entity/organisational level; and the group of people/individual level. These levels relate to their application of capacity in society.

The broader system/societal level

The highest level within which capacity initiatives may be considered is the system or enabling environment level. For development initiatives that are national in context, the system would cover the entire country or society and all subcomponents that are involved. For initiatives at a sectoral level, the system would include only those components that are relevant. The dimensions of capacity at a systems level may include areas such as policies, legal/regulatory framework, management and accountability perspectives, and the resources available.

The entity/organisational level

An entity may be a formal organisation such as government or one of its departments or agencies, a private sector operation, or an informal organisation such as a community based or volunteer organisation. At this level, successful approaches to capacity building include the role of the entity within the system, and the interaction with other entities, stakeholders, and clients. The dimensions of capacity at the entity level may include areas such as mission and strategy, culture and competencies, processes, resources (human, financial and information resources), and infrastructure.

The group of people/individual level

This level addresses the need for individuals to function efficiently and effectively within the entity and within the broader system. Human Resource Development (HRD) is about assessing the

capacity needs of people and addressing the gaps through adequate measures of education and training. Capacity assessment and development at this third level is considered the most critical. The dimension of capacity at the individual level should include the design of educational and training programs and courses to meet the identified gaps within the skills base and to provide the appropriate number of number of qualified staff to operate the systems.

Strategies for capacity assessment and development can be focused on any level, but it is crucial that strategies are formulated on the basis of a sound analysis of all relevant dimensions. Often capacity issues are first addressed at the organisational level. Organisational capacity (such as capacity of SDI coordinating agency or jurisdictional infrastructure) is, however, influenced by not only the internal structures, systems and procedures, but also by the collective capabilities of its staff on the one hand, as well as by external factors in the wider institutional environment – such as the policy framework, and other political, economic and cultural factors – on the other hand. These may constrain or support performance and influence issues of organisational credibility, efficiency, and legitimacy. By taking this approach, capacity building measures can be addressed in a more comprehensive societal context.

It should be noted that the entry point for capacity analysis and development may vary according to the major focus of the project. However, it is important to understand that capacity building is not a linear process. Whatever is the entry point and whatever is the issue currently in focus, there may be a need to zoom in or zoom out in order to look at the conditions and consequences at the upper or lower level(s). Capacity building should be seen as a comprehensive methodology aiming to provide a sustainable outcome through assessing and addressing a whole range of relevant issues and their interrelationships.

SPATIAL DATA INFRASTRUCTURES

Spatial Data Infrastructure (SDI) is fundamentally about facilitation and coordination of the exchange and sharing of spatial data between stakeholders from different jurisdictional levels in the spatial data community. SDIs have become very important in determining the way in which spatial data are used throughout an organisation, a nation, different regions and the world. An SDI encompasses the policies, technologies, standards and people (including partnerships) necessary for the effective collection, management, access, delivery and utilisation of spatial data for a specific jurisdiction or community. The people component of SDIs includes the spatial data users and suppliers and any value-adding agents in between, who interact to drive the development of the SDI.

Viewing the core components of SDI, Rajabifard *et al.* (2002) suggested that different categories could be formed based on the different nature of their interactions within the SDI framework. Considering the important and fundamental role between people and data as one category, a second can be considered consisting of the main technological components: the access networks, policy and standards. The best example of access network is the clearinghouse. The nature of both categories is very dynamic due to the changes occurring in communities (people) and their needs, as well as their ongoing requirement for different sets of data. Additionally, with the rapidity with which technology develops, the need for the mediation of rights, restrictions and responsibilities between people and data are also constantly subject to change. This suggests an integrated SDI cannot be composed of spatial data, value-added services and end-users alone, but instead involves other important issues regarding interoperability, policies and networks. This in turn reflects the dynamic nature of the whole SDI concept.

According to the dynamic nature of SDIs, anyone (data users through producers) wishing to access datasets must utilise the technological components. The influence of the level of SDI and the focus for the technical components have an important influence on the approach taken for aligning components towards the development of SDIs.

The concept of SDI can be defined as an integrated, multi-levelled hierarchy of interconnected SDIs based on partnerships at corporate, local, state/provincial, national, regional (multi-national) and global levels. This enables users to save resources, time and effort when trying to acquire new datasets by avoiding duplication of expenses associated with the generation and maintenance of

data and their integration with other datasets. Based on this Rajabifard *et al*. (2003) distinguished and reported on two generations of SDIs, the first and the second generations.

