Spatially Enabling Society

Research, Emerging Trends and Critical Assessment

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Foreword

This book is the result of a collaborative initiative of the Global Spatial Data Infrastructure Association (GSDI), UN sponsored Permanent Committee on GIS Infrastructure for Asia and the Pacific, Centre for SDIs and Land Administration (CSDILA) in The University of Melbourne, SPATIALIST Spatial Data Infrastructure and Public Sector Innovation in Flanders, Department of Geo-information and Land Development in Delft University of Technology and Singapore Land Authority. In addition to the traditional call for papers for the GSDI 12 World Conference: "Spatially Enabled Societies" contribution of full articles were solicited for publication in this peer reviewed book.

In several instances, the articles submitted addressed the theme of the conference. In the others they stuck to the more traditional field of SDI. The reviewing process resulted in 17 chapters that together can be summarized as realizing Spatial Enabled Societies . These topics are represented well in this book. We thank the authors of the chapters and the members of the peer review Board.

We are grateful to Leuven University Press for their willingness to produce this work under a Creative Common Attribution 3.0 License. It allows all to use the experiences and research presented in this book to their advantages.

We specially thank the sponsors of this book.

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Spatially Enabling Society

Part 1

Concepts and Fundamentals

Chapter 1

Spatially Enabled Societies

Abbas Rajabifard[1], Joep Crompvoets[2],
Mohsen Kalantari[3] and Bas Kok[4]

1. Introduction to Spatially Enabled Societies

The creation of economic wealth, social stability and environmental protection objectives can be facilitated through the development of products and services based on spatial information collected by all levels of societies including governments, private sectors, and citizens.

For instance, geographically referenced statistics are used to monitor activity within an area. Health, wealth and population distributions are all examples of information collected and aggregated to areas. Because these areas or administrative units can be mapped and analysed spatially, datasets are one of the most critical sources of information for planning and decision making across a number of disciplines particularly epidemiology, economics and environmental management. To meet increasing demands for information, analysts are regularly required to integrate data from an ever expanding number of sources and depend on sophisticated applications (Eagleson, 2007).

The above mentioned objectives can be realized through the development of a spatially enabled government and society. Spatial Enablement requires data and in particular services to be accessible and accurate, well-maintained and sufficiently reliable for use by the majority of society which is not spatially aware.

For example, the Victorian Mapping and Address Service in Australia helped to spatially enable Victorian Government employees, the majority of whom have no spatial background, providing operational efficiencies of standard work practices, increasing the accuracy and reliability of address information that is captured and recorded as part of business operations, while eliminating the need for specialised software, training or resources. Since the system has been designed as a whole of Victorian Government web service, costs associated with its hosting and information maintenance and update are minimised (Davies, 2007).

Spatial enablement should be regarded as an evolving definition. Similar to emerging concepts, there are different views on spatial enablement. This chapter presents different definitions for spatial enablement, its characteristics, development stages and players. In addition, it proposes action items towards realizing Spatially Enabled Societies (SES). It then presents the structure of the book and the chapters dealing one way or another with SES are briefly introduced and the key findings are summarized.

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Definitions

Societies 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' (Williamson *et al.,* 2006). In this regard, the vast majority of the public are users, either knowingly or unknowingly, of spatial information. The daily business of people is implicitly connected to a location. Locations are presented in variety of ways such as address, maps, coordinates, landmarks etc.

The spatial tools will no longer be sequestered in mapping agencies where they were originally created. The broader attractions of spatial technologies lie in how they present information, whether users rely on computers and the Internet, or on communications technologies (Williamson *et al.,* 2010a). An obvious example is the use of Google Maps and Virtual Map and their mash–up abilities in facilitating services provision. There are many instances from the professional web sites to the private and individual web pages that use spatial mash-up technologies in providing user friendly services or organizing private and business activities.

Spatial systems now combine information from other services and convert queries into much more user friendly results. Finding properties for sale is much more convenient by combining buyers' preferences and presenting final results in an easy to comprehend visual (map) format (Figure 1).

Figure 1. Mash up technologies for spatially enabling property market (http://www.realestate.com.au/)

The power of the visual over the verbal both reduces the amount of information and organizes it into "brain-ready" information. When people are spatially informed, the "map condenses thousands of spreadsheets". Combined with the web environment, opportunities for communication of information among levels in the managing agency and between the agency and its stakeholders are vastly improved (Williamson *et al.,* 2010b).

A service is regarded as spatially enabled if the service delivery process incorporates seamless access to all the information that a user of the service might need to make spatial or location-specific decisions associated with the service (Ezigbalike and Rajabifard, 2009).

Finally, the “Spatially enabled society” is an evolving concept where location, place and other spatial information are available to governments, citizens and businesses as a means of organizing their activities and information (Williamson *et al.,* 2010b).

Characteristics

Ezigbalike and Rajabifard (2009) describe characteristics of the SESs and list important elements. In such societies, the user would be expected to know which datasets are required and to specifically request these and combine them. With emphasis on the spatial enablement of services, the onus is on the service provider and system designers to ensure that relevant spatial information is integrated into any enquiry or request application. The service provider would have included spatial considerations in all decision analyses undertaken during the planning phase.

Van der Molen (2007) describes that a SES is twofold:

- When the public administration, the private sector and citizens (the actors in ‘governance’) decide on issues where the spatial component is one of the determinants for those decisions, they need access to spatial information that is relevant and might contribute in a meaningful way to the process of making that decision.
- Decisions seldom need only one source of information; on the contrary they tend to require information from many sources. Integration and sharing transforms single source data into meaningful information and services. This cannot be pursued without a digital environment.

Issues relating to the locations of service points; of target beneficiaries or service takers; resources and other input factors required to deliver the service; would all have been analyzed together with social, economic and financial issues. Subsequently when a user enquires about the service, the query result would include spatial aspects.

Players in SES

Spatial enablement is not just about developing and using geographic information systems (GIS) technologies. It is a concept that permeates the whole of government and society and draws heavily on the spatial data infrastructure available in the jurisdiction (Williamson *et al.,* 2010a). There are different players in an SES such as governments, data suppliers and societies as a whole. To realize an SES, Van der Molen (2007) identifies three aspects emphasising the above mentioned players:

- With the aim to safeguard the availability of, access to and use of spatial information for society, it is the responsibility of the government to facilitate a (spatial) data infrastructure.

- As society evolves through transactions between parties and the participation of stakeholders in public decisions, the government should facilitate electronic legal and economic transactions and participation.
- Data suppliers bear responsibility for organizing the availability of and access to information and services in order to respond to the needs of society, i.e. to deliver quality information and services.

Different international organizations such as the Global Spatial Data Infrastructure (GSDI) association and the International Federation of Surveyors (FIG) are playing a major role in facilitating SES goals. Due to the importance of SES, the GSDI Association is focusing on this concept and developed its strategy plan (2009-2013) in line with spatial enablement. The essence of what GSDI does in the Association is to help to create an enabling environment that enhances outcomes in societies, economies and the global environment. The betterment of societies through spatial enablement is one of the goals of current strategy plan.

Spatial enablement will assist both developed and developing countries to pursue sustainable development objectives and it will ensure better productivity and efficiency. Therefore, the theme for the GSDI 12 World Conference in Singapore in October 2010 (jointly with the United Nations sponsored Permanent Committee on GIS Infrastructure for Asia and the Pacific) has been chosen as "Realizing Spatially Enabled Societies" as well as adopting this theme as a main focus for the Association in its next work period.

Furthermore, as a result of the importance of SES and SEG, FIG through its Commission 7 has setup a Short-Term Task Force on "Spatially Enabled Society" to develop the first framework for the embarking on this initiative. The Task Force was established by the FIG Council and endorsed by the General Assembly in May 2009 in Eilat, Israel. It will deliver its final report by the end of 2010 (Steudler and Rajabifard, 2010).

In this effort, the Taskforce team has considered the importance of the global discussions concerned with topics that have economic, social and environmental elements, and which are all related to long-term sustainability, including the following areas:

- UN Millennium development goals: The first of the eight main goals concerns the eradication of poverty, which can strongly be related to land and ownership of land.
- Climate change and global warming: These topics are of a true global scale and affect humankind as a whole.
- Disaster management: Examples are the effects after the tsunami in 2004, which destroyed much of the infrastructure in several countries. Already weak land registration and cadastral systems have become defunct after the disaster, and for financial sharks, it became effortless to manipulate land registration documents and to evict previous land owners.

As part of this effort, Steudler and Rajabifard (2010) have highlighted the following elements to facilitate defining spatial ability by:

- rules for representing the real world situation;
- the existence of a legal framework;
- a reference between reality and the model;
- the ability to position objects correctly;

- representing situations correctly;
- disposing of the needed human resources an technical tools;
- having as much spatial information as needed;
- area coverage.

Based on the above considerations, the following statements have been suggested:

- A precondition for spatial enablement is the modeling of reality, i.e. spatial enablement is best practice, when real world reality is modeled as closely as possible.
- For establishing real world models, there is a need of modeling rules and tools.

Indicators to measure spatial enabling include comprehensiveness, coverage, reliability and accuracy. A crucial element in dealing with global problems is the information about land ownership, i.e. a cadastre is crucial for establishing the link people to land.

Stages of SES Development

In a pragmatic description Wallace (2007) explained SESs in two stages.

The first stage involves the excitement of images, and the simple, visible answers to ubiquitous questions such as "Where am I?". This stage involves converting the non-spatial information and processes used to manage our finances, our health, our education, our taxation and so on, into spatially enabled systems.

The second stage of spatial enablement involves the linking data with a geocoded reference, the North/South, East/West 2D codes, and even height, to give a precise reference on the Earth's surface. Geocoding allows the data to be mixed and matched with other information about the same place to reveal an open-ended range of relationships and processes. The technical opportunities of using 2D XY coordinates plus 3D height, and even the 4th dimension of time, to reveal relationships are now real. But the linking must not merely deliver "pretty pictures" or gather even more data. The business driver of improving processes in government must ensure that the new approaches deliver real efficiency gains by saving time, improving understanding and, obviously, creating information once and using it many times over.

Wallace (2007) further describes the logic of stage two of spatial enablement allows relationships between a numbers of factors related to information to be spatially organized:

- Activities – the commercial, social and institutional activities and processes. This factor could also lead towards evaluative or qualitative measures, for example tracking success and failure rates of some policy application.
- Locations or Places – measurements, position in terms of coordinates, relations in space, and spatial components.
- Times – an historical, future or real-time perspective. The crucial impact of time inclusion allows the order of events to be spatially tracked.
- People – who might be owners of land, clients of an agency, taxpayers or any particular relationship.

This is graphically presented in Figure 2 below.

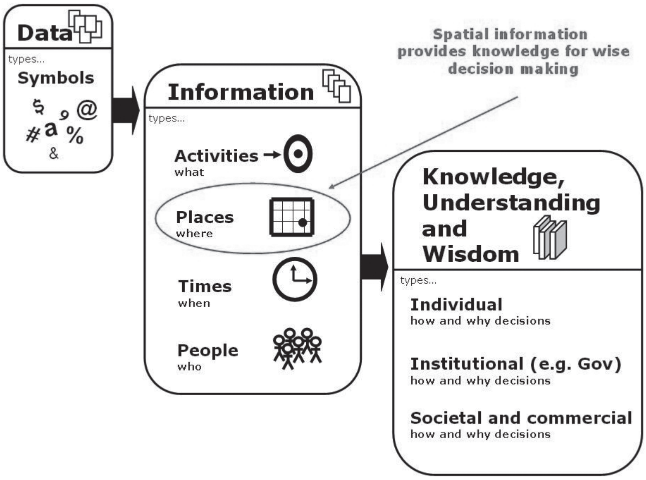

Figure 2. Place as an important factor to improve information manageability (Wallace 2007)

Action Items

Spatial enablement should offer new opportunities for government and society in the use and development of spatial information. The ability to implement spatial enablement requires a range of activities and processes to be created across all jurisdictional levels. These include (Rajabifard, 2007):

- an enabling platform comprising institutional, collaborative framework, governance, legal and technical tools for data sharing as part of ICT, e-government and information sharing strategies;
- building on SDIs and related initiatives;
- using geocodes and "place" related information, such as national geocoded street address files;
- often re-engineering the institutions of government;
- legal frameworks to facilitate integration and management;
- activities on spatial data standards, interoperability and integratability;
- development of authoritative registers of key spatial information;
- research and development;
- growth in capacity at societal, institutional and individual levels.

There is also the need to develop institutional practices to make existing and future technology more effective. Research has found that very few jurisdictions have developed a framework for establishing a spatial infrastructure that addresses comprehensively operational, organisational and legal issues.

The development of a spatially enabled government and society is ongoing and multi-disciplinary; achieving it will draw on a wide range of experiences and disciplines from surveying and mapping, land administration, GIS, information and communications technology, computer science, legal and public administration and many more. Jurisdictions will need to work together over the long-term if the vision of a SES is to become reality.

2. Book Outline

This book is a compilation of articles as book chapters each focusing on a certain aspect of SES. All the chapters together give an overview of the current concepts, fundamentals, activities, facilities and practices of SES in the world. The chapters presented in this book have gone through a full peer review process as part of the GSDI 12 World Conference in 2010. It appears that this volume covers four foci areas of SES: (1) Concepts and Fundamentals, (2) Regional Activities, (3) Facilitating Spatial Enablement, and (4) Practices towards SES.

Part 1: Concepts and Fundamentals

In the first part, the concepts and fundamentals of SES are explained in more depth from different perspectives. In the context of this book, with concept we mean the understanding of Spatially Enabled Societies, retained from experience, literature and reasoning. With fundamentals, we mean the factors that influence the spatial enablement of societies. This part 1 with four chapters has a more theoretical focus on the concepts and fundamentals.

In Chapter 2, the concepts and fundamentals of SES are first explained from the perspective of Coastal Zone Management. In *Spatially Enabling Coastal Zone Management: Drivers, Design Elements, and Future Research Directions* by Rohan Bennett, Abbas Rajabifard, and Sheelan Vaez, the drivers, design elements and issues associated with the spatially enabling the management of coastal zones are clarified. Coastal zones are encumbered by hundreds of property rights, restrictions, and responsibilities. Currently, the interests are managed disparately across and between governments: sustainability requires these interests to be managed in an integrated fashion. Spatial enablement can deliver information integration and minimizes the need for redesigning legal, institutional and administrative frameworks. Emerging concepts including Marine Cadastres, Marine SDIs, Seamless SDIs, and Property Objects will inform the solution; however, this chapter suggests further research is required to fully understand the complete legal, administrative and technical arrangements in the coastal zone. Moreover, methods for streamlining the integration of property and non-property information are required, particularly the harmonization of vertical datums.

In Chapter 3, *Developing spatially-enabled business processes: the role of organizational structures* by Ezra Dessers, Geert Van Hootegem, Joep Crompvoets, and Paul Hendriks, it is clear that SES is a complex concept with many facets based on numerous flows of spatial information. The chapter argues that the analysis of spatial information flows cannot be separated from the business processes in which they are embedded. The performance of both is expected to be influenced by the structural characteristics of the organisations involved, and of their mutual relations. Task division is a central concept for describing these (inter)organisational structures. Based on theoretical considerations, the chapter advances the proposition that, given the level of complexity and dynamism of the current social environment, a move towards a more process-based and decentralised task division could contribute to the development of spatially-enabled business processes.

As written before, Wallace (2007) emphasises that one of the key factors of SES is Location or Place. In Chapter 4, *Spatially Enabling 'Place' Information* by Stephan Winter, Rohan Bennett, Marie Truelove, Abbas Rajabifard, Matt Duckham, Allison Kealy, and Joe Leach, the concepts and fundamentals of SES are explained from the 'location/Place' perspective. It appears that the concept of 'place' is difficult to embed in the concept of SES. Resolving places to single georeferenced points has been identified as a major factor. The chapter demonstrates that more complex modelling of place is just part of the solution. In order to have successful spatial enabling societies, it is necessary to include some location-related issues such as: accuracy definitions of place using emerging sources of data (e.g. crowd-sourced) into SDI's, and embedding measures of the salience of place.

