[1]Challenges and Issues for SDI Development

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Abstract

This paper aims to introduce and discuss six challenges and issues facing the development of SDIs which will be able to meet the sustainable development objectives of society. These issues and challenges include:

- SDI to facilitate spatially enabled government
- Role of government, private and academic sectors
- Development of SDI vision, mission and road map – where are we heading?
- SDI to facilitate integration of natural and built environment datasets
- SDI to support marine administration- Seamless SDI model
- Capacity building

Current research within the Centre for SDIs and Land Administration in the Department of Geomatics, University of Melbourne in the context of these meeting these challenges and issues is also discussed.

Key Words: Spatial Data Infrastructures, spatially enabled government, data integration, enabling platform

1.   INTRODUCTION

The ability of society to meet sustainable development objectives is a complex and temporal process involving multiple stakeholders. It requires data to be accessible as information that is accurate, well-maintained and sufficiently reliable for use by a spatially literate society. Cooperation between the private, public and academic sectors is essential to form the information infrastructure required to support a knowledge based society. With this in mind, many countries are developing Spatial Data Infrastructures (SDIs) to improve access and sharing

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of spatial data, however, there are still many issues and challenges which need to be overcome in order to have a fully functioning SDI.

SDI is now playing a much broader role in a modern society. SDIs are an evolving concept providing the spatial or geographic base underpinning a state's or a country's economic, environmental and social activities. The concept involves a complex digital environment including a wide range of spatial data bases and is concerned with standards, institutional structures and technologies including the World Wide Web (WWW) and Wireless Application Protocol (WAP). SDIs are now moving to underpin an information society and enable a society to become spatially enabled. They are an essential part of eGovernment strategies and are beginning to play a role in underpinning communities of practice outside the surveying and mapping and land administration area including environmental management, counter terrorism operations and emergency management through the provision of timely and relevant information to the public, business and government. This is especially so in the area of government, with the ability to design and develop a spatially enabled platform for decision making in support of sustainable development, a key application area with the ability to spatially enable government.

However, in order to achieve this, the following challenges and issues need to be considered:
- SDI to facilitate spatially enabled government
- Role of government, private and academic sectors
- Development of SDI vision, mission and road map – where are we heading?
- SDI to facilitate integration of natural and built environment datasets
- SDI to support marine administration- Seamless SDI model
- Capacity building

This paper aims to introduce and discuss the above challenges and issues in SDI development and the involvement and research activities of the Centre for SDIs and Land Administration in Department of Geomatics, University of Melbourne within this area.

2.   SDI TO FACILITATE SPATIALLY ENABLED GOVERNMENT: KNOWLEDGE BASED SOCIETY

Governments can be regarded as spatially enabled 'where location and spatial information are regarded as common goods made available to citizens and businesses to encourage creativity and product development. This will revolutionize land information held by governments, as location allows databases and other computer applications to graphically identify places and positions of items and processes, and increasingly, to provide useful details about

characteristics and creates an environment in which the majority of the public are users of spatial information, either knowingly or unknowingly."(Wallace, *et al.* 2006) This highlights the need for sustainable decision making and the demands that this will have on technologies, policies and institutions. This includes the need for management of our marine environment, the ability to mediate the tensions between the economic, environmental and social priorities of society and the need to progress from an information age to a knowledge age, where society is empowered to digest the information necessary to make well informed decisions. In order to achieve this however, SDIs must become more effective in supporting non-spatially aware users in a transparent manner. The INSPIRE framework provides a good starting point for adoption in order to aid in spatially enabling government and include:

- Data should be collected once and maintained at the level where this can be done most effectively
- It should be possible to combine seamlessly spatial data from different sources and share it between many users and applications
- Spatial data should be collected at one level of government and shared between all levels
- Spatial data needed for good governance should be available on conditions that are not restricting its extensive use
- It should be easy to discover which spatial data is available, to evaluate its fitness for purpose and to know which conditions apply for its use.