The first generation of SDIs development has emerged since mid 1980s in which countries developing SDI at this stage had only very limited ideas and knowledge about different dimensions and issues of the SDI concept, and rather less experience of such development. Within this generation, each country designed and developed SDI based on their specific requirements and priorities and nationally specific characteristics. A significant milestone overcome by the first generation, for whom there were few experiences and existing SDI developments from which to learn, was the documentation of researchers' and practitioners' experiences and status reports on their SDI initiatives and as part of that report on their clearinghouse activities which facilitated their SDI initiatives. This achievement not only gave countries a knowledge-base from which to learn and/or develop their initiatives, providing exposure to the developmental strengths and weaknesses of different SDI initiatives, but it provided social capital to share and foster SDI developments in other countries. As a result many countries involved in SDI development over the first generation took a product-based approach (Rajabifard *et al.* 2002), which became the dominant model for SDI justification and development partially through a lack of awareness of other options.

However, the transition to the second generation can be marked by a change in focus on SDI development by several countries involved in developing the concept from the beginning. This led to a rapid increase in the number of countries becoming involved in SDI development, fostered by the definition of an SDI community where experiences could be shared and exchanged experiences. This shows the continuum of strategic spatial data development. The second generation started around 2000 when some of the leading countries on SDI development changed their development strategies and updated their conceptual models. In second generation SDI, the strategy for SDI development is changing towards a more process-based approach (Rajabifard *et al.* 2003). This approach focuses on the creation of a suitable infrastructure to facilitate the management of information assets instead of the linkage to existing and future databases.

The distinguishing features of the second generation include leverage of the experiences, expertise, social capital of SDI development and the development of clearinghouse systems derived from the first generation. For the first generation, data was the key driver for SDI development and the focus of initiative development. However, for the second generation, the use of that data (and data applications) and the need of users are the driving force for SDI development. Introduction of web services are the main technological indicator of second generation SDI, because web services are partly able to fulfil the needs of the users and to improve the use of data. In summary, in the second generation SDI development has been relatively quick due to the concept gaining momentum and the existence of early prototypes, clarification on many initial design issues, increased sharing and documentation of experiences to facilitate implementation and face the complexity of decision- support challenges.

Although the rate of SDI development are growing very fast in the second generation, but still the question of what constitutes an SDI in a developing country is also rises. This is due to the fact that no developing country has a jurisdiction wide Information and Communications Technology (ICT) infrastructure, without even considering a range of jurisdiction wide spatial data sets. There is no doubt that the concept has gained considerable support in the developed world but there is still considerable research needed before a clear view and justification is available for developing countries. While the justification in developing countries appears obvious, the reality is that SDIs are simply not on the development agenda of many developing countries. At the same time there is now a greater understanding of the role of SDIs in society and the contribution they make to a state or country. There is now an acceptance or at least a level of understanding in the governments in the developed world that an effective SDI is critical if the broader objectives of economic development, social justice and environmental management are to be achieved.

With an improved understanding of the SDI hierarchy has come the challenge to improve the relationships between SDIs in different jurisdictions as well as between different spatial data initiatives. The key to building successful SDIs is in the establishment of these relationships, especially through mutually beneficial partnerships, which are both inter- and intra-jurisdictional within the SDI hierarchy. What is certain is that in the foreseeable future the SDI concept will

continue to develop to a large degree in parallel with the evolution of information technology and the mainstreaming of sustainable development objectives in government polices.

BUILDING CAPACITY FOR SDI: AN AUSTRALIAN CASE STUDY

As discussed above, SDI concept is still a fuzzy concept to many, with practitioners, researchers and governments adopting different perspectives depending on their needs and circumstances. This is due to its dynamic and complex nature. SDI continues to evolve, as it becomes a core infrastructure supporting economic development, environmental management and social stability in developed countries and increasingly developing countries. At the same time capacity building is also a complex issue with the term capacity having many different meanings and interpretations depending on who uses it and in what context it is used.

Therefore it is understandable that the development of appropriate strategies for capacity building for SDIs is unclear due to the application of a complex and unclear process to a fuzzy concept (Williamson *et al.* 2003). As a result the best way to understand the application of capacity building to SDIs is to look at a case study. In this regard the capacity building activities in response to the needs of Australia and the region and particularly those of the Department of Geomatics and Centre of SDIs and Land Administration at The University of Melbourne, are discussed. These activities are considered in the context of the three levels (and related dimensions) of capacity building as illustrated in Figure 1.