Finally, Chapter 5, *Towards an assessment framework for spatially enabled government* by Peter Holland, Abbas Rajabifard and Ian Williamson focuses on one of the key requirements of SES is a means of assessing whether investments in spatial enablement are achieving the expected outcomes. The framework being developed builds on assessment methods under development or in place for e-Government, SDI and, public policy and program evaluation.

Part 2: Regional Activities

With the previous part being more theoretically focused, this part is more practical in nature. In this part 2 illustrative examples of activities from different regions in the world are presented that somehow might contribute to the development of SES. These examples help to better understand the concepts and clarify the fundamentals of SES.

The first example in Chapter 6 deals with the Asia-Pacific region which is a vast area with 60 percent of the world's population covering 56 countries. The chapter *Spatially enabled Government in Asia-Pacific Region* by Abbas Rajabifard, Ian Williamson and Sheelan Vaez presents activities and summarises the outcomes of two major events that have been organised in the region regarding spatial enablement; the PCGIAP/GSDI international workshop 'Spatial Enablement of Government and National SDI-Policy Implications' (Seoul, South Korea, June 2007), and the 'Spatially Enabling Government' Conference organised by the Australian Government (Canberra, Australia August 2007). The chapter outlines the opportunities, issues and challenges involved in the design and development of spatially enabled government and society. The actions already listed under section Action Items are important outcomes of these organised events.

Chapter 7 on *Spatially Enabled Government in Europe as a basic ingredient for Spatially Enabled Societies* by Bas Kok and Joep Crompvoets illustrates with examples from Denmark, Norway, Finland, Sweden, Spain and The Netherlands that SDI governance and the use of spatially enabled platforms are fundamental conditions for successful partnership building in national EU Member States e-government programs. The chapter clarifies that societies can be spatially enabled without successful SDIs, because of the fast growing technological developments and the high availability of spatial information from various media, mobiles, etc. However, national governments play a fundamental role in providing successful SDI tools for the realization of efficient government performances as well as for business development and citizens' e-democracy issues. Therefore, the focus of this chapter is on Spatially Enabled

Government as a crucial part towards optimizing the creation of a genuine SES. More effort is needed to determine how the SDI-community can contribute to other communities to optimize the use of each others' spatial data, such as the space community and the data collected by voluntary communities. Convergence between these communities at the strategic and operational level is a basic condition for optimizing Spatial Enabled Communities.

Another example in Chapter 8 is from Singapore. In this country, SES is partly achieved by SG-SPACE; Singapore Spatial Collaborative Environment. This program aims to provide a platform for government agencies to share and use spatial data. The chapter *Spatially Enables Singapore through Singapore Geospatial Collaborative Environment* by Loh Sook Yee and Victor Khoo shows that SG-SPACE is Singapore's environment leading to SES.

Part 3: Facilitating Spatial Enablement

Not only a better understanding of the concepts and clarification of the fundamentals of SES is needed, but more knowledge is needed about the facilities that ease and assist in accomplishing the objectives of SES. These facilities can be technological, institutional and legal in nature. This part 3 contains four chapters which discuss aspects that are important to realise SES.

Chapter 9 on *Automatic Spatial Metadata Enrichment: Reducing Metadata Creation Burden through Spatial Folksonomies* by Mohsen Kalantari, Hamed Olfat, and Abbas Rajabifard focuses on metadata as an fundamental element in functioning and facilitating SES in Spatial Data Infrastructure (SDI) initiatives. Since we are dealing with a large amount of spatial information being managed, it is necessary to automate the extraction and update of spatial metadata. This chapter explores the automatic metadata enrichment stream based on the tagging and folksonomy concepts.

In Chapter 10, *Volunteered Geographic Information in Spatial Data Infrastructure: An Early Look at Opportunities and Constraints,* David Coleman focuses on the risks and opportunities created by the emergence of Volunteered Geographic Information (or "VGI") as a viable facility for updating and enriching spatial databases maintained by public and private sector providers. He demonstrates clearly that VGI has the potential to relocate and redistribute selected GI productive activities from mapping agencies to networks of non-state volunteer actors by tapping the distributed knowledge, personal time and energy of volunteer contributors. This development is likely to be fundamental for SES.

In Chapter 11, *Towards Service Level Agreements in Spatial Data Infrastructures,* Bastian Baranski and Bastian Schäffer focus on Service Level Agreements as a legal facility to support the development of SES. A SLA is a negotiated contract between a service consumer and a service provider that formalises a business relationship. In this way, it is possible to enable contractual parties to measure, manage and enforce a certain quality of service.

Chapter 12, *Legal Interoperability In Support of Spatially Enabling Society* by Harlan Onsrud, presents a legal interoperability vision for facilitating the access, and use of spatial data and proposes an operational environment for gaining much greater legal clarity and efficiency in wide scale sharing and licensing of such data. This chapter emphasizes the high need to have more knowledge about legal interoperability allowing users to legally access and use the spatial data of others without seeking permission on a case-by-case basis. In this way, legal interoperability support SES.

Part 4: Practices towards SES

In this final part 4, some nice practices leading to towards SES are presented. These practices show clearly the key drivers, main strengths, the diversity of the scope, jurisdiction levels and sectors involved. These societies strive for location information as common goods made widely available.

SES demand accurate and timely information about land. This information provides the link between people and activities. Chapter 13 on *Spatially Enabling Land Administration: Drivers, Initiatives and Future Directions for Australia* by Jude Wallace, Brian Marwick, Rohan Bennett, Abbas Rajabifard, Ian Williamson, Nilofer Tambuwala, Katie Potts, and Muyiwa Agunbiade focuses on the current challenges of land information in Australia. Land management issues now require approaches based on need, not jurisdiction. Information to found sound policymaking at a national level is also essential. Indeed, an Australian infrastructure for managing land information is an obvious tool needed by governments at all levels. In order to achieve this workable infrastructure, eight design elements must be developed: a shared vision, a common language or ontology, a governance framework, a business case for change, selection of a data model, an accompanying technical infrastructure, an implementation/ maintenance model, and an international compatibility framework. Finally, it is recommended to analyse the key national drivers and emerging (inter)national initiatives in order to ensure that the elements be developed to suit national needs.

Chapter 14, *UDOP: A Collaborative System for Geospatial Data* by A.J Clark, Patton Holliday, John Clark, Jordon Mears, Robyn Chau, Laurent Nielsen, Melinda Chau, Harris Eisenberg, and Tony Eckersley underlines strongly the SES demand for accurate and timely information. The aftermath of Haiti's January 12 2010 earthquake typified disaster relief in that efficiency and situational awareness were reduced by the chaotic, uncoordinated influx of relief and aid. The lack of an environment in which spatial information could be shared was a major component of this chaos. The application of the UDOP to relief efforts in Haiti shows the strengths of current geographic information technology to optimize the gathering and management of spatial data from government, military, non-government agencies, and first responder resources, which consequently improved relief efforts simply by inviting a large user community to share data on an intuitive common platform. The experience in and lessons learned from Haiti promise great strides into the future of the geographic information technology for SES.

The next practice towards SES refers to the domain of spatial planning. Spatial planning is increasingly regarded as one of the important instrument in disaster risk reduction. It facilitates the decision on the future use of space in any administrative unit, which in some cases may be confronted by natural hazards. This is important for any society and government wishing to become spatially enabled. Chapter 15, *Integrating Spatial Planning and Disaster Risk Reduction at the Local Level in the Context of Spatially Enabled Government* by Heri Sutanta, Abbas Rajabifard, and Ian Bishop, presents an approach in integrating disaster risk reduction into spatial planning at the local government level. This example shows how the local government in Indonesia tries to incorporate disaster risk reduction in the spatial planning.

Another practice towards SES in Indonesia refers to Volcanic Disaster Risk Management. The Sleman local government conducts a risk management program for the Merapi Volcano to minimize damage and casualties in case of an eruption. The program applies geographic information technology to enhance decision making and enable coordination of the risk management activities. The research written in Chapter 16, *Making Sense of Local Spatial Data*

Infrastructure in Volcanic Disaster Risk Management; A Case Study at Sleman Regency, Indonesia by Tandang Yuliadi Dwi Putra, Trias Aditya, and Walter de Vries, aimed to design and test an application (geoportal) to support a local Spatial Data Infrastructure (SDI) for risk management efforts. The research results show the potential use of geocollaboration portals supporting the development of SES.

Finally, the last practice leading towards SES refers to road safety in Victoria (Australia).

In Chapter 17, *Intelligent Speed Assist: Spatially Enabling Societies*, Hossein Mohammdi, Alistair Colebatch, Gary Dawson and Stuart Ballingall presents Intelligent Speed Assistance as one of the initiatives which contribute to SES. The speed-aware road network to be developed assists citizens to choose an appropriate speed and assists governments to maintain citizens' safety. The chapter focuses on the business processes to establish the minimum requirements for building and maintaining the speed-aware road network data.

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Chapter 2

Spatially Enabling Coastal Zone Management: Drivers, Design Elements, and Future Research Directions

Rohan Bennett[1], Abbas Rajabifard[2] and Sheelan Vaez[3]

Abstract

This chapter provides an insight to the drivers, design elements and issues associated with spatially enabling the management of coastal zones, in particular coastal property rights, restrictions and responsibilities. Coastal zones are encumbered by hundreds of property rights, restrictions, and responsibilities. These are created to manage coastal population increases, climate change, and to deliver good governance. Currently, the interests are managed disparately across and between governments: sustainability requires these interests to be managed in an integrated fashion. Spatial enablement can deliver information integration and minimizes the need for redesigning legal, institutional and administrative frameworks. This is recognized in international, regional, and national coastal forums. Emerging concepts including Marine Cadastres, Marine SDI, Seamless SDIs, and Property Objects will inform the solution, however, this chapter suggests further research is required to fully understand the complete legal, administrative and technical arrangements in the coastal zone. Moreover, methods for streamlining the integration of property and non-property information are required, particularly the harmonization vertical datums. Finally, the feasibility of spatially enablement needs to be assessed.

Keywords: Spatial Enablement; Coastal Zone; Marine SDI, Property Rights, Restrictions, and Responsibilities

1. Introduction

Coastal zones are the areas where population growth, climate change, sea level rise, and natural resource discovery are played out. In an effort to manage these complex environments, governments have increasingly legislated new property rights, restrictions, and responsibilities. Examples include special planning controls in coastal zones, protected coastline reserves, and

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submerged petroleum extraction rights. Coastal zone governance regimes are now extremely complex (Bartlett *et al.,* 2004; FIG, 2006): the hundreds of new coastal property interests are managed disparately across and between different levels of government. Moreover, historically land and marine administration have operated in isolation to one another. The coastal zone includes both contexts and administrative voids and overlap between local, regional, state, and national management bodies are common (Strain *et al.,* 2006).

Coastal challenges including flooding, sea level rises, erosion, population increase, planning, development and property insurance cannot be managed if coastal property administration and information remains disaggregated (Binns *et al.,* 2005). Disaggregated information and processes means decisions are made without full knowledge of the surrounding legal context. In order to manage the coastal zone in a sustainable manner a holistic or seamless framework including legal, administration, and technical components is required in the coastal zone (FIG, 2006). The framework must enable governments, businesses and communities to make sustainable decisions in relation to the coastal zone.

Spatial enablement holds the key. Spatial enablement is an evolving concept (Holland, 2009), however, it is generally considered the establishment of an enabling infrastructure to facilitate use of place or location to organize information about activities of people and businesses, and about government actions, decisions and polices (Williamson *et al.,* 2006). In the context of coastal property interest management, spatial enablement offers the opportunity to integrate land and marine information for a diverse set of stakeholders. Coastal property information sets could be linked via their spatial attributes. Blockages in decision-making processes caused by inadequate access to data would be eased. Moreover, spatial enablement would decrease the need to re-engineer pre-existing complex legal and administrative arrangements: a technical platform enabling data sharing would over-ride the need to undertake expensive institutional and legal reform.

The concept of spatial enabling coastal zone management already has some traction (Vaez *et al.,* 2009), however, clearer articulation and quantification of the underlying problem is required. Moreover, an up-to-date review of the key drivers, current state-of-play, and future research requirements appears necessary. To this end, this chapter aims to quantify the problem and provide an introductory synopsis of the key drivers, status, and future requirements for spatially enabling the management of coastal property rights, restrictions and responsibilities. First, the methodology underpinning the collection of data and collation of results is described. This leads to a discussion of the results. The size of the problem and key drivers for spatial enablement are articulated. The drivers are discussed under the headings of population increase and climate change. Australia is used as a case study. Second, existing theories underpinning the requirements for, and design elements of, spatially enabled coastal zone management are discussed. Third, current initiatives and planned future work relating to spatially enabling coastal property management are covered. Again, the Australian context is used to guide discussion. Finally, the chapter concludes with a summary of the key issues emerging from the chapter.

2. Method and Approach

The research underlying this chapter was centred on an exploratory case study. This is distinct from a 'descriptive' or 'explanatory' case study. Exploratory case studies discover new theories often after the completion of data collection (Yin, 1993). They can be used to develop hypotheses that are more rigorously tested in later studies. This technique appeared highly appropriate as the study aimed to review the current context and develop hypotheses relating to the future development of spatially enabled coastal property management.

In general, the global context was used as the underlying case study, however, the country of Australia and its state of Victoria were utilized as more specific case study sites. Selection was based on the country's extremely large coastal zone, inter-jurisdictional coastal management regimes, involvement in regional coastal management forums, and its proximity to the research team.

The study included qualitative and quantitative components. The qualitative components were used to answer the questions relating to drivers, current status, and future research directions of spatially enabled coastal property management. The quantitative component was used to measure the size of the problem. The study included five stages: quantifying the problem, identifying the drivers, synthesizing existing theories, analysing current progress, and articulating the future research directions. Figure 1 illustrates how these stages were interrelated.

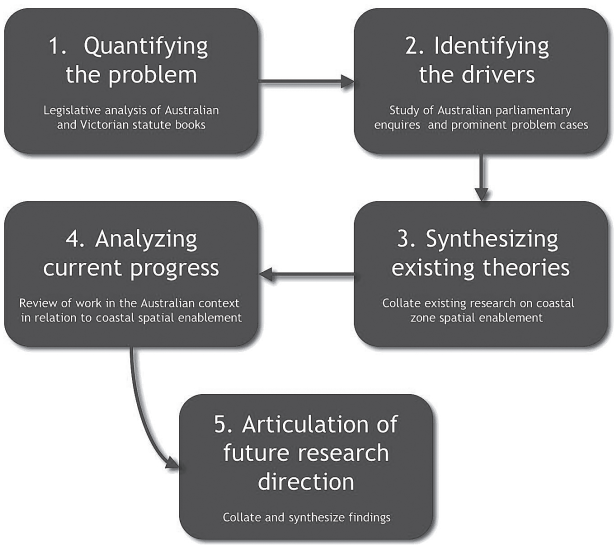

Figure 1. Research Design

Stage 1 consisted of a legislative analysis. It intended to quantify the problem by determining the number of statues creating coastal property rights, restrictions and responsibilities at federal (Australian Government) and state level (Victorian Government). No study of this type has been undertaken in the Australian context. The statute books of both jurisdictions were reviewed and statutes that created coastal property interests were recorded. As statutes books do not remain static a snapshot date for the legislative analysis was determined.

Stage 2 involved a study of the drivers impacting decision-making in coastal zones. The review qualitatively considered contemporary parliamentary enquires and prominent problem cases relating to Australia's coastal zone.