(INSPIRE 2005)

  Unfortunately however, diversified services and functions exist to manage information from across communities of practice (environmental management, land administration, emergency management) and often operate as unconnected systems in information silos. The management of property restrictions and responsibilities for example poses a major barrier for governments in achieving sustainable management. Disparate management of individual restrictions has made it extremely difficult to develop and evaluate the effects of land policy and the management of land and natural resources must be far more collective (Bennett *et al.* 2006). The development of a spatially referenced data model within the context of SDI development as opposed to one based on the physical land parcel as the means of exchanging information will aid in providing interoperability amongst these communities of practice. This will also aid in consolidating and providing greater access to both private and public rights, restrictions responsibilities.

  In order to bring diversified services and functions together and achieve the INSPIRE principles listed above, there is a need to develop and establish an enabling platform that will facilitate the provision of the place or where or location to all human activities, government actions, decisions and policies. This will allow business transactions to be linked to a place or location and further allows that

place or location to facilitate the evaluation and analysis of relationships between people, business transactions and government. For this to occur however, the role of the traditional SDI needs to be re-engineered (Radwan *et al.* 2005). There is a need for a service-oriented infrastructure in which citizens and organisations can rely for the provision of required services. Current understanding of SDIs has seen the development of SDI models that have not met user needs as expected, currently providing mainly an ability to access and retrieve spatial data. Hence the concept of an SDI needs to progress so that it allows more than just the ability to access spatial information. It needs to become an entity that is enhanced so that it is possible to share data, business goals, strategies, processes, operations and value-added products and services in order to support a spatially enabled government (Rajabifard *et al.* 2005b).

This builds on the concept of a virtual jurisdiction, which aims to support a knowledge base to provide a major point of discovery and communication to complete, correct and current information about the environment and related spatial information applications. This concept will also not only provide access to information and applications, but take into account related legal, privacy and intellectual property issues associated with the data itself, aspects which are often overlooked. This will help to create a more inclusive mechanism for data access and use across jurisdictions and help in managing the changing role of governments, the private sector and academia in SDI development (Rajabifard *et al.* 2006b).

3.   ROLE OF GOVERNMENT, PRIVATE AND ACADEMIC SECTORS

SDI initiatives developed throughout the world have generally been driven by a top-down National Government approach as seen in the development of the 1st Generation of SDIs (Masser 1998). Countries designed SDIs based on their specific national characteristics, requirements and priorities. From this, most countries developed a product-based approach to SDI development of which data was a key driver (Rajabifard *et al.* 2003). The second generation of SDI development however is being driven by the needs of users, with the focus on the use of data and data applications as opposed to the data itself, with one result being that sub-national governments and the private sector are beginning to have a greater influence on SDI development. This influence can be seen in the Federal Geographic Data Committee (FGDC) Future Directions Project which states that 'the continued development of the NSDI requires that the private sector, academia, the utility industries as well as state, tribal and local governments play a major role' in order to effectively achieve the NSDI vision for the country (FGDC 2004). This has meant that the previous influence of national governments at both strategic and operational levels of SDI development have diminished, although there is still a strong case for strategic national government role in SDI coordination. This can be seen in the development of the INSPIRE

initiative in Europe through the Directive establishing a European SDI that is currently before the Council of Ministers and the European Parliament.

The operational level of SDI development has now moved to the sub-national government level (Rajabifard *et al.* 2006a). This is where the majority of the large scale 'people' relevant data is produced. This is the data which aids in the collection of land taxes, land use planning, infrastructure development etc. and is the key to spatially enabling governments. The ability to generate solutions to cross-jurisdictional issues has become a national priority for countries such as Australia and the development of effective decision-making tools is a major area of business for the spatial information industry. Much of the technology needed to create these solutions already exists, however it also depends on an institutional and cultural willingness to share outside of ones immediate work group. This creates the need for more inclusive coordination mechanisms to be created which are understood and accepted by stakeholders from all communities of practice (environmental management, land administration, emergency management) at all levels of government (national and sub-national) so that information can be created once and used many times across both jurisdictions and communities of practice. Such coordination mechanisms are only part of the picture however, with the ability to gain access to information and services moving well beyond the domain of single organisations, and SDIs now require an enabling platform to support the chaining of services across participating organisations. For this to occur, it is important for a jurisdiction to develop an effective SDI vision, mission and road map that will inform the development of this enabling platform.