The capacity building concept discussed earlier identifies two components; capacity assessment and capacity building. Capacity assessment is a diagnosis of the need and justification for capacity building. With regard to SDIs, the need for capacity building has been encouraged and justified by a wide range of initiatives, particularly over the last five years or so. Some of these are discussed below:

1. Australian Spatial Information Industry Action Agenda (http://www.anzlic.org.au/pubinfo/2358011765)
2. Challenges identified by the SDI Standing Committee of the Australian and New Zealand land Information Council (ANZLIC) http://www.anzlic.org.au/infrastructure_ASDI.html
3. The significance of the Prime Minister of Australia identifying *geo-informatics* as one of four frontier technologies as part of his announcement of Australia's National Research Priorities in December, 2002 (http://www.pm.gov.au/news/media_releases/2002/media_release2018.htm)
4. The issues identified by the Victorian Spatial Information Strategy www.land.vic.gov.au
5. The issues identified by the industry advisory body to the Victorian Government (GIRG) http://www.land.vic.gov.au/web/root/domino/cm_da/lcnlc2.nsf/frameset/spatial

The need for SDI capacity has been identified at the broader system and society level in Australia at both a state and national level. Australia has also recognised the need to support SDI capacity at the regional level for Asia and the Pacific. At the national level the needs are to support defence, economic development, mineral exploration, environmental management and particularly the management of water rights. At the state level the needs are similar but are larger scale and focus more on human activity and resulting land management and land administration. As a result a range of policies, institutions, organisations, laws and strategies have been created or developed in order to provide the capacity for the jurisdiction to support SDI and related spatial information activities.

The need for SDI capacity at the entity or organisational level has again focussed on state and national levels as well as at a Federal Government level. There has been an ongoing review of the capacity of the entities or organisations which build and manage SDIs at all these levels by many government reviews, committees and even Royal Commissions investigating and reporting on this need for over 200 years. As result these organisations have a whole range of policies, data, standards, access arrangements and people to provide the capacity to deliver the SDI vision.

The need for SDI capacity at the individual level has received considerable attention in recent years but not nearly as much as at the organisational level. The result has been a wide range of education, training and research initiatives.

In summary Australia can be reasonably satisfied of ongoing SDI capacity assessment across the broader system, organisation and individual levels.

The Broader System/Societal Level

At a national level Australia has responded to the need for SDI capacity at political and institutional levels. At the political level, there is support for a spatially enabled society as shown by the statement by the Prime Minister, the support for the Australian Spatial Information Industry Action Agenda, the awarding of an $80 million research grant in the spatial information area and a commitment to support SDI research. Support is evidenced at a national and Federal Government level by a whole range of initiatives and organisations such as ANZLIC, the Public Sector Mapping Agencies Ltd (PSMA Ltd), Geoscience Australia as well as professional bodies such as the Spatial Sciences Institute and the Australian Spatial Information Industry Association (ASIBA).

In a similar manner each state and territory in Australia has their range of institutions and strategies such as the Victorian Spatial Information Strategy (VSIS) and the industry advisory body GIRG mentioned above which provide the political, legal and institutional environment to support the growth and operation of SDI. There are also state or territory chapters of each of the national professional or industry bodies.

In simple terms, at national federal and state levels, institutions and strategies have been put in place to provide capacity for the creation, operation and managements of SDIs.

The Entity/Organisational Level

The focus at the organisational level is on the data, policies, standards, access networks and people who provide the capacity for the respective organisation to provide its support for the SDI vision. These aspects are found at state, federal and national levels in Australia. It is the components that provide the richest source of information about the development of SDIs in Australia, with this information found on a wide range of web sites.

The Group of People/Individual Level

Capacity development for SDI at the people or individual level includes a whole range of activities such as:

- short courses including web delivery
- components of university degree programs
- conferences, seminars and workshops
- research training (Masters degree and PhD students) ie training people to do SDI research
- preparation of books, articles and reports

Some examples of these undertaken through the University of Melbourne are listed below.

International Symposium on SDI

The Centre for SDIs and Land Administration, the University of Melbourne organised the International Symposium on SDIs on the 19th and 20th November, 2001. Over 100 delegates from 15 countries attended the Symposium to discuss the issues and challenges facing SDI development. Practitioners presented reports detailing their experiences and achievements from local, state, national, regional and global SDI initiatives. Researchers from the Centre for SDIs and

Land Administration, the University of Melbourne also made a number of presentations on key research areas.