Stage 3 collated existing research relating to spatially enabled coastal, marine and land property management. This included a literature review of recently developed theories and concepts related to marine, land, and coastal zone administration. The outcomes of this stage provide the theoretical underpinnings for spatially enabling the management of the coastal zone.

Stage 4 consisted of reviewing progress towards spatial enabling the management of the coastal zone. This component considered work being undertaken within Australia and more globally.

Stage 5 collated the outcomes of the previous four stages and resulted in the articulation of a future research direction required for spatially enabling the management of the coastal zone.

The results of all five phases were collated and synthesized. The subsequent results are discussed in the following sections.

3. Quantifying the Problem

As the coastal zone is increasingly the most important 20% of the worlds land area, it demands good governance (FIG, 2006). Good governance relies on an effective legal framework. Legislative sprawl is often a sign of a legal framework under strain. Legislative sprawl is the rapid acceleration in the creation of statutes and related regulations within a jurisdiction. It is generally seen as a bad thing as it impedes the drive for good governance by creating complex administrative systems. It is prominent in the marine context.

A simple method of measuring legislative sprawl is to quantify the amount of legislation relating to coastal zone management within a jurisdiction. Figure 2 and 3 provide results from the legislative analysis conducted on the Australian and Victorian (an Australian state) statute books. The graphs reveal the number of statutes legislating property interests relating to the coastal zone at state and federal level within Australia.

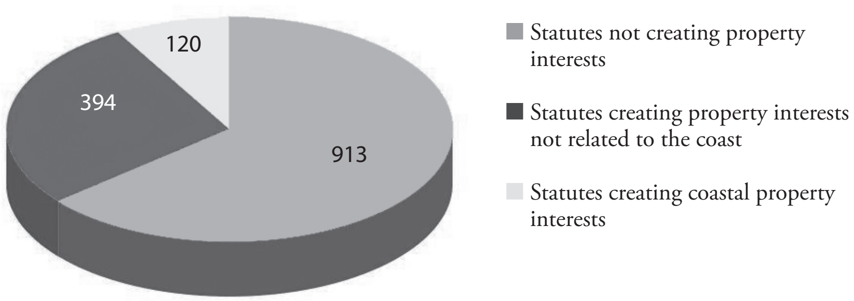

Figure 2. Australian federal statutes creating coastal property interests

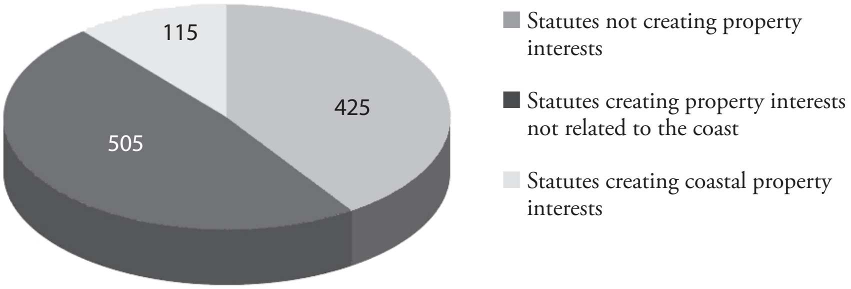

Figure 3. Victorian state statutes creating coastal property interests

A number of points are worth making about the figures. First, the number of statutes creating coastal property interests is significant. Of the 1427 statutes in total at the federal level, 514 create property interests. Of these 120 relate to the coastal zone. Of the 1045 statutes at the state level, 620 create property interests. Of these 115 relate to the coastal zone. These statutes represent hundreds of rights, restrictions, and responsibilities in the coastal zone, all potentially managed using different institutions, databases and processes. It is also worth noting that within each statute there could be multiple interests created. Therefore, the graphs under represent the total number of interests in the coastal zone. Second, the graphs do not reveal the acceleration in the creation of interests over the last thirty years. This acceleration is a concern as it is contributing to the unwieldy complexity of coastal zone management. Third, while the number of coastal statutes appears to be a small number in comparison to the total number of statutes, the activities they administer certainly are not. These statutes constitute some of the most significant built and natural environment coastal management functions of government.

It is also worth noting that this simple legislative analysis cannot reveal the detail in complex problems relating to existing coastal management systems. For example, in Australia land and marine components are generally managed separately though a range of community, local, state, regional and federal organizations. In the marine environment there is legislative frameworks for managing the oil and gas sector, fisheries, aquaculture, shipping, conservation, marine heritage, native title, and cables/pipelines. These activities are generally managed in isolation to one another. Example legislation includes: Petroleum (Submerged Lands) Act 1967 (Cth), Petroleum (Submerged Lands) Act 1982 (Vic), Fisheries Administration Act 1991 (Cth), Fisheries Management Act 1991 (Cth), Fisheries Act 1995 (Vic), Fisheries Management Act 1995 (Vic), Navigation Act 1912 (Cth), Australian Maritime Safety Act 1990 (Cth), Marine Act 1988 (Vic), Environmental Protection and Biodiversity Conservation Act 1999 (Cth), Environmental Protection (Sea Dumping) Act 1981 (Cth), Historic Shipwrecks Act 1976 (Cth), Submarine Cables and Pipelines Protection Act 1963 (Cth) and many others. In the land domain there are legislative frameworks for managing all land-based activities including land tenure organization, land valuation, land-use planning, and land development. Example legislation includes: Surveyors Act 2004 (Vic), Subdivision Act 1988 (Vic), Property Law Act 1958, Land Act 1958, Planning and Environment Act 1987 (Vic), Native Title Act 1993 (Cth) and hundreds more including the planning controls of local government. Again, many of these land activities are governed in isolation to one another. Further complexity is added in the coastal zone where the already disparate land and marine legislative frameworks interact. How the various pieces of legislation interact along the coastline is often unclear. This makes management and decision-making relating emerging issues such as coastal erosion and sea-level rise quite problematic. More specific issues relating to coastal zone management is revealed in the works of Neely *et al.* (1998), Binns (2004) and FIG (2006).

At any rate, it can be summarized that the management of coastal zones depends on a complex legal web of overlapping and conflicting property rights, restrictions and responsibilities governed by disparate land and marine interest groups.

4. Identifying the Drivers

Many issues were found to be driving the need for improved management of the coastal zone, however, here two key drivers are focused upon: managing population increases in the coastal zone, and managing climate change and variability. These drivers are now outlined.

4.1 Population Increase

Human societies are increasingly tending towards coastal zones. Approximately half of the world's cities with over one million people are located around river and coastal areas (UN-PCGIAP, 2004). Since 2000 a dramatic migration of people to the coast occurred. Now over three billion people, half the world's population, live within 200km of the coast (FIG, 2006). It is estimated that by 2025, this figure will double. Combined with other cities, coastal metropolises will use 75% of the world's resources and expel equal amounts of waste. More people in coastal areas create more pressure on both land and marine environments. Management of these large coastal populations will be an ongoing challenge for the remainder of the 21st century.

Governments have responded to the pressures created by population increases in coastal areas by creating new property interests to organize people movement, sustain land-use, and control land development. An ad hoc approach has prevailed with different interests groups and arms of government developing, implementing, and administering the new interests in isolation to others. The coastal zone is now a complex legal quagmire of overlapping property rights, restrictions, and responsibilities. A single textual or graphical view of the situation is unobtainable as no agency has the responsibility, authority, or capacity to deliver it. This results in slower decision-making processes for government agencies, often without the complete legal situation being clear to the responsible authority. A new legal, institutional, and administrative approach is required in order to better manage the relationship between people and coastal zones.

4.2 Climate Change

Climate change is another force driving the need for improved governance of coastal zones, in particular coastal property interests. It is predicted sea levels will potentially rise hundreds of millimeters (IPCC, 2007), if not hundreds of centimeters (Allison, 2009), over the coming decades. The impact of these rises has radical implications for countries that conduct activities and desire to protect their coastal zones. Many nations are dependant on their coastal zones for economic, social and political strength. Ports and harbours act as hubs for trade, commerce and transport networks. Millions of people use coastlines as places for dwelling and recreation. Coastal zones are also host to diverse natural environments and sensitive ecosystems. Large changes in sea levels will impact upon all these activities and all the property interests that relate to them. Interests related to parcels, buildings, trade hubs and the natural environment are all potentially impacted. An integrated understanding of all coastal property interests and the impact of climate change on them appear increasingly urgent.

In Australia, climate change will also result in areas of decreased rainfall. This will mean decreased inflows from rivers into ports, harbours and lakes. Holders of commercial oyster leases, fishing licenses and recreational permits, will feel the impact. Fishing stocks including Taylor, Salmon and Brim are already under increasing stress in areas of southeast Australia. Decreased rainfall has the potential to radically alter the nature, use and economic viability of existing agriculture in coastal zones. Many property rights, restrictions and responsibilities relate to the management of coastal fisheries and coastal infrastructure. It appears that in order to manage the impacts of climate change, sea-level rise models need to be integrated with coastal property information.

In summary, coastal population increase and climate change are driving the need for existing land and marine administrative systems to better deliver the property information requirements of stakeholders in coastal areas. A new infrastructure or re-engineered cadastre for the coastal zone is required, one that bridges the gap between marine and land environments and enables holistic definition and sustainable management of all property rights, restrictions and responsibilities in the coastal zone. Moreover, property information needs to be integrated with other forms of spatial data such as sea-level rise models and demographic trends. The underlying theory of this new infrastructure is now discussed.

5. Synthesizing Theories on Spatial Enablement and Coastal Zone Management

Over the last decade researchers in geomatic engineering, land administration, and marine management have focused on improving information management in land and marine environments. Initial work focused on defining the underlying problems (c.f. Clark, 1997; Gillespie, 2000; Longhorn, 2003). In the marine context the concepts of Marine Cadastres (Binns *et al.,* 2004), Marine SDI (Stain *et al.,* 2005; Tolvanen and Kalliola, 2008) and Seamless SDI models (Vaez *et al.,* 2009) were defined. Property Objects (Bennett *et al.,* 2008) and Land Administration Systems enabling sustainability (Williamson *et al.,* 2009) emerged in land context. In the Australian context a number of Australian Research Council grants focused on the land and marine interface. These included 'Defining and Developing a Marine Cadastre for Australia' (2002-2003), and building 'A Marine Cadastre for Australia - Addressing Key Scientific and Policy Issues (2003-2007). This work brought together the usually disparate land and marine administration communities. The problems with managing the land-marine interface were seen with greater clarity.

Combined research into land and marine administrative systems naturally resulted in a focus on the coastal and zone. It was increasingly clear that the complex layers of coastal property interests lacked reliable, organized and accurate spatial data (Clark, 1997; Li, 2000). Moreover, the complex physical, legal and governance relationships existing within the coastal zone further inhibited sound management of the coastal zone: the 'silo' approach could not continue (Longhorn, 2003; Gillespie, 2000).

Many issues associated with the management of coastal property rights, restrictions, and responsibilities could be overcome if a holistic framework for integrating coastal property information system existed. Redesigned legal, institutional and administrative frameworks would be important components of any long-term solution, however, it was the integration of information via spatial technologies that would improve the situation in the short term. Therefore, the concept of spatial enablement holds great promise to the realm of coastal property interest management. The concept emerged in the mid 2000s and provides for the establishment of an enabling infrastructure to facilitate use of place or location to organize information about activities of people and businesses, and about government actions, decisions and polices (Williamson *et al.,* 2006).

Spatial enablement provides the conceptual solution to improving management of coastal property rights, restrictions and responsibilities. Spatial enablement of the coastal property interests would enable the hundreds of competing coastal zone interests shown in Figure 2 and 3 to be brought together within a single view as all property interests share the common characteristic of being attached to a place (Williamson *et al.,* 2004; Rajabifard *et al.,* 2005; Masser, 2005). It is the linking ability of spatial information that can improve decision-making as it enables holistic understandings and integrated management of the complex coastal zone (Figure 4).

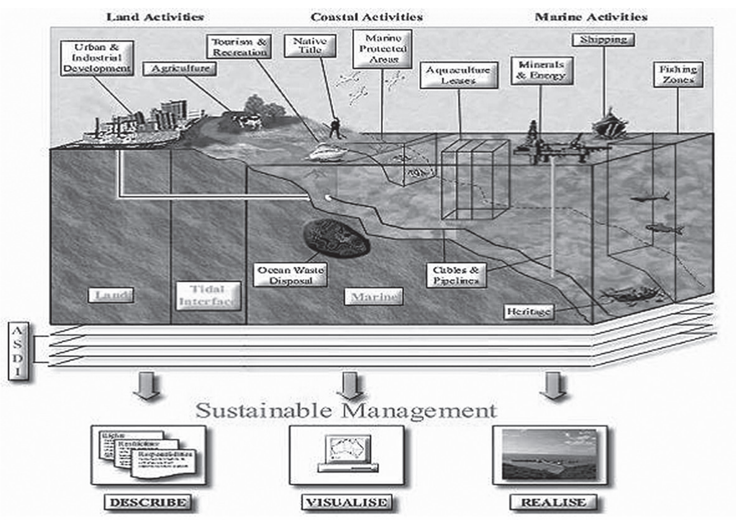

Figure 4. Spatial information enables a holistic view of coastal zone property objects (Williamson *et al.,* 2004)

The International Federation of Surveyors (FIG) now recognizes the potential of spatial technologies in the coastal zone (FIG, 2006). It advocates for a seamless information-sharing platform connecting the land and sea interface. There must be a move away from traditional cadastres that focus on land and stop at the shoreline. Additionally, existing spatial data infrastructures (SDIs) must undergo the same transformation: they tend to direct their attention landward or marine-ward and neglect the complex coastal zone. Achieving these objectives would position a jurisdiction as a leader in coastal zone management and the sustainable administration of coastal property rights, restrictions and responsibilities.

6. Current Progress towards Spatial Enablement

At the international level a number of global and regional initiatives aim to improve the management of the marine and land interface. These include the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA), Integrated Coastal Zone Management (ICZM) and the 3rd United Nations Convention on the Law of the Sea (UNCLOS). Whilst these initiatives do not explicitly mention spatial enablement, they are important steps towards a shared understanding of the need to improve coastal zone management. These initiatives are mimicking the well-developed land use management frameworks from urban areas. However, in the coastal zone, the diversity of interests, some terrestrial and some marine, compounds the issues (Rajabifard *et al.,* 2008).

International land and marine administration communities are naturally more inclined to highlight the importance of the spatial information and its use in coastal zone management. In Malaysia in 2004 The Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) conducted a conference on 'Administering the Marine Environment – The Spatial Dimension.' The meeting was endorsed by the United Nations (UN) and highlighted the importance of coastal information infrastructures. Accordingly a resolution was passed at the 17th United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP) in Bangkok in 2006. The resolution defined the spatial dimension of the marine cadastre and recommended that a marine cadastre be added to existing national information infrastructures to ensure a continuum across the coastal zone (UNRCC-AP, 2006). Additionally, the International Hydrographic Organization (IHO) is developing strategies for integrating land and marine SDIs. Its seminar on "The Role of Hydrographic Services with regard to Geospatial Data and Planning Infrastructure" formally recognized an option for Hydrographic Offices to become national SDI partners (Maratos, 2006).

In Australia the need was recognized by most recently by the Australian Parliament's Standing Committee on Climate Change, Water, Environment and the Arts. Recommendation 11 of their 2009 Report on 'Managing our coastal zone in a change climate' calls for the establishment of a 'National Coastal Zone Database to improve access to and consistency of information relevant to coastal adaptation.' The significance of an integrated coastal information infrastructure for managing the coastal zone is now patently clear at the highest levels of government. The report 'National Coastal Zone Database' will be an important tool in the management of climate change. However, the report only focuses on the provision of elevation and vulnerability data. The inclusion of information relating to property rights, restrictions and responsibilities would radically enhance the database, enabling stakeholders to visually assess the actual impact of climate change on the property interests of people. Also in Australia, research into the coastal zone is a National Research Priority as work in the area is seen as supporting environmental sustainability and also responds to climate change and variability.