4. DEVELOPMENT OF SDI VISION, MISSION AND ROAD MAP – WHERE ARE WE HEADING?

The steps to develop an SDI model vary among countries, depending on a country's background and needs. However, it is important that countries develop and follow a roadmap for SDI implementation. Such aspects include the development of an SDI vision, the required improvements in capacity of the country, the integration of different spatial datasets, the establishment of partnerships, and the financial support for an SDI. An example of such a vision is the Virtual Australia concept promoted in Australia (Rajabifard *et al.* 2006b).

A vision within the SDI initiative is essential not only for sectors involved within an SDI project but for the general public as well, as it helps people to understand the government's objectives and work towards them. In order to reach the vision however, a mission needs to be developed. Mission development is of primary concern, as it is through this that the tasks of each particular sector involved are defined. This mission will aid in the establishment of advanced partnership

arrangements amongst spatial data users and stakeholders within a society and increase awareness of the importance of data integration.

Along this line, the SDI roadmap is important for the implementation of an SDI imitative. Without following an action schedule development of an SDI within a defined timeframe will not be successful. The development of such a road map depends upon socio-economic, technological and political conditions of the jurisdiction or country developing the SDI and since SDI development is by nature a long-term project and a jurisdictions status is always evolving, the SDI roadmap should encompass a dynamic approach.

5.   SDI TO FACILITATE INTEGRATION OF NATURAL AND BUILT ENVIRONMENT DATASETS

The dynamic nature of the environment that we live in is also a factor in influencing the design of SDIs that meet the sustainable development challenges of today's society. Achieving sustainable development is not possible without a comprehensive understanding of the changing environment and monitoring the impact of human activities on the environment through the integration of its built and natural environmental components. Despite the significance of data integration however, many jurisdictions have fragmented institutional arrangements and data custodianship in the built and natural information areas. The fragmentation of data custodians has brought about a diversity of approaches in data acquisition, data models, maintenance and sharing. Consequently, the lack of a holistic approach to coordinate these activities using a common framework has hampered many of the applications to efficiently and easily access, integrate and use spatial data, especially at large to medium scales where the build environmental data is based on the cadastre or land administration activities. Within this environment each data provider also creates and maintains datasets in a manner that better responds to its own requirements. These inconsistencies are attempting to be addressed by many countries through developing Spatial Data Infrastructure (SDI), however the development of SDIs needs to take a further step to facilitate the integration of multi-sourced spatial data by providing the required framework and associated tools for data integration (Mohammadi *et al.* 2006).

The importance of the research on integration of multi-source spatial datasets has been highlighted in numerous publications, declarations and resolutions and in particular UN resolutions. Rajabifard and Williamson (2004) have promulgated the integration of built and natural datasets within National SDI initiatives as a major concern in the success of National SDI. Resolution 15 of the 14th UN Regional Cartographic Conference for Asia-Pacific (UNRCC-AP), calls for issues in the integration of cadastral and topographic datasets to be investigated (UNRCC-AP 1997). The UN Bogor Declaration (FIG 1996) urges the creation of

National Spatial Data Infrastructure to ensure integration and highlights the homogeneity of the topographical and cadastral datasets (as two core spatial datasets) to achieve the integration to their maximum potential. These declarations also highlight the need for sharing of integrated data among nations, particularly to address common ecological problems in alignment with sustainability objectives.

With this in mind, an SDI can provide the institutional, political, and technical basis to ensure the national consistency of content to meet user needs in the context of sustainable development (Williamson *et al.* 2003a). An SDI provides the foundation to access built and natural environmental datasets. However, in most countries as stated, these two foundation datasets are normally managed separately to serve different purposes. The lack of uniformity across different jurisdictions within a country often creates problems in attempts to integrate the two datasets at a national level. These issues are caused due to technical heterogeneity, institutional structure, policy issues, legal concerns and social effects of the integration, as described in Table 1 below.

Table 1. Integration Issues (Mohammadi *et al.* 2006)

Technical Issues	Institutional Issues	Policy Issues	Legal Issues	Social Issues
- Computational Heterogeneity (Standards and Interoperability) - Semantic - Reference System and Scale - Data Quality - Metadata - Format	- Collaboration models - Funding Model - Linkage between data management units	- Political Stability - Legislation Issues - Priorities/ Sustainable Development - Awareness of Data Existence	- Rights, Restrictions and Responsibilities - Copyright and Intellectual Property Rights (IPR) - Data Access and Pricing - Privacy - Licensing	- Cultural Issues - Capacity Building - Equity

There is a need to integrate these two forms of spatial data in support of sustainable development through the development of an integration data model and framework together with associated tools capable of being used in diverse jurisdictions.