The Symposium enabled contact among, and international comparisons with, those working independently on similar SDI initiatives, who are facing similar problems, and are using similar or alternative approaches. It brought together key researchers and agencies in technology development, management information systems, sociology, and users and producers from the spatial data community. Through this interdisciplinary approach constructive criticism was sought of the methods used and results achieved in SDI development to date. As a result directions were drawn for extending research into priority areas for the future.

SDI Book

The diversity of perspectives on SDI development offers a rich variety of experiences from which to learn and an extensive resource to the broader SDI community when documented. Contributing to the process of documentation was one of the motivations for producing this SDI book (Williamson *et al,* 2003). The book aims to provide some clarity to the SDI concept by drawing on practitioners and researchers from different backgrounds and jurisdictions to document their understanding of SDI and to share their experiences in building and analysing SDI.

The aim of the book is to provide an introduction to the concepts, organizational models and progress made on SDI developments and the cross-jurisdictional relationships of these developments, for those participating in and managing SDI implementation. The book is designed to be an educational and professional resource to help build information resource management capacity for the spatial industry in the context of SDI. Although directed at spatial scientists, technologists, professionals, managers, policy makers, students and researchers, it will have broader applications for other disciplines as the concept of SDI continues to adapt in response to user needs. The book is divided into six parts with each comprising a number of chapters, and in total eighteen chapters.

The SDI book built on a number of previous initiatives which have focussed on the concept and development of SDIs and the sharing of development experiences. The latter has included an increasing number of conferences on SDIs, with the leading forums being the Global Spatial Data Infrastructure (GSDI) conferences, United Nations Regional Cartographic Conferences (UNRCC), the meetings of the UN-sponsored Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) and such initiatives as the Digital Earth conference and the International Symposium on SDI which gave the initial impetus for the book. These forums form the basis of professional SDI development networks facilitating the exchange of experiences and the sharing of problems as well as opportunities, to look for solutions in the experiences of others in different jurisdictions.

SDI Short Course

Following successful completion of the SDI book, the Centre for SDIs and Land Administration has decided to design and conduct an SDI short course aimed at both the needs of Australia and the needs of countries in the Asia and Pacific region. The first course was run from 19-21 November 2003. The course was held following the recommendation of Resolution 5 (Capacity Building) of the 16th UNRCC for Asia and the Pacific (UNRCC-AP) and was further endorsed at the 9th Permanent Committee on GIS Infrastructures for Asia and the Pacific (PCGIAP) meeting in Okinawa, Japan, July 2003. The course focus was on Developing SDIs: from concept to reality and it introduced the concept and hierarchical nature of SDIs as well as discussing some SDI applications, issues and challenges for future SDI initiatives.

This course was designed partially based on a so-called problem-based learning environment in which participants were confronted with a series of SDI cases. In this course 24 people were attended from seven countries, who were both suppliers and users of spatial data.

SDI components of Undergraduate and Graduate Courses

The Department of Geomatics at the University of Melbourne offers a range of degrees concerned with SDI but more broadly surveying, mapping, GIS, satellite positioning, remote sensing, land administration, cadastre for example (www.geom.unimelb.edu.au/). The main professional degree is the four year Bachelor of Geomatic Engineering with a three year Bachelor of Geographic Information Technology aimed at the GIS market. At the graduate level the Department offers the 12 month coursework Master of Geographic Information Technology as well as 6 month Certificate and 12 month Graduate Diploma degrees.

All these degrees have components concerned with designing, building and managing SDIs, such as the subject on Land Administration which can be taken at both undergraduate and graduate levels (www.geom.unimelb.edu.au/subjects/451/418/index.html).

SDI RESEARCH AND DEVELOPMENT

As in all technical disciplines, research and development is essential to the ongoing evolution of the technology and associated concepts. It is a critically important component of capacity building especially in an evolving discipline such as SDIs if it is to grow and reach its full potential. At this point in time, international research in SDIs is in its infancy with only a handful of universities around the world actively pursuing SDI research. While much of the research which supports the development of SDIs can be considered as being undertaken under many related discipline areas in the spatial information and land administration area, such as in data collection, positioning and geographic information science, specific SDI related research which has been identified in Australia includes:

- understanding, identifying and promoting the nature of SDI
- developing conceptual models of SDI within the SDI hierarchy
- comparing SDI initiatives to identify best practices
- investigating differences between the various levels in the SDI hierarchy
- investigating technical issues in support of SDI development and implementation including testing and evaluating prototypes
- technical issues concerned with interoperability and access
- data issues of privacy, intellectual property and security
- pricing policies and funding models
- statutory control of spatial data
- cultural and indigenous issues concerned with the establishment and maintenance of SDI
- establishment and integration of marine SDI within the SDI concept

While this is by no means a comprehensive coverage of the diverse range of challenges facing SDI development, it simply demonstrates some of the areas for research ranging from social and cultural dimensions, legal, policy and institutional considerations, through to technical issues and their intersection with the former. Nevertheless there is a whole range of issues which impact on the development of SDIs which need to be researched if the SDI concept is going to deliver its potential.