Technical solutions are emerging. At the consumer level, Google Earth now integrates various forms of land and marine data within its single visual platform. Whilst the platform is not used to deliver property information, extended licensing agreements would allow it to do so. In Australia, Google Maps does provide access to the parcel outlines; however, no tenure or valuation details are provided. This trend is likely to continue, as governments are extremely cautious about licensing private property datasets to private companies. Additionally, Google Earth cannot provide an authority on accuracy, reliability, and integration on this type of data. Vaez *et al.* (2009) relates how much work is being done in the realm of technical standards. The ISO/TC211 terrestrial based standard is the basis of the S-100 hydrographic standard currently in development. The S-100 standard will enable sharing and integration of hydrographic information with other forms of spatial data. It will have manageable flexibility that can accommodate change and facilitate interoperability with other terrestrial standards.

7. Future Research Directions

While this chapter provided an initial insight into the size of the problem via the legislative analysis, more in-depth analysis of the complete legal, institutional, and administrative situation relating to these coastal statutes is required. This type of analysis will inform the development of a framework for spatially enabling coastal zone property management.

To further support the spatial enablement of the management of coastal property rights, restrictions, and responsibilities, there is a need for a number of new techniques and associated tools. These include designing an infrastructure that integrates technical, legal and institutional management of all property rights, restrictions and responsibilities in coastal zones; developing methods for integrating other forms of non-property information within the management infrastructure, including environmental data, sea-level rise data, climate change data, social data and economic data; testing the infrastructure and methods by developing a scenario to assess how sea-level rise and climate change will impact on coastal property rights, restrictions and responsibilities; and identifying requirements and indicators of resources needed to facilitate the implementation of the infrastructure. None of these components currently exist within the Australian context.

These initiatives will improve data management and support new products and solutions for the sustainable development of the coastal zone. They will directly service the needs of government, business and society at local, state and national levels. They will assist with emerging challenges including climate change, potential sea level rise, ecological conservation, population increase, planning, development, property insurance, and risk management. In the Australian context it will assist in the delivery of the 'National Coastal Zone Database' as called for in Recommendation 11 of The Australian Parliament's 'Standing Committee on Climate Change, Water, Environment and the Art's' 2009 report on 'Managing our coastal zone in a change climate'.

The need for methods for integrating property and non-property coastal information (e.g. sea level rise data) is worth highlighting. The focus on developing technical solutions for overcoming existing impediments to data integration is essential. Vertical datums continue to be an issue for data integration, particularly in the Australian context. A seamless platform will enable the impact of sea level rise on various forms of property to be assessed. Also worth highlighting is the feasibility plan for implementing the coastal management infrastructure. The feasibility of the infrastructure through in terms of costing, timelines and resource requirements has currently not received attention.

8. Conclusion

Coastal zones are encumbered by hundreds of property rights, restrictions, and responsibilities. These are emerging due to population increase and climate change. The interests are managed disparately across and between governments. Sustainability requires that these interests be managed in an integrated fashion. Spatial enablement can deliver this integration with minimal redesign of legal and administrative frameworks. International, regional, and national coordination bodies now recognize the power and need for seamless spatial information sharing platforms in coastal contexts. Concepts such as Marine Cadastres, Marine SDI, Seamless SDIs, and Property Objects provide components of the required framework.

Further research is required to understand the complete legal, administrative and technical arrangements in the coastal zone. Moreover, methods for streamlining the integration of property and non-property information is required, particularly the harmonization vertical datums. Additionally, the feasibility of spatially enabling coastal zone property management needs to be assessed: the technical and economic constraints need identification. Outputs from these short-term research activities will be significant components of future coastal SDIs: an essential infrastructure for enabling sustainable coastal zone management.

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Chapter 3

Developing Spatially-Enabled Business Processes: The Role of Organisational Structures

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Abstract

Although Spatial Data Infrastructure (SDI) is a complex concept with many facets, it is widely recognised that SDIs are about facilitating and coordinating spatial information flows. This chapter argues that the analysis of spatial information flows should not be separated from the business processes in which they are embedded. The performance of both is expected to be influenced by the structural characteristics of the organisations involved, and of their mutual relations. Task division is a central concept for describing these (inter)organisational structures. Based on theoretical considerations, the chapter advances the proposition that, given the level of complexity and dynamism of the current social environment, a move towards a more process-based and decentralised task division could contribute to the development of spatially-enabled business processes.

Keywords: spatially-enabled society, spatial data infrastructures, business process, task division, organisational structures

1. Introduction

Spatial Data Infrastructures (SDIs) have been developed in many countries worldwide to support the generation of spatially-enabled societies (Rajabifard, 2007). Currently, SDI researchers widely agree that organisational aspects are of fundamental importance to SDI development, and a more intensive contribution by organisation experts is often advocated (Budhathoki *et al.,* 2007). This evolution has recently led to several studies addressing the organisational sides to SDI (Koerten, 2008). However, little attention has been paid so far to the potential role of organisational structures, although their relevance is widely acknowledged in organisation literature (Daft, 2001).

Despite the many definitions and approaches, a Spatial Data Infrastructure (SDI) is typically defined as a set of interacting resources for facilitating and coordinating spatial data access, use

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and exchange (Rajabifard *et al.,* 2002; Nedovic-Budic *et al.,* 2008). The objective of this chapter is to explore the relation between organisational structures and the access, use and exchange of spatial data by the organisations involved. This organisational viewpoint derives from the fact that organisations are key stakeholders of an SDI. The actual goal of an SDI is not to serve the data handling functions per se, but to serve the needs of the user community (Rajabifard *et al.,* 2002). This research is part of the multidisciplinary SPATIALIST project (Crompvoets *et al.,* 2008), which aims to identify and analyse key elements affecting the access, use and exchange of spatial data. Organisational, public-management, legal, economic and technological elements are taken into account. This multidisciplinary approach should provide unique insights into the mutual connections between organisational and other elements, when explaining spatial data access, use and exchange.

The chapter consists of seven parts. While this introduction has sketched the topic of the chapter, which involves a focus on organisational aspects of SDI, the next part introduces the concept of business processes and explains why spatial information flows should not be studied separately from the business processes in which they are embedded. The third part explores the relationship between business processes, organisational structures and organisations. The fourth part discusses the role of SDI in the organisational conditions for business processes. The fifth part discusses the changing performance demands made on business processes that involve spatial information handling and the implied consequences for organisational structures. The sixth part briefly explains the application of the theoretical concepts developed in this chapter in the current, multidisciplinary SDI research of the SPATIALIST project (Crompvoets *et al.,* 2008). This chapter ends in the seventh part with conclusions regarding the development of spatially-enabled business processes.

2. SDI and Business Processes

Since an SDI concerns facilities for coordinating and facilitating spatial data access, use and exchange, the infrastructure is dealing with data and, eventually, information flows. The data-centred facilities offered by SDI will therefore only become meaningful once they are used to generate and use information. The connection to information points to the need to study SDI in relationship to the context of SDI use. We argue that a generic concept for introducing the context can be found in the concept of 'business processes'. The term 'business process' is used here in a broad sense, referring to processes in any organised form of cooperation, not just in 'businesses' in the restricted sense of private sector organisations. A business process perceived in this broad sense is the sequence of steps involved in producing products and services (Daft, 2001; Desmidt *et al.,* 2005). It usually takes the form of a series of interrelated activities, which turn a certain input of resources into an output of products or services. The performance of the business processes refers to these products and services in connection to what is expected from them by their users and society at large. Connecting SDI to business processes therefore provides an attractive option for SDI analysis. SDIs do not and should not develop in isolation of the business processes they are to support (Chan *et al.,* 1999). Business processes are defined as spatially enabled, when there is a high performing integration of spatial information flows in these business processes. Spatial information flows and the business processes involved should best be analysed together (Vandenbroucke *et al.,* 2009). Both are intertwined, and so is their performance (de Sitter, 2000).

Information is not flowing in the void, but instead it is running through a network of business processes. The relevance of the information flows depends on their significance for these business processes (Daft, 2001). The key question is then which factors might impact the performance of both business processes and their spatial information flows. Business processes can be linked to questions of organisation in two distinct ways. The first connection refers to organisation in the sense of deliberately and intentionally providing the conditions for smooth-running, high-performance business processes. An SDI can be part of these intentionally-provided conditions when business processes need to be spatially enabled. The second connection refers to the organisations that are the actors of the business processes. Business processes are typically embedded in networks of business processes. A growing number of these business processes cross organisational boundaries (Huws *et al.,* 2006). Therefore, when spatial data and information are key resources of these business processes, the actors involve organisations – and the individuals and departments within these organisations – as well as organisational networks. Rather than analysing the performance of particular organisational-internal business processes, interdependent activities within and across the organisations have to be taken into account (Davenport *et al.,* 1990).

The primary focus in this chapter is on the first connection. It will be argued below that the role of SDI as an intentionally-provided facilitator of business processes is predicated upon the way these processes have been structured.

3. Organising Business Processes

3.1 The Organisation of Business Processes: The Role of Organisation Structures

Organising a business process involves providing the conditions for these business processes to reach their goals (products and services meeting the needs of their users and society at large). Among these conditions, the way tasks or process steps are identified, grouped and coordinated plays a primordial role (e.g. Simons, 2005; de Sitter, 2000). Individual behaviour, organisation culture, or social relations are crucially important to make business processes successful. Yet a systems view on organisations (Daft, 2001; Seddon, 2008; Achterbergh *et al.,* 2009) regards organisational structures as the fundament on which the other dimensions rest. An organisational structure can be defined as the sum total of the ways in which (1) a composite task (the production of a good or service) is divided into distinct tasks and (2) the coordination is achieved among these tasks (Mintzberg, 1993). The implied task division results in (1) a production structure and (2) a control (or coordination) structure (de Sitter *et al.,* 1997). As Figure 1 shows, the production structure can be defined as the architecture of grouping and linking the executing tasks of production, preparation and support in relation with the business process flows. The control structure can be defined as the architecture of grouping and linking coordinating and steering activities (de Sitter, 2000).

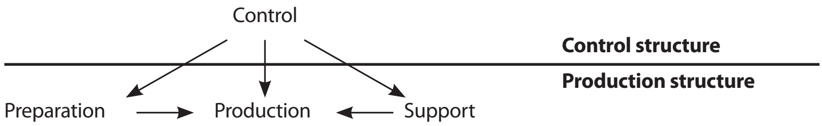

Figure 1. The control and the production structure (Adapted from: Van Hootegem, 2000)

With regard to the production structure, de Sitter (2000) argues that task division is essentially based on decisions regarding the level of functional concentration, which concerns whether or not similar functions are grouped into the same organisational subsystems. Based on this criterion, two basic structuring forms can be distinguished: a function-based and a process-based task division. (1) A function-based task division implies a high level of functional concentration. Similar or related activities are brought together in one organisational unit (Stoner *et al.,* 1995). The creation of the product or service is divided across various subsystems, which all produce only a limited part of the complete product or service. Homogeneous units are established within which always the same operations are performed. Business processes follow criss-cross lines between the units (Van Hootegem, 2000). (2) A process-based task division builds on a low level of functional concentration (which could be identified as de-concentration). All activities related to the production and marketing of a product or service (or a related group of products or services), or related to a certain type of customer, are brought together in one organisational unit. Unlike a division into functional departments, a division by process leads to an organisation form that resembles separate businesses (Stoner *et al.,* 1995). The business processes are assembled in parallel, heterogeneous and relatively autonomous subsystems (Van Hootegem, 2000). Both basic forms can be found within and between numerous organisations. Evidently, also hybrid forms can be identified (Buelens, 1992; Dawson, 1996; Hatch, 1997; Van Hootegem *et al.,* 2008).

With regard to the control structure, again two basic alternatives are possible (Van Hootegem, 2000; Daft, 2001). (1) The coordination function can be separated from the productive, preparative and support functions. The coordination capacity is then situated at a management level, away from the operational work, resulting in a centralised control structure. (2) If, on the contrary, the coordination function is integrated in the production structure, a decentralised control structure is created. According to Van Hootegem (Van Hootegem, 2000), separating the coordination function from the executing functions could also be regarded as a form of functional concentration.

3.2 Impact of Organisational Structures on Business Process Performance

Environmental demands are key factors for assessing the effectiveness of organisational structures, because they influence the amount of coordination needed to make the business processes perform well (Daft, 2001). In order to understand the relation between organisational structures and business process performance a "systems approach" of organisations is applied (Daft, 2001). Luhmann (1984) describes a social system as any entity selecting certain possibilities available in its environment, thus becoming less complex and more stable than the environment.

The Modern Socio-Technical Systems (MSTS) approach offers a social systems based framework for the analysis and design of organisations (van Eijnatten, 1993; de Sitter, 2000; van Amelsvoort, 2000). MSTS argues that the organisational structure creates the necessary and boundary conditions to meet the environmental demands. Based on Ashby's law of requisite variety (Ashby, 1957), MSTS states that the variety of control mechanisms must be greater than or equal to the variety of interferences. In other words, the coordinating capacity of an organisational unit should be in proportion to its coordinating needs. A function-based task division can be very effective in dealing with efficiency and quality demands, because internal efficiency of every business process step can be maximised. When business processes are running stable and routine, the coordination needs in the production structure are usually limited, because the routine tasks can be standardised and allow central coordination (Daft, 2001). However, when the environment becomes more dynamic, and flexibility and innovation gain importance, the business processes should be able to react swiftly to environmental changes. The needs for coordination increase. A function-based organisational structure is likely to cause trouble in meeting these needs: on the one hand, each unit only controls a very small step in the entire business process; on the other hand, every unit has to deal with many business processes, and their connected demands. Business processes that are organised in a more process-oriented way run parallel with each other, and cause less interference. In that way, coordination needs could become manageable again. Besides, a process-based structure could also increase the coordinating capacity, because the entire process could run in a more integrated way. Coordination problems could be minimised, by no longer dividing the work in as many subtasks as possible, but instead, in logically connected streams (Van Hootegem *et al.,* 2008). Taken together, the environment is by definition highly relevant for business process performance, because the changing external demands determine what defines the effectiveness of existing organisational structures.

4. SDI's and Organisational Structures

Concerning SDI, there is undeniably an increasing stream of studies that address the organisational sides to SDI (Masser, 2006; Koerten, 2008; Craglia *et al.,* 2009). When considering factors which influence organisational performance, topics like strategy, leadership and technology get significant scholarly and managerial attention. Most publications stress the importance of (organisational) culture and (individual and organisational) behaviour (Coleman *et al.,* 2000; Nedovic-Budic *et al.,* 2001; Wehn de Montalvo, 2003; Craig, 2005; Masser, 2005; de Man, 2007; Omran *et al.,* 2007; Koerten, 2008; Nedovic-Budic *et al.,* 2008; Van Loenen *et al.,* 2008).

However, several references to business processes and organisational structures can be found in the assorted SDI writings, especially in the context of inter-organisational interoperability (Nedovic-Budic & Pinto, 2001). Rajabifard (2003) studied the engagement of states in a regional SDI initiative, and dealt with the possible utility of his approach to analyse the participation of organisations in actual spatial data sharing. Nedovic-Budic *et al.* (2004b) examined the structural characteristics of interaction mechanisms between organisations, concluding that spatial data sharing efforts involve redefinition of existing tasks and structures, and the establishment of new ones. McDougall *et al.* (2007) analysed the characteristics of spatial data sharing partnerships between state and local governments in Australia. Harvey and Tulloch (2006) stated that SDI development requires stronger connections between SDI policy and other government policies and activities. They recommended that data sharing should be part of the business processes at all levels of government. Finally, some studies actually focussed on the business processes of individual organisations (Nedovic-Budic *et al.,* 2004b; Pornon 2004; Bekkers and Moody, 2006; Akinyemi, 2007; Omran and Van Etten, 2007; Vonk *et al.,* 2007). In short, even if several references to business processes and organisational structures are to be found in the assorted SDI writings, a systematic account of how different structures relate to business process performance, and how spatial information flows are to fit in these, appears lacking. Although SDI literature seems to recognise the relevance of organisational structures, the fundamental characteristic of organisational structures, which is functional concentration, appears to be overlooked.