6.   SDI TO FACILITATE MARINE ADMINISTRATION- SEAMLESS SDI MODEL

Administering the spatial dimension of the marine environment is very important as decision-makers in both land and marine related areas of the coastal zone need to access marine related datasets in order to effectively achieve their

economic, social and environmental objectives. Historically, the marine environment has been managed differently to the terrestrial environment through sectoral planning, with government fisheries agencies managing fisheries and historical shipwrecks managed by a separate government agency for example. Jurisdictional limits and marine boundaries are multiple and often unclear. There is generally no single agency managing offshore rights, restrictions and responsibilities, and the mapping of legal boundaries is difficult due to the three-dimensional (and often four-dimensional) aspect and lack of physical reference. Added to this, information needed to effectively manage the marine environment is stored within silos, with no interconnection between relevant information streams (Binns *et al.* 2005).

While many countries are developing SDIs to improve access and sharing of spatial data, most of these initiatives stop at the coastline. The need for access to spatial data for improved decision-making and management however, does not.

Therefore, there is a need to develop a seamless SDI that can include data from the land, coast zone and marine environments which will improve access and sharing of data between these environments. With this in mind, the importance of understanding the link between land and marine environments (they cannot be treated in isolation) and the need for cooperation between nations as maritime actions transcend national boundaries is a major issue as highlighted by Rajabifard *et al.* (2005a) and illustrated in Figure 1. In order to have such an environment, there is also a need to identify socio-economic, policy and technical issues hindering coordination and effective management of the marine environment.

Figure 1 – Importance of linking the land and marine environments
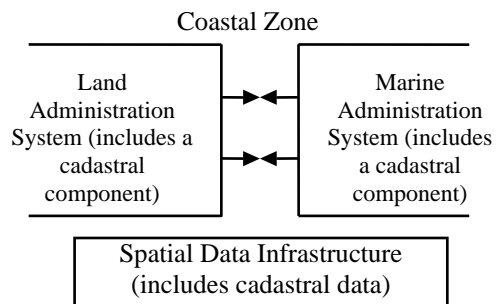
7.   CAPACITY BUILDING

Capacity building is an important challenge for SDI implementation across both the land and marine environments and is especially important if the vision to spatially enable government is to become a reality. SDI is still a fuzzy concept to many, with practitioners, researchers and governments adopting different perspectives depending on their needs and circumstances. Capacity building is 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.

Capacity is the power of something – a system, an organisation or a person to perform and produce properly. The conventional concept of capacity building has changed over recent years towards a broader and more holistic view, covering both institutional and country specific initiatives. As summarised by Williamson *et al.* (2003b), 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, nevertheless there must 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.

There are different capacity factors that are important for the success of SDI implementation. 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. Tacking these capacity factors into account will help to develop the capacity of the spatially aware to build SDIs and enabling platforms to support activates of the majority of the public and government who are not spatially aware but who increasingly use spatial enablement in a transparent manner.

8.   CONCLUSION

This paper considers a number of challenges and issues that will influence the development of future SDIs. SDIs are now playing a much broader role in a modern society, with the ability to spatial enable governments and society being a major factor in SDI development. For this to occur, cooperation between the

private, public and academic sectors is essential to form the information infrastructure required to support a knowledge based society. This also requires an effective road map which sets out an appropriate vision and mission statements in order to guide SDI development.

The dynamic nature of the environment in which we live is also a factor in creating SDIs that meet the sustainable development challenges of today's society. Information must be easily integratable across not only the land jurisdiction, but also the marine environment, if we are to successfully monitor both the built and natural environmental impact of human activities.

SDIs are now moving to underpin an information society across a wide range of communities, helping to break down the silo mentality of information and data producers. However SDI is still a fuzzy concept to many, with practitioners, researchers and governments adopting different perspectives depending on their needs and circumstances. This requires effective capacity building to ensure that the development of SDIs will support the activities of the majority of the public who are not spatially aware.

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