SDI research does not fall within just one of the capacity building levels. Remembering capacity building is the power of something – a system, an organisation or a person to perform and produce properly, research is being undertaken into capacity building for SDI at the system or societal level at both the state and national levels in Australia as well as being undertaken at the entity or organisational level, again at state and national levels. These areas comprise the vast majority of SDI research. Very little research is done at the people or individual level concerned with the ability of people to design, build or manage SDIs although this is a difficult area of research which would normally fall outside the skills of an SDI researcher.

SDI research is funded in Australia from a range of organisations. Both state and federal governments have provided substantial research funds for this area over almost a decade such as the funding from the Victorian and NSW State Governments and the Federal Government for research undertaken through the Centre for SDI and Land Administration at the University of Melbourne. At the same time the Australian Research Council (ARC) (the Australian national

research body which provides peer reviewed research funds to university researchers) has also provided a range of grants over the years. Universities and the Federal Government also provide research scholarships with some of these going to SDI researchers. The recent CRC-SI will also provide significant funding for SDI research over the next seven years with funds coming from the government, educational and private sectors.

An example of a four year research project (2001-2004) funded jointly by the ARC and government partners focussed on the need to better understand the nature of SDIs and to be able to design the next generation of this form of infrastructure. Specifically the partners identified two technical problems within the broad SDI area that they believe need to be addressed if future SDIs are to be successful. The first concerns the development of methodologies to describe and map SDI's multi-dimensional capacity as an inter- and intra-jurisdictional spatial information framework. The second concerns the need to develop methodologies and GIS based algorithms, to improve administrative boundary design to enhance data integration and data exchange. Solutions to these problems will build on recent Diffusion and Hierarchical Spatial Reasoning (HSR) research. Both these issues have been identified as problems with SDIs world-wide and as such the results of the research have generic application to other jurisdictions.

Two entities which are supporting SDI research are the Centre for SDIs and Land administration and the Cooperative Research Centre for Spatial Information (CRC-SI) described below.

Centre for SDIs and Land Administration

The Department of Geomatics, University of Melbourne has been undertaking research in Land Administration, and more recently in SDIs, for over a decade. However the last few years have seen a dramatic increase of interest in spatial data and land administration infrastructures at State and Federal levels in Australia and internationally. This resulted in the establishment of the Centre for SDIs and Land Administration Research in the Department of Geomatics in 2001. The close relationship between land administration and SDIs in a large-scale context at a state level was the driving force behind the establishment of the Centre. The Centre receives significant funding from the State Government of Victoria, due to the need to better understand the complex issues surrounding the role of spatial data in an information society with a focus on the role of SDIs and land administration.

This Centre comprises 15 full-time researchers with strong linkages to the State governments of Victoria and New South Wales, the Federal Government, the United Nations, The World Bank and several universities and foreign governments.

The Centre provides a focus for research in SDI and Land Administration by building on ongoing research relationships and creating new links through extended collaboration both nationally and internationally.

Cooperative Research Centre for Spatial Information (CRC-SI)

Cooperative Research Centres (CRCs) are long-term collaborative ventures between researchers from universities and other government research agencies, and private industry or public sector research users, which support research, development and education activities of national economic or social significance. CRCs are selected through a competitive process, with successful bids receiving substantial funding from the Commonwealth Government for seven years.

The need for a CRC was specially identified in the Spatial Information Action Agenda as critical to the implementation of the Agenda. As a result, key elements of the Australian spatial information community provided a model of how the academic, government and commercial sectors are collaborating within the ASDI context through the establishment of a 'CRC for Spatial Information' (CRC-SI) in 2002 (www.spatialinfocrc.org). The core partners comprised spatial information agencies from the Commonwealth and three state governments (Victoria, New South Wales and Western Australia), three universities (Melbourne, New South Wales and Curtin), and a consortium of 43 private sector companies. The CRC-SI operates from five centres around Australia.