SDIs are to be considered as intentionally-crafted conditions for those business processes that make use of or produce spatial data and information. Therefore an understanding of SDIs would be incomplete unless attention is paid to (1) their connection to business processes and (2) their position within the broader set of conditions for these business processes. As regards (2), it has been argued here that the choice of organisation structure defines the setting in which SDIs become effective. What the SDI should or should not do and what it can and cannot do is heavily influenced by these organisation structures. A distinction can be made between the organisation structures that refer to task division and coordination of whole organisations within a business process network, and those that specify task division and coordination inside the organisations that form the network together with others. The first will be labelled as 'inter-organisational structures', whereas the latter are identified here as 'intra-organisational structures'. Both classes of organisation structure and their relevance to spatially-enabled business processes will now be discussed in some detail and illustrated with examples from SDI-cases in the region of Flanders (Belgium).

4.1 Inter-Organisational Structures

Many of the business processes in which spatial information is involved cross the boundaries of a single organisation (McDougall *et al.,* 2007; Bekkers *et al.,* 2006). These "value chains" (Huws *et al.,* 2006) imply an inter-organisational task division, which can be achieved by function - by bundling similar functions (like IT) in a separate organisation - or by process - by keeping the business process together within a single organisation. This task division results in an inter-organisational production structure, referring to the allocation of different steps in the business process to different organisations. For example, the registration and processing of traffic accidents may involve a whole chain of organisations, from the local police department over the national statistics agency to the ministry of mobility (Federaal Wetenschapsbeleid, 2004), while the entire business process of assigning street names and house numbers for a specific area could be the full responsibility of only one local community (AGIV, 2007). Functional concentration is then about the level of functional specialisation of an organisation.

As for the control structure, the transaction between two organisations could be mediated by the market, or by some form of governance. The waterway management in the region of Flanders (Belgium) is, for example, fragmented across many organisations at different administrative levels, each of which is responsible for one type of waterway within a certain administrative boundary. Waterway management processes, however, are essentially based on the natural structure of the water system basins. Hence, a large, parallel, inter-organisational consultation structure was created to coordinate the efforts of the various organisations (CIW, 2007).

Also when developing SDI initiatives, choices are made regarding the inter-organisational task division. One option is to centralise the main SDI-functions (like data harmonisation, or reference database management) in a large central agency for spatial information. This may offer good opportunities for knowledge management and standardisation strategies, but may involve a serious coordination challenge regarding the real needs and aspirations of the numerous organisations which are affected by the SDI policy of the agency. A more decentralised option would be to integrate SDI functions in the existing operational processes of the different organisations involved. While this option could provide more chance to avoid a central agency from setting targets and developing strategies with which the stakeholders could not identify, the risk of loosing a coordinated approach between the different processes could evidently be large.

Not only the production functions, but also preparation and support functions can be allocated across multiple organisations. An SDI agency could put out certain SDI functions to subcontractors. Again, the option has merits and demerits. By contracting out certain tasks, external expertise can be drawn on. But coordination with the subcontractor could also require much work and attention. Take for example the actualisation of a large scale base map (AGIV, 2001). This job could be done by a central mapping agency, whether or not by contracting out certain subtasks, as photogrammetry or land survey. But the actualisation responsibility could also be integrated in the business processes of, for example, the local governments, or other organisations involved.

The need for inter-organisational interoperability (Nedovic-Budic *et al.,* 2001) is often mentioned in SDI literature. But, as the next section will describe, also the choices regarding the intra-organisational task division are bound to be highly relevant to spatial data handling business processes.

4.2 Intra-Organisational Structures

The intra-organisational structure is again the result of the way in which the production, the preparation and the support functions are divided into separate tasks, of how these tasks are allocated across organisational divisions, and of the level of separation between the control and the executing functions. A provincial administration in Belgium (Reynaert *et al.,* 2007) could have a function-based production structure, with separate departments for spatial planning, environment, nature, cultural heritage, housing etc. In contrast, another province may have chosen for a more process-based approach, by creating multifunctional departments, which each are responsible for an integrated policy towards a specific area, such as rural communities or urban districts.

The positioning of the preparation and support functions vis-à-vis the production function is the next issue that has to be dealt with (de Sitter, 2000). While one municipality could centralise most of the spatial data related functions in a large GIS department, another may strive towards a far-reaching integration of GIS functions (like database updating) into the business processes of the various departments (Swerts, 2003).

The last issue is about the internal control and coordination structure. An SDI support centre, such as the Agency for Geographic Information in Flanders (Belgium) (AGIV, 2006), could be made up of function-based departments (such as Information Technology & Databases, Planning & Operations, Human Resources & Support, Project Implementation) of which each is further divided into specialised sections. Most business processes will then have to pass through many sections and departments. The more business processes are divided across departments and specialisms, the more coordination and consultation is likely to be needed (Van Hootegem *et al.,* 2008). When every department or section is in charge of only one single step of various business processes, some form of central coordination will be necessary to synchronise between the different steps. Most of the organisations applying a far reaching function-based task division have a hierarchical control structure with a large number of managers and staff positions (de Sitter, 2000). But if an SDI support centre would instead have a more process-based production structure, with multi-skilled and cross-functional teams, each responsible for a specific product (like reference datasets, orthophoto imagery, digital terrain models, provision of external services), the need for a centralised coordination could be reduced, because each team would have control over an entire business process.

5. Changing Performance Demands for Business Processes and SDI's

An organisation is a relatively open system, which interacts with its environment (van Eijnatten, 1993; Daft, 2001; Desmidt *et al.,* 2005). The environment can be described in terms of the external demands which are put on the business processes, like demands for efficiency or reliability. Bekkers (1998) calls these demands the domain of an organisation. The domain is defined by the claims of customers, suppliers, competitors and regulating bodies like governments. Business process performance depends on the extent to which these environmental demands can be met or controlled. Organisational structures may need to adapt themselves to a changed environment.

During the last decades, demands for flexibility, innovation and sustainability were added to the classical economic demands for efficiency and quality (Bolwijn *et al.,* 1991; Van Hootegem *et al.,* 2008), both in the private and in the public sector. Moreover, governments need to combine these new demands with specific requirements that are put on the public sector, like legal security, trust and transparency (Toonen, 2003). Due to this evolution, the environment has become more dynamic. Above that, technological developments, and the use and exchange of information, have become increasingly important in contemporary society (Castells *et al.,* 2002; Roche *et al.,* 2004). Daft (2001) states that an uncertain environment requires organisational departments to process more information to understand and respond to unexpected events. The growing number of SDI initiatives itself is an illustration of this evolution. Both in number and size, the streams of information are ever growing. Accurate and purposive dealing with these information streams increase again the demands for flexibility. Besides, the various SDI initiatives can create specific demands on organisations. INSPIRE, for instance, requires certain public authorities to comply with the directive. A variable and complex environment confronts the organisations with a high level of uncertainty (Pfeffer *et al.,* 1978). Organisations must cope with this uncertainty to be effective. Daft (2001) argues that the structure of an organisation is to a considerable extent dependent on the level of uncertainty in its environment.

In general, the environmental evolution can be characterised by (1) an increasing level of uncertainty, causing the environment to become more complex to handle (De Vries *et al.,* 2010), and (2) a rising level of dependence on external resources, leading to a growing network of interdependencies between organisations. As a result of this evolution, business processes are confronted with increasing demands for flexibility and innovation. They are becoming less predictable, routine and transparent. A large number of these business processes makes use of spatial data, in one way or the other (Longhorn *et al.,* 2008). In addition, the growing importance of spatial information itself raises the need for mutual alignment and cooperation, both between and within organisations (Campbell *et al.,* 1995; Omran *et al.,* 2007). Apparently, the integration of spatial information flows in the business processes goes hand in hand with increased flexibility demands.

Not only the private, but also the public sector prospered for a long time thanks to its far-reaching function-based task division, resulting in bureaucratic structures (Du Gay, 2000; Meier *et al.,* 2005). However, the environmental developments, described in the previous section, have brought this model up for discussion, both in the private (Hammer & Champy, 1993) and in the public sector (Osborne *et al.,* 1992). The call for a more process-based approach does not only receive attention from within the organisational sciences. Business process management has also become a central concept in recent managerial literature (for example: Becker *et al.,* 2003; Smith *et al.,* 2007). Moreover, policy documents increasingly refer to the need of a more process-based work organisation, for example of the International Labour Organisation (Ashton *et al.,* 2002). Rajabifard *et al.* (2002) already brought up some interesting thoughts about the transition from product-based to process-based approaches to SDI development.

6. Toward Empirical Research

Based on the above-mentioned theoretical considerations, a process-based task division, both at the intra- and inter-organisational level, may provide a better option to reach a high performing integration of spatial information flows in the business processes. Process-based means that task allocation and coordination is primarily based on keeping business processes together, rather than subdividing them into separate tasks, spread across different organisational units.

The testing of this hypothesis is part of the aim of a series of multidisciplinary case studies. This empirical research is performed in the context of the 'SPATIALIST'-project that was mentioned in the introduction (Crompvoets *et al.,* 2008). The research focuses on the development of spatially-enabled governments (Rajabifard, 2007). A case is defined as a business process between and within government organisations in the region of Flanders (Belgium), in which spatial information is accessed, used and exchanged. Four cases were selected: (1) spatial zoning planning, (2) flood planning, (3) address management and (4) traffic accidents registration. Since each case comprises many organisations, further selections were needed to keep the research feasible. Within each case, about 6 organisations were selected as embedded case (Yin, 2003). The selection of both the cases and the embedded cases was based on expected variations regarding the disciplinary key elements, including organisational structures. Data collection is done mainly by multiple in-depth interviews in each embedded case.

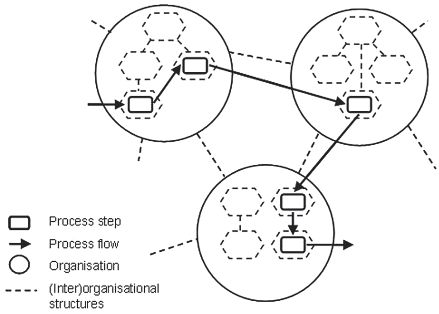

Figure 2. Schematic overview of a case

Figure 2 presents a schematic overview of such a case. Each of the three circles represents an organisation (i.e. an embedded case). The arrows indicate the flow of the business process, connecting the different business process steps. As can be seen from the Figure, the business process crosses organisational boundaries. The task division within the business process will be analysed both at the intra- and inter-organisational level. But it has been argued that a business process is embedded in broader organisational structures, which are expected to impact its performance. Therefore, the different intra- and inter-organisational structures concerned are also described and analysed. In Figure 2, the dashed lines represent the organisational structures.

The level of spatially enablement of the business process is measured by describing to what extent access, use and exchange of spatial information is an integrated part of the business process, and to which degree this contributes to overall business process performance. Comparative analysis should provide insight into the relation between organisational structures and the level of spatially enablement of the business process involved. Apart from the study of the impact of organisational structures, the SPATIALIST research team will also identify public management, legal, economical and technological aspects of the business processes (cases) and organisations (embedded cases), which might impact on the integration of spatial information flows. Moreover, these disciplinary approaches will be combined in a multidisciplinary analysis. The examination of different combinations of causally relevant elements should lead to the identification of distinct "recipes" for developing spatially-enabled business processes.

7. Conclusion

This chapter has argued that developing spatially-enabled business processes is a major institutional challenge in advancing spatially-enabled societies. A number of organisational issues relating to the integration of spatial information flows in the business processes have been considered. The chapter showed that the choice of organisational structures of business processes is bound to have a fundamental impact on the performance of these business processes. Based on theoretical considerations, a process-based task division, both at the intra- and inter-organisational level, is likely to improve the development of spatially-enabled business processes.

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Chapter 4

Spatially Enabling 'Place' Information

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Abstract

Many attempts to embed the concept of 'place' into current location-based technologies and spatial data infrastructures have failed spectacularly. Resolving places to single georeferenced points has been identified as a major factor. The prevailing hypothesis is that more complex georeferenced descriptions of places will resolve the problem. This chapter refutes this hypothesis. It challenges it from five perspectives including issues related to: determining positional accuracy, defining vague and dynamic places, administering natural places with uncertain boundaries, supporting vanity and vernacular places, and representing the salience of places. These five perspectives demonstrate that while more complex modeling of place is necessary, it is only part of the solution. Successful spatial enablement of place will require other essential issues to be addressed including: combining absolute, relative, and visual accuracy definitions of place, using emerging sources of data (e.g. crowd-sourced) to develop dynamic descriptions of places, determining how to capture 'places' from remotely sensed data, incorporating vanity and vernacular places into spatial data infrastructures, and embedding measures of the salience of place into spatial data infrastructures. These findings are synthesized into a future research agenda in spatial data infrastructures, or spatial information science in general.

Keywords: Place, Spatial Enablement

1. Introduction

The drive to simplify and personalize human to computer interactions, such as those experienced in location-based services, has focused attention on the concept of place. People communicate about space by referring to places. They want to go to places, to meet at places and to find services around places. Places are familiar, often with complex cultural meanings, and do not always map comfortably into technical frameworks of geographic information underpinned by coordinates, polygons, or even address strings. Inadequate modeling in

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computers can lead to spectacular failures of human-computer interaction resulting in consumer frustration with web mapping tools and car navigation systems, to more serious life threatening scenarios for emergency call centers. For example, in a current commercial web mapping service, local search requests often fail to interpret the person's intentions when place information is provided. The request Carlton and surrounding suburbs fails to identify the surrounding suburbs, the cafe opposite the city hall is instead resolved to the cafe near city hall, and certainly more complex requests such as half an hour from the car park at the reserve's entrance will fail.

One of the major impediments hindering the modeling of place is the lack of spatial semantics: places tend to be georeferenced and understood in databases as points, in the sense of 'points of interest'. Examples are current gazetteers (geographic names databases) and corresponding mapping services such as Google Maps that return a point on a place request (Winter and Truelove, accepted). This immature modeling technique often means spatial relationships cannot be resolved: topological, directional, or distance queries often return nonsensical results. For example the teahouse in the Botanical Gardens cannot be found if both the teahouse and the Botanical Garden are georeferenced by a point, and the café in the CBD cannot be distinguished from the café near the CBD. The prevailing hypothesis has been that enabling place datasets to access and store the spatial extent of places will resolve the problem. For example, the teahouse in the Botanical Gardens can be identified by spatial analysis of the polygon describing the Botanical Gardens, and the sets of polygons or points describing the teahouses in the area.

This chapter aims to refute this hypothesis and identify additional future research directions that will better allow for the spatial enablement of place information. First, a background to the concept of place and previous attempts at embedding place into spatial technologies is provided. This leads to a discussion of the hypothesis that enabling place datasets to access and store the spatial extent of places will resolve the human-computer communication problems about place. The hypothesis is then refuted by challenging it from five different perspectives: issues relating to determining positional accuracy, defining vague and dynamic places, administering natural places with uncertain boundaries, supporting vanity and vernacular places, and representing the salience of places guide the discussion. Key findings are then synthesized into future directions of research for further approaching the problem of spatially enabling 'place' information. At the end, the chapter will have identified essential issues for a further research agenda in spatial data infrastructures, or spatial information science in general.

2. Background

2.1 Defining 'Place'

Talking about place is an issue arising in human-computer interaction rather than computer-computer interaction. Place is a cognitive conceptualization of the geographic environment, based on bodily experience (Lakoff and Johnson, 1999), and hard to formalize (Tuan, 1977; Cresswell, 2004; Bennett and Agarwal, 2007). References to places are explications of these cognitive concepts in language. For Aristotle places belong to bodies (Aristotle, 350BC), hence we may conclude places always have a spatial extent of more than one dimension. Aristotle also claims that places are always of finite extent. However, even if places are bounded entities this does not automatically imply crisply bounded entities (Burrough and Frank, 1996). Moreover, there exists ontological distinctions between bona fide (physical) and fiat (agreed) boundaries (Smith, 1995). Additionally, Aristotle considered a body to have a proper place, defined by its spatial embedding, but also, at the same time, to be at an infinite number of other places. The teahouse, for example, is not only at a particular location (its proper place) in the Botanical Gardens, but also in Melbourne and next to a lake. Relevance theory studies which of these places is selected in the context of a particular communication (Wilson and Sperber, 2004; Tomko and Winter, 2006; Raper, 2007).

Placenames are labels that identify individual places, and place descriptions identify individual places by the relationships they have with other places. Not every place must have a placename to be identified. For example, the place where I have parked my car has no individual placename. A placename can be seen as a trivial place description, with no further relationship other than with the place itself. For example, the placename Federation Square is one such trivial place description, a more complex place description being the square between the film museum and the national gallery.

2.2 Approaches and Contributions to Model and Manage 'Place'

People communicate with ease about place. Since every citizen in Melbourne knows Federation Square, an expression, 'Let's meet at Federation Square' will work for both communication partners despite the inherent vagueness (where exactly at Federation Square?) and ambiguity (which Federation Square?). Schelling developed the theory of focal points to explain how people meet with such vague and ambiguous arrangements (Schelling, 1960). A computer, however, has difficulties understanding place descriptions. Gazetteers typically associate a placename with a coordinate tuple (Hill, 2006), mapping a place(name) to a point (a location), although a place must have spatial extent. Google Maps, for example, when asked for Federation Square, shows a point. But when asked for the square between ACMI (the film museum) and NGV (the national gallery), Google Maps returns (in March 2010) eight links of varying relevance, each of them a point on the returned map (the second one in the list is a link to Federation Square).

Geographic databases describe features and their spatial extent in a vector representation. Features can be described in a two-dimensional space as points, polylines, or polygons (Portele, 2007), depending on the granularity of their abstraction. Only polygons capture the spatial extent of the represented objects, but even polygons vary in their level of detail, accuracy, and other parameters.

The spatial relationships in place descriptions are typically qualitative, and fall into a small number of categories: topological relations (such as 'inside' or 'surrounding'), directional relations (egocentric, e.g., 'in front of', or allocentric, e.g., 'North of'), and distance relations ('near'). People prefer such qualitative relationships in their language over quantitative relationships (Talmy, 1983; Landau and Jackendoff, 1993; Couclelis, 1996; Levinson, 2003; Van der Zee and Slack, 2003).

Qualitative spatial relationships are a well-researched area in spatial information science (Cohn and Hazarika, 2001), and tools exist to represent and reason over qualitative relationships. Topological relations can be represented in point set topology (Egenhofer and Franzosa, 1991) or in a logical calculus (Randell *et al.,* 1992), qualitative directional relations can be formalized, e.g., in the double cross calculus (Freksa, 1992), and qualitative distance relations can be formalized (Frank, 1992; Hernàndez *et al.,* 1995). Representations and reasoning vary with the dimensionality of the features linked by the relations.

This means, if places (of objects) were represented by polygons these representations and reasoning could be applied, resolving much of the challenge in interpreting place descriptions such as the tea house in the Botanic Garden, in Carlton and surrounding suburbs, or the square between the film museum and the national gallery. To enable this kind of interpretation is what we mean by 'spatially enabled place information'. Establishing the link between places and polygons, however, is neither yet realized in most infrastructures, nor that straightforward.

In the following sections we present some of the challenges beyond this level of spatial enablement, requesting more spatial intelligence than just the description of a place by a polygon, and outline additional pathways towards a spatially enabled discussion about place. These suggestions must remain partial, however, because communication about place is a hard problem for computers, as we have introduced earlier (Winter and Wu, 2009).

3. Approach

3.1 Issues with the Positioning Accuracy of 'Place'

As discussed in the previous sections, placenames attached to real world objects are typically georeferenced to the coordinates of a point. In reality, however, these objects are at least areal in their extents (e.g., Federation Square), and taking a point as a representation neglects the spatial meaning and introduces potential interpretation conflicts. For example, while a GIS is able to locate a placename, it is not able to identify a placename for any location.

Identifying a placename for a point—i.e., solving the classical point-in-polygon problem—is heavily dependent on the accuracy of the point coordinates used. Fundamentally, the accurate identification of a place is directly correlated with the positioning accuracy of the points used, that is, an inaccurate position may incorrectly identify a particular place. The research challenge is therefore to ensure that the points used to represent real world features described by polygons are placed correctly within the polygon or are defined with a known error bound.

The accuracy of a position is traditionally defined as how closely the coordinates (of a point as determined by some measurement process) relates to its true position on the surface of the Earth. The further away the measured position is from the true position, the lower the accuracy and vice versa. For the diversity of location-based services being developed today, there are a wide array of positioning technologies available to determine real-time positions of mobile users: GSM-based positioning, radio frequency identification (RFID), ultra wideband (UWB), ultrasound, Wi-Fi, traditional network surveying, and inertial and satellite-based positioning. The inherent strengths and weaknesses of these technologies means that the achievable positioning accuracy varies greatly (Table 1).

Positioning Method		Observations	Accuracy
GNSS	GPS	y, x, z	± 6 – 10 m
	DGPS		± 1 – 4 m
Cellular Phone Positioning (GSM)	Cell ID	y, x	± 150 m – 35 km
	Solo Matrix		± 50 – 100 m
WLAN Positioning	IMST ipos	y, x, z	± 1 – 3 m
UWB Positioning (TDoA)		y, x, z	± 0.2 – 1 m
RFID Positioning (active landmarks)		y, x, z	± 6 m
Bluetooth (active landmarks)		y, x, z	± 10 m

Table 1. Positioning technologies with their corresponding observables and accuracies (IMST, 2003; Duffett-Smith and Craig, 2004; Kong *et al.,* 2004; Chon *et al.,* 2005)

Much research is already underway to improve the positioning accuracy of these technologies, and various integration and filtering architectures have demonstrated some success in this regard. What remains a challenge, however, is that it is still possible for the derived coordinates of a point to be statistically outside the polygon that it intends to represent. To address this issue, two additional positioning accuracy definitions need to be considered: visual accuracy and relative accuracy. Visual accuracy refers to the correction of a measured coordinate to its logical position; for example, a car navigation system will always locate the driver to a position on a road, based on the logic that this is where a car should be. Relative accuracy is defined as how closely a measured coordinate relates to other nearby points, for example, comparing distances between features on a map and the distance measured between the corresponding objects on the surface of the Earth.

It is proposed here that an approach that integrates these three definitions of accuracy is required. This will provide a robust infrastructure that constrains the point coordinates used to georeference an object, i.e., describe its place. Similar to map matching algorithms, the first processing phase will compute a position solution using measured or derived data from individual combinations of technologies. The second phase will introduce synthetic measurements based on known relationships between features, and the final phase will integrate logical constraints based on the user's context. The outcome will be a visually correct position with parameters describing its absolute, relative and visual accuracy.

3.2 Defining Vague and Dynamic Places

Many of the terms and spatial relations commonly used to refer to places are vague. Although the term vague is often used in vernacular loosely, vagueness has (somewhat antithetically) a very precise meaning in the philosophical literature. Vagueness concerns terms or concepts that have no precisely defined boundary (Keefe and Smith, 1996). For example, consider place descriptions like downtown or near the clock tower. There will typically exist locations that are definitely at that place (e.g., right under the clock tower, or in the main city center shopping mall); locations that are definitely not at the place (e.g., out of sight of the clock tower, or in a rural field far from urbanization); and crucially many locations for which it is indeterminate whether or not they are at that place.

The vagueness inherent in many place descriptions raises two important problems: representing and reasoning about places. Most spatial information systems use data structures (like polygons and lines) that enforce crisp boundaries of features: locations are either in or out of the polygon, or left or right of a directed line. Using three-valued logics can help to relax this crispness somewhat. In a three-valued logic, statements can be true, false, or indeterminate. In the context of vague place descriptions, this gives rise to regions with indeterminate boundaries (Cohn and Gotts, 1996). One well-known example of such a model is the egg-yolk calculus (where the yolk of the egg contains locations that are definitely in the region; the white of the egg represents the indeterminate boundary; and locations outside the egg are outside the region). Such a model can be relatively easily implemented using conventional spatial data structures. However, while such approaches are a useful step reducing the commitment to a crisp in/out dichotomy, they still require a commitment to a crisp in/indeterminate and indeterminate/out trichotomy. This issue is an example of a well-studied, but so far insoluble problem known as higher order vagueness. Switching to more discerning formal models, like 4- or n-valued logics, or even to degree theories, like fuzzy set theory, refines the representation but cannot overcome the problems of higher order vagueness.

The problems of representing vagueness are further exacerbated when we come to reason about vague places. The problems of reasoning about vague concepts have been cogitated on since ancient Greek times (e.g., the sorites paradox, Fisher, 2000). As an illustration of the types of reasoning problems that occur, Duckham and Worboys (2001) investigated whether different places on a university campus were judged to be near one another. Properties like symmetry do not hold in such vague place descriptions (e.g., if place A is near place B, it does not necessarily follow that place B is near place A).

While many theoretical challenges remain, advances have been made. A variety of innovative and ingenious systems for representing and reasoning about vague places have, and continue to be proposed (e.g., Bennett, 2001; Galton and Hood, 2005). Up to now, a major barrier in realizing such systems is a lack of available data about human understanding of places. But, recent growth in geotagging, crowd-sourcing, and volunteer geographic information offers the potential for a rich source of data about human understanding of places (e.g., Grothe and Schaab, 2009; Schlieder and Matyas, 2009). To take advantage of these new data sources, we require new practical techniques for fusing diverse, natural language descriptions of places. In this context, polygon descriptions of places appear anachronistic: emerging techniques will provide for far richer depictions of vague and dynamic places (Davies *et al.,* 2009).

3.3 Administering Natural and Uncertain 'Places' Boundaries

Natural places are common in language but they lack the clearly defined boundaries of the human built environments. This lack of boundary clarity is not a problem with the spatial database; it is an inherent quality of these spaces (Burrough, 1996). If a tourist talking of their visit to Melbourne were to mention the beautiful mountain forest on the eastern boundary, a Melbourne resident would know the place that was meant even though no exact location has been mentioned. However, if they were speaking to another tourist who did not know Melbourne, that tourist would search in vain for this place on maps. The forest in question is partly national park, partly state forest park and partly on private land. It has many geographic names associated with it, there is no precise definition of its boundary and yet it is all the same forest, which can have only one proper place.

What is true of forests is true of many natural places, for example, where exactly is the boundary of a mountain range (Smith and Mark, 2003)? There is also an inherent uncertainty in the terminology used for such places. When exactly does a treed plain become an open forest? While there are technical definitions for such things, these do not always correspond with common usage that is often variable and inconsistent (cf. Bennett *et al.,* 2010). Any polygons used to reference such places would thus have a somewhat arbitrary character and would impose an artificial, and false, definition to the boundary.

This is especially true if we consider the means used to define these polygons. One common approach is land use mapping via remote sensing techniques. The problems of land use definition and mixel classification have been well documented (cf. Anderson *et al.,* 1976; Townshend *et al.,* 1987; Chen and Stow, 2003). These problems are even greater when we consider the concept of place. There are two major and related problems here: the scale of the imagery, which constrains the definitions of objects and their place.

The picnic table at which I eat my lunch is an object with a proper place, but it is within the clearing that is the picnic ground, which is also a place, and this is within the forest, another place. In remote sensing spatial scale is determined by the pixel size and the image coverage (Jensen, 2007). It is fixed in a way that place references are not. Is the picnic ground clearing a part of the forest? Can the picnic table be seen to exist? The answer to these questions depends on the image data used and will be inflexible within that data set.

The greater problem is one of definition. Remote sensing tools classify the Earth's surface by grouping pixels of similar spectral character (Drury, 1987). This may relate well to the perceived character of a place, for example forest/not forest. However, there are many natural features that do not have a clear spectral marker, for example a mountain range or a hill. The advanced analysis approaches used in hyperspectral imagery, such as End Member Analysis (cf. Plaza *et al.,* 2004) actually make this problem worse since they focus on the distribution of specific features rather than on the amalgamation of these features to form a place.

These are difficult problems that need a great deal of further investigation into how people perceive and define natural places. Imposing a series of arbitrary polygons is not going to form an adequate solution since it respects neither the innate properties of the places themselves, nor the way in which people conceive and talk about them.

3.4 Dealing With Vanity and Vernacular 'Places'

Places and placenames often have a perceived (market) value. This leads to vanity addressing by individuals and industry, particularly those involved in markets dealing with place. Vanity addressing is the process whereby a person deliberately distorts an address in order to improve the value of a particular property, business, or other activity. For example, in the Australian context it is common for real estate agents to link an advertised property to the most attractive surrounding suburb, rather than to the official postcode. Shop traders also regularly list themselves in more attractive places than their actual postcode might suggest.

Whilst governments and other administrators of 'places' do not condone this behavior, it is certainly not illegal in Australian jurisdictions. Addresses emerged from the bottom up and in many ways still maintain a social or cultural quality. Despite the best efforts of state governments to develop address registries and placename gazetteers (cf. ANZLIC, 2009), the issue still persists.

Cardinal directions in names provide another complication. These are often incorporated into Australian suburb names in correspondence to the direction of the originating suburb. Sometimes these places have a defined postcode, other times they do not. Examples include Fitzroy North, South Melbourne, Brunswick Lower, or East Coburg. Vernacular permutations often emerge and gain widespread use within a community. For example, Fitzroy North is commonly referred to as North Fitzroy by Melbournians. These simple variations have minimal impact on person-to-person interactions; however, their result on person-to-computer interactions can be profound. Online web mapping systems such as Google Maps become unreliable or utterly fail when vernacular places are used in the person-computer dialogue (Winter and Truelove, accepted).

A key issue then is how to deal with vanity and vernacular places in spatial data infrastructures and location-based services, particularly those used by governments to administer societal activities and provide government services. For example, if a vanity address has gained social credence, the dispatch of emergency services or provision of directions can be greatly impeded. Four strategies are available to administrators: do nothing, regulate, educate, or incorporate. Of these, the final three warrant some discussion.

Some jurisdictions, such as those in Europe or South Korea, use regulations to successfully create authoritative approaches to addressing. However, this method requires community agreement and tends to ignore the social aspects of addressing that are prevalent in other jurisdictions. Another approach is to incorporate educational processes into systems. This approach is already gaining traction in online location search tools where 'Did you mean…' server responses are provided to users. Incorporation takes the educational strategy further: not only does the search tool list several alternative matches, it is smart enough to work out which of those addresses the user was actually searching for. This process is underpinned by the Semantic Web concept (Berners-Lee *et al.,* 2001) and will rely on tools such as the Web Ontology Language (OWL). The concept is gaining traction, however, it is still a very much in the developmental phase. A preliminary example can be found in the multi-criteria route-planning systems developed by Niaraki and Kim (2009).

At any rate, dealing with vanity and vernacular places is a difficult problem. Directed research is required into how and when people use such descriptions, and how the phenomena can be embedded into spatial technologies. Any suggestion that modeling places with polygons resolves vanity and vernacular place naming issues is ill conceived. Such a solution only recognizes the spatial aspects of the problem, not the social and cultural aspects.