The CRC-SI supports national research priorities and enhances the outcomes of many others CRCs in Australia which rely on spatial data and related science and technology. The importance of spatial information was identified in December 2002 when the Prime Minister of Australia announced the National Research Priorities. As part of the National Research Priorities he identified frontier technologies for building and transforming Australian industries. He specifically stated "frontier technologies for building and transforming Australian industries is about fostering creativity and innovation by supporting leading edge research in areas such as information and communication technology (ICT), bio- and geo-informatics, nanotechnology and biotechnology … Support for these areas of research will help stimulate vibrant new industries and ensure our future competitiveness".

The identification of geo-informatics (for geomatics, geomatic engineering, GIS and spatial information science) alongside ICT, nanotechnology and biotechnology is an important recognition of the role that spatial information will play in the development of Australia.

The objectives of the CRC-SI include a close involvement of spatial information users in research activities, stronger collaboration between industry academic and government researchers and research users, development of a long-term research agenda for spatial information, more efficient research training, and enhanced commercialization of spatial information technologies. The research program includes spatial information technologies, decision support systems and spatial data infrastructures. The central theme is to develop a 'Virtual Australia' by uniting research and commercial innovation in spatial information technologies. The CRC-SI will greatly strengthen the research base for ASDI development.

CONCLUSIONS

The main objective of this Paper is to apply the concepts of capacity building to support and maintain SDI development initiatives. The paper initially develops a conceptual framework to better understand the capacity building concept. The concept recognises that capacity building comprises capacity assessment and capacity development.

While it is accepted that the SDI concept is still evolving and is unclear to many, and that the capacity building concept is similarly complex and having different interpretations, this paper has attempted to provide some clarity by examining SDI capacity building initiatives in Australia. Hopefully this case study will provide clarity to the levels and dimensions of SDI capacity building.

However the paper recognises that the above description of capacity building for SDI is considered primarily in the context of a developed country. As a result the paper also poses the question of what constitutes an SDI in developing countries while not attempting to provide an answer. The authors believe this is an important challenge for SDI coordinating agencies if the SDI concept is to be universally accepted, adopted and to reach its potential. The only way to adequately address human resource development in support of long-term sustainability of land administration and SDI projects is to establish a long-term commitment to education and research within a university in the host country. This commitment to HRD should not be a seen as an add-on to a project but a central and mainstream component of the project and should be funded at least for the duration of the project.

Whatever the outcome, one thing is certain, and that is that without a commitment to capacity building at all levels in support of SDI development, the SDI vision will remain unclear and unachievable, especially in developing countries. A challenge is for SDI coordinating agencies to apply these three levels of capacity building framework to the development of SDI for any jurisdictions.

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REFERENCES

Georgiadou, Y. (2001), Capacity Building Aspects for a Geospatial Data Infrastructure (GDI). Proceedings of 5th Global Spatial Data Infrastructure Conference, 21-25 May, Cartagena de Indias Colombia.

Groot, Richard and Paul van der Molen, Eds. (2000), Workshop on Capacity Building in Land Administration for Developing Countries – Final Report. ITC, Enchede, The Netherlands, 12-15 November 2000.

Rajabifard, A., Feeney, M.E., Williamson, I. and Masser, I. (2003), National SDI-initiatives (Chapter 6). In Developing Spatial Data Infrastructures: From Concept to Reality, edited by I. Williamson, A, Rajabifard and M.E. Feeney, pp. 95-109. (Taylor & Francis).

Rajabifard, A., (2002), Diffusion for Regional Spatial Data Infrastructures: particular reference to Asia and the Pacific. PhD-thesis, The University of Melbourne, Melbourne, Australia.

Rajabifard, A., Feeney, M.E.F. and Williamson, I.P. (2002), Future Directions for SDI Development. International Journal of Applied Earth Observation and Geoinformation, 4, 11-22.

UNDP (1998), Capacity Assessment and Development. Technical Advisory Paper No.3. http://magnet.undp.org/Docs/cap/CAPTECH3.htm Accessed 13 April 2003.

Williamson, I.P., Rajabifard, A. and Feeney, M-E. (2003), Developing Spatial Data Infrastructures – From concept to reality, Taylor and Francis, London.

Williamson, I.P., Rajabifard, A. and Enemark, S. (2003), Capacity Building for SDIs, Proceedings of 16th United Nations Regional Cartographic Conference for Asia and the Pacific, Okinawa, Japan, 14-18 July, E/CONF/95/1, 17 pages.

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