3.5 Adding Salience to 'Places'

Although linking placenames with polygons can generate more intelligent spatial representations, such representations still fall short compared to cognitive representations. Cognitive representations are known to be distorted (Stevens and Coupe, 1978), hierarchic (Hirtle and Jonides, 1985), and led by anchor points (Sadalla *et al.,* 1980; Couclelis *et al.,* 1987). Sadalla *et al.* (1980) relate these anchor points directly to landmarks (Lynch, 1960; Presson and Montello, 1988). The very existence of landmarks means that features of the same type are not equally important; some—the landmarks—are cognitively more salient. Correspondingly, in expressions about places some placenames—the more salient ones—are used to 'anchor' a given place.

The documented cases of referring expressions about place take the asymmetry from spatial (part-of) hierarchies, which typically lead to zooming-in or zooming-out expressions (Shanon, 1979; Paraboni *et al.,* 2007). For example, in Federation Square, Melbourne the referent (Federation Square) is anchored by another more prominent placename (Melbourne) in a clear order by their part-of relationship, and since several Federation Squares may exist in the world, specifying the one in Melbourne resolves potential ambiguities. A second case of asymmetry is imposed by cognitive salience, between objects without an order relation by type. For example, in the building next to the library, the referent—an unnamed building—is anchored by a more prominent and named building, the library.

The first asymmetry is completely explained by the spatial extent of places. Federation Square is a proper part within Melbourne, and hence, also smaller than Melbourne. The latter kind of asymmetry, based on cognitive salience, is not sufficiently explained by the spatial extent of places. The building next to the library is not necessarily smaller than the library. For a service to understand and generate place descriptions this asymmetry needs to be built into the service's intelligence.

So what makes geographic features cognitively more salient, such that their places are used for ordering cognitive spatial representations? Some preliminary work suggests visual, social and structural characteristics when combined can serve for a measure of salience (Sorrows and Hirtle, 1999; Raubal and Winter, 2002; Elias, 2003; Duckham *et al.,* 2010). We are expanding this list, claiming the following factors can have an impact on cognitive salience:

Perceptual factors including visual ('the blue building' or 'the large building'), aural ('the quiet place') and olfactory;
Individual experience ('the place where I met you for the first time') and individual preference ('a place where I can get good coffee');
Collective experience, including historical ('the place of first settlement'), cultural ('the sacred place') and functional factors ('the (place of the) library');
Structural factors in reference to the street network ('the place at the intersection').

Approached this way salience is a quantitative measure, that is, salience does not identify landmarks, but characterizes the 'landmarkness' of a feature or its place. One preliminary work has used quantitative measures to organize a hierarchy among neighboring features or their places (Winter *et al.,* 2008), reflecting the anchor points in cognitive spatial representations. In other preliminary work it has already been suggested to use such a measure of salience to generate (Tomko and Winter, 2009) or understand place descriptions (Wu and Winter, 2010).

What is completely missing, however, is a spatial data infrastructure that enables the provision of measures of salience. This infrastructure must provide for the data to determine the factors, and the analysis methods to process this data. The data is partially environmental, that is sensors in the environment can capture it, and partially social, that is it can be collected from individual behaviors. Challenges are in the type of analysis (e.g., the 'color of a facade') or in the sheer size of data required in addition to existing spatial data resources, a factor that is already discussed in (Duckham *et al.,* 2010).

4. Results and Discussion

The approach above highlights the inadequacy of the stated hypothesis: that polygonal georeferenced descriptions of places alone will resolve the problems of modeling and using 'place' in spatial data infrastructures and location-based technologies.

The above discussions reveal five exemplary areas where future research activities should be directed in order to deliver computer-based representations and reasoning methods for spatial data infrastructures and location-based technologies that adequately deal with the concept of place. Table 2 summarizes these directions as key themes, associated disciplines and the underlying research questions. Together, these research questions provide a research agenda for spatial data infrastructures, and spatial information science more generally.

Research Theme	Associated Disciplines	Research Questions
1. Issues with the positional accuracy of place	Geodesy	How do we combine absolute, visual and relative definitions of accuracy to provide for more robust descriptions of the spatial accuracy of 'places'?
2. Determining vague and dynamic places	Spatial Information Science, Spatial Data Infrastructures	How can we use emerging spatial data sources (e.g. crowd- sourced data) to automate the development and maintenance of more organic dynamic place descriptions?
3. Administering natural and uncertain place boundaries	Remote Sensing	How should we deal with issues of scale and definition when attempting to use imagery and remote sensing to articulate natural places with uncertain boundaries?
4. Dealing with vanity and vernacular places	Spatial Data Infrastructures	How do we best deal with the phenomena of vanity and vernacular places in relation to spatial data infrastructures? Should we ignore, educate, regulate, or incorporate?
5. Adding salience to place	Spatial Information Science, Spatial Data Infrastructures	What tools are required to enable measures of salience to be incorporated into spatial data infrastructures? How should we build these tools?

Table 2. Key elements of a research agenda for spatially enabling 'place' information

Clearly there are more issues associated with spatially enabling 'place'. These include other technical challenges such as designing the human-computer interface, including cartographic expressions of place and cartographic generalization of place information. Other, and broader issues associated with place require attention as well, such as philosophical, social, and governance issues.

5. Conclusion

This chapter opened by suggesting that many attempts to embed the concept of place into current location-based technologies and spatial data infrastructures have failed spectacularly. Resolving places to single georeferenced points was identified as a major factor. The prevailing hypothesis that more complex georeferenced descriptions of places—polygons—will resolve the problem was declared problematic. In response, this chapter refuted the hypothesis.

The hypothesis was challenged from five different perspectives including issues related to: determining positional accuracy, defining vague and dynamic places, modeling indigenous concepts of place, administering natural places with uncertain boundaries, supporting vanity and vernacular places, and representing the salience of places. These five perspectives demonstrated that while more complex modeling of place is necessary, it is only part of the solution.

The five perspectives revealed that successful spatial enablement of place will require other essential issues to be addressed including: combining absolute, relative, and visual accuracies of place; using emerging sources of data (e.g. crowd-sourced) to develop and maintain dynamic descriptions of places; determining how to capture natural 'places' from remotely sensed data; incorporating vanity and vernacular places into spatial data infrastructures; and embedding measures of the salience of place into spatial data infrastructures. These findings have led to the development of a future research agenda in spatial data infrastructures, or spatial information science in general. The challenge now remains to respond to this agenda.

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Chapter 5

Towards an Assessment Framework for Spatially Enabled Government

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Abstract

Government today confronts challenging and complex issues – the global financial crisis, terrorism, climate change, an aging population, deteriorating public infrastructure, natural resource depletion, and increasing demands for welfare support. Many of these issues require coordinated action across governments. In nearly every case government responses require knowledge of location – where are the people, infrastructure and resources affected by these issues and where should the response be targeted. Although government has benefited from the use of spatial technology for many years, this use has been for the most part fragmented and uncoordinated. Relatively recent developments in the fields of ICT, the internet and spatial data infrastructure (SDI), now offer the real prospect of cost-effective deployment of knowledge of location in business systems across the whole of government. This is called the spatial enablement of government (SEG), part of a broader and all encompassing phenomenon, the spatial enablement of society. One of the key requirements of SEG is a means of assessing whether investments in enablement are achieving expected outcomes. This chapter briefly reviews the state of global development on SEG and cases of SEG in Australia, North America and Europe; and then focuses on an assessment framework for SEG. The framework builds on assessment methods under development or in place for eGovernment, SDI and, public policy and program evaluation. The chapter concludes with some views on future directions for research on SEG assessment frameworks.

Keywords: spatially enabled government (SEG), spatial data infrastructure (SDI), assessment framework

1. Introduction

In simple terms the purpose of government is to ensure the well-being and betterment of society and the protection of the sovereignty of the state. From a government perspective this purpose is achieved through implementation of government policy. Government policies, be they social, economic, environmental or security, are typically developed and administered by government ministers and their departments, and are implemented through actions

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like the delivery of services, imposition of regulations and collection of revenue. During this process government interacts with stakeholders, principally its citizens, businesses and other governments. This overall process, that is the process of government, depends variously upon human, financial and technical resources and systems.

Most of the tasks involved in the process of government, that is, consultation, analysis, decision-making, communication, design, implementation and review, in relation to policy, services, regulation and revenue collection requires knowledge of the location of people, infrastructure and resources. Spatial technology has been used in parts of government for many years to help provide knowledge of location. Contemporary developments in technology, particularly information and communication technology (ICT) and spatial data infrastructure (SDI), now present government with the opportunity to integrate knowledge of location cost-effectively and seamlessly into business processes and systems across the whole of government. By taking this step government becomes spatially enabled. A growing number of governments around the world, at local, provincial and national level, are presently taking steps to become spatially enabled.

Spatial enablement of government (SEG) is part of larger phenomenon now impacting the world, the spatial enablement of societies.

A question presently being considered by those in involved in spatial enablement research and practice is, what are the requirements for, and indications of, spatial enablement and how might spatial enablement be assessed. In order to answer this question is helpful to first consider the global state of research and development on SEG, present cases of implementation of SEG, and to have conceptual view of SEG, particularly its purpose and its essential characteristics.

With this in mind this chapter discusses some of the research on SEG and the closely related field of SDI follows by implementations of SEG in Australia, the USA, Canada and Europe. It focuses on a conceptual framework of SEG, particularly as it relates to assessment and present approaches to assessment in some key areas of relevance to SEG. Finally, a possible assessment framework for SEG taking account of issues raised in previous sections is proposed.

2. Research on SEG

Rajabifard *et al.* (2003, 2006) and Masser (2009) describe the changes of SDI over time and their influence on SEG. The 1st generation of SDIs were explicitly national in scope and their titles referred to 'spatial data' and included the term 'infrastructure'. The 2nd generation of SDI's were characterised by a shift from product to process and a shift from data producers to data users who emphasised data sharing and reusing data collected by a wide range of agencies for a great diversity of purposes; by a shift from centralised structures to the decentralised and distributed networks that are a basic feature of the WWW; and, by a shift from SDI formulation to implementation and from single level to multi level participation. In this generation of SDI coordination models are more complex and inclusive models of governance have emerged. In the last few years there are signs of a 3rd generation of SDIs emerging. The balance of power has shifted from the national to the sub national level, the source of most large-scale land related data. There is also a shift from government led approaches to whole of industry models where the private sector operates on the same terms as its government partners. The concept of SEG that is emerging as a result of these SDI trends presents important challenges. The vast majority of the public today are users, either knowingly or unknowingly, of spatial information. As a result SDIs must develop in such a way that they provide an enabling platform that will serve the wider needs of society in a transparent manner.

Rajabifard *et al.* (2005) note that users now require precise spatial information in real-time about real-world objects and this requires governments and industry to work together to create such products and services. Although whole-of-government initiatives are underway to provide access to government data holdings, industry is not engaged in many of these initiatives The authors argue the need for the creation of an infrastructure or enabling platform linking government and private industry from which applications and services can be leveraged and value added, and providing the ability to grow the private sector and spatial information industry as a whole.

Wallace *et al.* (2006) consider the topic of SEG from the perspective of land administration. They argue that land administration systems can become important sources of spatial information for use by government if these systems are re-engineered accordingly; and the spatial enablement of information in these systems will permit more equitable administration of land and resources. They view the cadastre as the vital information layer of an integrated land management system, and suggest that in future it will underpin information systems of modern governments. They conclude that a whole of government approach is needed to ensure that the spatial enablement of interoperable networked systems goes beyond the existing core businesses of land administration system organisation.

Holland *et al.* (2009b) argue the importance of referencing and geocoding any elements involved in SEG and e-Government from both a national and regional perspective in particular the geocodes for address files. In many instances geocodes are derived from digital cadastral databases.

In Williamson *et al.* (2006) start to see a vision for SEG - establishing an enabling infrastructure to facilitate use of place or location to organise information about activities of people and businesses, and about government actions, decisions and polices. The authors suggest that the present infrastructure used to administer land needs to be integrated and operate in an Internet enabled e-Government environment. In this regime, information policy becomes crucial. SEG in this environment involves the whole of government. Williamson *et al.* (2007) go on to present the SEG research problem: that governments are not using transformational spatial technologies to improve business processes, thereby limiting their effectiveness, efficiency and international competitiveness; and, the SEG research aim, to develop an internationally applicable, whole of government path to use transformational spatial technologies, particularly land information, to manage national activities, provide services and deliver local, national and regional information.

Rajabifard (2007) introduces the idea of spatial enablement of society. The authors argue that the creation of economic wealth, social stability and environmental protection can be achieved through developing products and services that are based on spatial information collected by all levels of government. These objectives can be facilitated by developing a spatially enabled government and society where spatial information is regarded as a common good made available to citizens and businesses to encourage creativity and product development. To do so requires data to be accessible and accurate, well-maintained and sufficiently reliable for use by the majority of society who are not spatially aware. There needs to be a mechanism of assessment that uses a set of agreed indicators to measure the progress of its development and delivery of its services.

Another effort in assessing SEG which has been done recently is the work by Ezigbalike and Rajabifard (2009) where the authors have proposed two methods for selecting indicators and they tried to identify indicators for assessing spatially enabled government services. In particular, they addressed various challenges and issues associated in the new vision of SEG. They also discussed the importance, role and value of benchmarking government services and the level of their spatial enablement and proposed methods for selecting indicators for measuring and comparing different aspects.

It has been highlighted that, one of the key features of government services, and the associated choices in e-government is the location of the services centres, vis-à-vis the service takers, be they citizens, businesses or government agencies. This has led to the concept of SEG, which is now part of the objectives of countries in the Asia Pacific region, Europe and North America. The combination of strategies in the spatial enablement of government and mainstream e-government are now emerging trends in many parts of the world.

The discussion on spatially enabled government and society is continued in Rajabifard (2010) and Williamson *et al.* (2010).

3. Implementations of SEG

Australia

National level. Paull and Bower (2003) identify collaboration and innovation as important requirements for spatial enablement in at the national level in Australia. Location-based information relating to people, activities, and resources is critical to informed decision making within both private and public sectors. A readily available consistent seamless national geospatial framework for location-based information is essential. Collaboration by the national governments through PSMA Australia Limited has seen the development of seamless national framework datasets, including a geocoded national address file called G-NAF, and a supply chain infrastructure. These elements are crucial to SEG in Australia. In a political context SEG was discussed for the first time by national ministers at the Online and Communications Council in 2006 (OCC, 2006). Ministers noted that SEG used place or location to manage and integrate government services and enhance business opportunities. It required a mix of both research and implementation and a partnership between public and private sectors; re-use of existing spatial data; and, spatially enabled addresses. Ministers agreed to develop a national address management framework. Subsequently Ministers further agreed to develop a national government information sharing strategy. ANZLIC, Australia's spatial council, is presently looking at new and contemporary ways of creating the Australia New Zealand spatial infrastructure (ANZsi). The ANZsi is conceived to take the form of a spatial resource marketplace and would build on public and private capabilities and Web 2.0 methodologies. The Cooperative Research Centre for Spatial Information has recently received government funding to develop ANZsi (CRCSI, 2009).

State Government of Victoria: VSC (2008), Thomas *et al.* (2009) and Hedberg and Thomas (2010) present the concept of spatially enabled Victoria. Spatial enablement contributes to the expansion of consultative and participative government services such as e-government, policy and administration through cost reduction, public safety through more efficient emergency services, improved utilities infrastructure, better management of health services, and environmental sustainability. A strong institutional environment helps to build spatial capacity. A spatially enabled Victoria will be supported by land administration systems, and by the new uses and markets for spatial data created by technology convergence. The present state spatial information management framework is the foundation on which spatially enabled Victoria will be developed.

State Government of Western Australia: Fitzgerald (2008) describes the Western Australia Shared Land Information Platform (SLIP). SLIP is the infrastructure supporting SEG in the state. SLIP is a delivery system that provides efficient access to government spatial information and is based on an enabling framework of connected servers, delivering real time spatial data. SLIP aims to transform how government spatial information is used and shared. SLIP users have access to over 350 datasets from over 20 agencies (Armstrong, 2009). SLIP development is characterised by a strong public-private partnership.

State Government of New South Wales: The New South Wales government has implemented a number of SEG initiatives. These initiatives reflect international approaches and are being developed strategically within a unified architecture of location intelligence (Watkins and Harris, 2010).

Federal Government: Several SEG initiatives are being taken at federal government level. Of most interest is the Commonwealth spatial data initiative (CSDI). CSDI aims to support the government policy on social inclusion by facilitating the integration and sharing of authoritative spatially enabled social information. CSDI is being implemented by a lead department in partnership with other departments. A geospatial analytical capability is being deployed during the first stage of a CSDI pilot program. A focus for CSDI at present is building an evidence base of administrative data to strengthen government ability to deliver social policy through informed decision making, and on identifying and developing options for whole-of-government information sharing (DHS, 2009).

United States of America

A Presidential initiative on a Geospatial Line of Business (GLOB) commenced in 2004. This has led to the establishment of the National Geospatial Advisory Committee in 2008. This diverse committee is comprised of 28 experts from all levels of government, academia and the private sector, including a representative from the Office of Management and Budget (OMB), and reports to the Secretary of the Interior. The committee has developed a white paper to describe the changes and advancements the community has witnessed in the geospatial landscape over the past three-plus decades to set a context for its future deliberations NGAC (2009). The NGAC has urged the new Presidential Administration to make a strategic investment in geospatial programs and technologies to underpin and support the health, welfare, and safety of U.S. Citizens. A decision on this recommendation is pending. A view on a performance framework for the GLOB is shown in Figure 1 which illustrates the importance of information and governance in delivering capabilities to the society.

What is our VISION?	Serve the Nation's interests, and the core missions of Federal agencies and their partners, through the effective and efficient development, provision, and interoperability of geospatial data and services

What END OUTCOMES measure success?	**1. Data Reliability**	**2. Information Timeliness**	**3. Cost Effectiveness**	**4. Customer Utility**

What STRATEGIES will get us there?	A. Establish a governance mechanism that fosters collaboration across sectors	B. Coordinate planning & investment to maximize ROI	C. Optimize and standardize data and services

What INTERMEDIATE OUTCOMES indicate that strategies are working?	I. Increased agency use of data standards	II. Cost savings from shared data	III. Partners cooperate and comply with Federal requirements	IV. Active theme based communities with strong data stewards	V. Broader adoption of GIS Technology by Federal agencies

What TASKS will activate the strategies?	1. Enhance governance	2. Define data lifecycle	3. Establish lifecycle responsibilities	4. Utilize SmartBUY	5. Develop outreach programs
	6. Adopt grants language	7. Adopt procurement language	8. Reach common services agreements	9. Define IT infrastructure	10. Provide broker services

Figure 1. Draft GLOB performance framework (GLOB, 2008)

Canada

Canada is well advanced in its spatial enablement initiatives. It has a well developed SDI, the Canadian Geospatial Data Infrastructure (CGDI), a funded and comprehensive SDI partnership program, and a strong and inclusive SDI governance framework over-sighted by the Inter-Agency Committee on Geomatics (McLaren *et al.,* 2006).

European Union

A European Union Directive lays down a general framework for a SDI for Europe (INSPIRE). INSPIRE aims to improve the interoperability of, and access to, spatial information across the European Union at a local, regional, national and international level, facilitate improvements in the sharing of spatial information between public authorities and provide improved public access to spatial information. INSPIRE builds upon the infrastructures established and operated within countries (European Commission, 2007). INSPIRE is probably the most significant multi-country SDI implementation in the world at present and is an important case study on SEG is a case to see how it would help to facilitate and realize SEG in Europe.

4. A Conceptual View of Spatially Enabled Government

It is necessary to have a conceptual view on SEG, particularly its purpose and its elements, before considering approaches to assessment. A conceptual view of SEG is discussed in Holland *et al.* (2009a). This discussion suggests that SEG involves the interaction of organisations (government departments and agencies), technology (technical systems, particularly spatial data infrastructure) and people (citizens, businesses and academia). These entities are shown in Figure 2. SEG can be conceptually framed in the following way:

- The vision or purpose of SEG
- Its drivers, benefits and business case;
- Definitions, principles and objectives of SEG;
- Its characteristics and elements;
- Its theoretical bases and research needs;
- SEG implementation requirements; and, finally
- SEG assessment methods.

A vision for SEG might be **government actions informed by knowledge of location.** The USA Presidential vision that accompanied the establishment of a GLOB, that is, the nation's interests are served through the effective and efficient development, provision, and interoperability of geospatial data and services, is consistent with this more concise phrase. The purpose of SEG might be to facilitate better outcomes by government. These outcomes are both external to government, that is, more effective policy, service delivery, regulation and revenue collection; and, internal to government, that is, more efficient and effective people and systems.

The interacting elements of SEG include:

- Citizens and businesses communicating with government, affected by government policy and regulation, utilising government services, and providing government revenue;

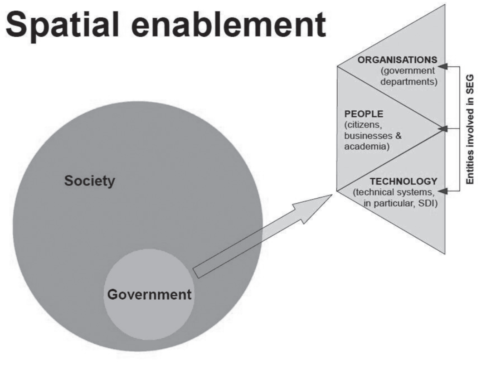

Figure 2. Entities involved in spatially enabled government

- Government ministers and departmental employees developing, implementing and reviewing policy, process and structure;
- Government departments and their operating policies, accountability and governance arrangements (including cross-departmental, and inter-governmental operating policies, accountability and governance arrangements);
- Government technology and systems (particularly ICT and spatial information and technology operating within and between departments, and between governments; and, common business systems operating across departments and between governments);
- National and international ICT, internet and SDI technical infrastructures; and, private sector product and service providers; and
- National and international institutions (for example, national coordinating bodies, academic and research institutions, and, standards and professional bodies).

These complex interactions are shown in Figure 3.

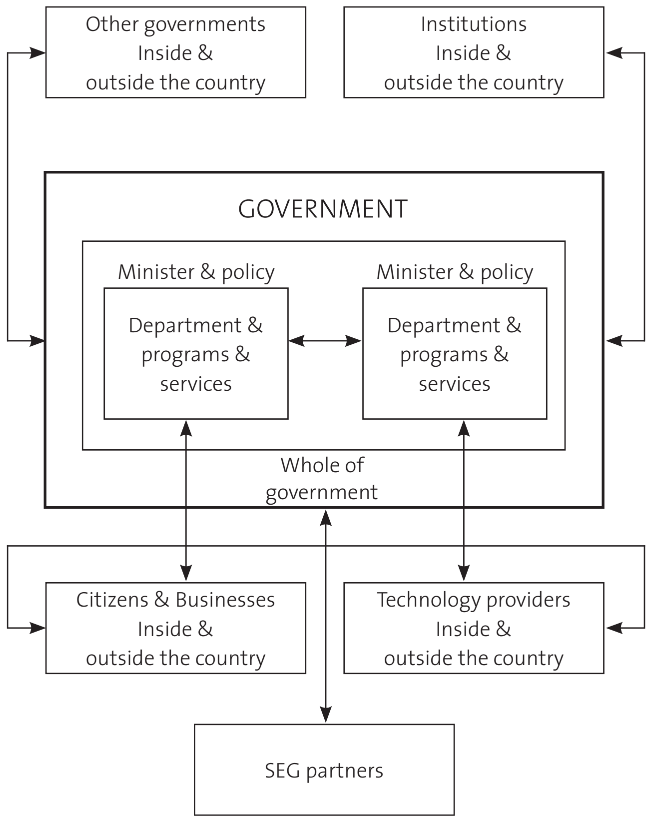

Figure 3. Interactions by a spatially enabled government

5. How Some Elements of SEG are Presently Assessed

There is no research literature at present on assessment frameworks for SEG, the methods that might be used to undertake such an assessment, or the elements of SEG that might be assessed. There are, however, existing assessment methods, and views on future assessment methods for processes and infrastructure required, or closely linked to, SEG. These include assessment frameworks for SDI, ICT and e-Government, and, government policies and programs.

5.1 Assessment of SDI

SDI assessment is comprehensively addressed in Crompvoets *et al.* (2008). In particular, the idea of a multi-view framework to assess SDIs is described in this publication (Grus *et al.,* 2008). A multi-view framework is appropriate given that SDIs can be treated as complex adaptive systems. The strength of the approach lies in its flexibility, its ability to provide a multi-disciplinary view of SDI, and the reduced bias in assessment results from using the approach. The approach also deepens knowledge of SDI, and may assist in SDI development. The multi-view assessment approach is shown in Figure 4.

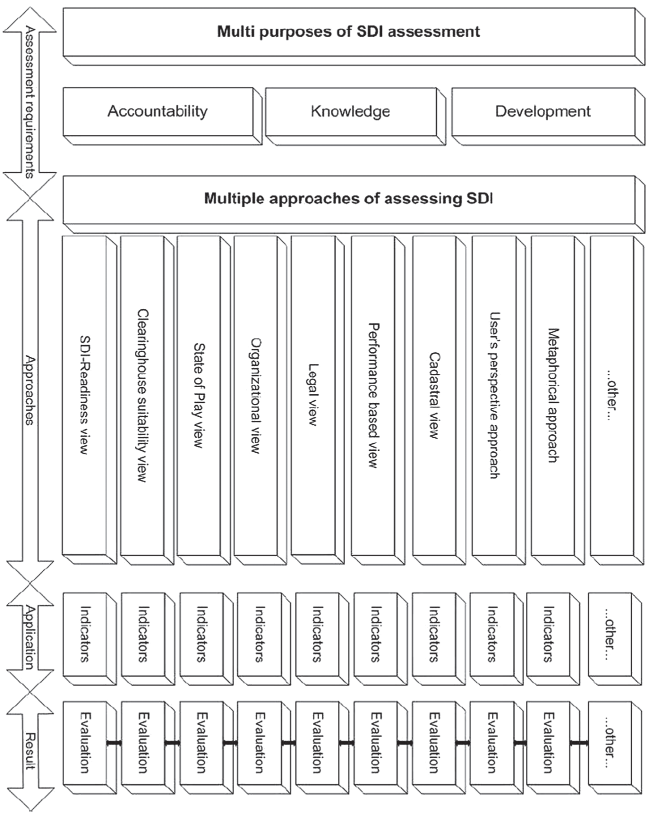

Figure 4. Multi-view SDI assessment framework (from Grus *et al.,* 2008)

In the concluding chapter of Crompvoets *et al.* (2008), Future Directions for Spatial Data Infrastructure Assessment, the editors of the publication suggest that three critical questions need to be asked before starting the actual assessment:

- The first question concerns the user of the SDI assessment. A policy-maker is interested, and requires, different information from a politician responsible for a SDI. A distinction needs to be made between those operating at the strategic, management or operational level;
- The second question is about what is going to be assessed; and
- Closely related to this is the third question which concerns the level of SDI being assessed.

5.2 Assessment of ICT and E-Government

The assessment of ICT investments in public administration is discussed in Becker *et al.* (2008).

Evaluation methods for eGovernment projects identify strengths, weaknesses, and best practices, for both local and international implementations. Both Hong Kong and Australia have implemented techniques to measure the success of eGovernment projects. In Hong Kong the eGovernment coordinating office commissioned an opinion survey to obtain user feedback on the design of government Web sites and the provision of eServices. In Australia, the Australian Bureau of Statistics used surveys to measure adoption of ICT in society as a whole. Some of the questions in the surveys were directed at measuring use of government online services, to better understand the demand-side for government. The European Union offers the eEurope Awards which includes three valuation criteria: innovativeness and effective management; practical results; and relevance and transferability. The implications of such awards highlight the importance of setting standards and defining measurable targets for efficient assessment. Effective assessment can determine success or failure of eGovernment projects. The United Nations Global eGovernment survey states that eGovernment measurements should track national progress, identify disparities in access to ICT, move toward an inclusive information society, and support international comparisons. The U.N. global survey also examines governments' willingness to use eGovernment to improve services to citizens. The survey contributes to the development efforts of the member states by focusing on whether eGovernment impacts the socioeconomic uplift of the people. The survey provides a benchmark of a country's state of e-readiness (Esteves and Joseph, 2007).

5.3 Assessment of Government Policies and Programs

Evaluation is a well-established practice in the public sector. There is a wealth of literature on evaluation methods and results. Evaluation methods include policy and program evaluation and performance review and audit. Evaluation seeks to determine how well a particular policy, program, structure, project or process is performing against expected outcomes. Evaluation results lead in many cases to modifications and improvements in government activity. Evaluation of public sector activities assists in ensuring accountability of government actions. The process of spatially enabling government, given its necessary use of public sector capacity, is a likely candidate for evaluation. In addition, the process of spatially enabling government may require additional public sector capacity than that presently available, particularly funding. It is now a common requirement in government for a business case, or cost benefit analysis, to accompany submissions for new government funding. Given that some implementations of SEG operate as a public-private partnership, commercial-style business cases may also be a requirement.

6. A Possible Assessment Framework for SEG

Several possible assessment methods might be used to assess a spatially enabled government. They include public sector methods, like policy and program evaluation, and performance review and audit; and non sector-specific methods to assess technology (for example, ICT and e-Government assessment methods, and SDI assessment methods. Some of these methods may need to be modified to accommodate particular elements of spatial enablement (for example, public sector methods do not as a general rule consider questions relating to location knowledge). Given the early stage of implementation of spatial enablement by governments assessment methods are likely to need refinement, particularly refinement based on experience from particular cases of implementation. Formal assessment methods might need to be supplemented with less formal approaches.

Drawing on the linkages shown in Figure 3, it is possible to begin to describe the stakeholders of a government that is spatially enabled, their expectations (as a result of government becoming spatially enabled, and the assessment methods that might be appropriate to test whether these expectations have been met:

- Citizens and businesses. These stakeholders might expect better services from, and better communication with government. An appropriate assessment method in this case might be program evaluation;
- Government politicians might expect that their constituents and the country are better off. Assessment methods in this case might include policy evaluation and less formal approaches;
- Government Ministers accountable for specific policies, or for spatial enablement within their government. These stakeholders might expect improved policy outcomes and an accountable spatial enablement environment. An appropriate assessment method might be policy evaluation in the former case, and performance review and audit in the latter case;
- Government employees. These stakeholders operate at different levels of responsibility and expectations are likely to vary between these levels. Lower level employees might expect improved business processes, and relevant skills in order to be able to perform in a spatially enabled environment; higher level employees might expect effective structural arrangements (including governance); effective linkages between departments within government; effective linkages between their government and sub-national and international governments; and, effective technical systems (including ICT, SDI, and spatial applications. Appropriate assessment methods here include program evaluation, performance review and audit, and technology assessment;

- Sub-national and international governments. These stakeholders might expect improved policy outcomes by the national government, effective links between governments, and, to the extent appropriate, effective technical systems for which they might be responsible. Assessment methods here might include policy evaluation and less formal assessment methods;
- Providers of technology and technical infrastructure. Expectations by government of this group might include effective relationships, and effective service delivery. Assessment methods here include performance review and audit and less formal methods; and, to the extent that it is relevant;
- Partners with government in creating a spatially enabled government (for example, academic and research institutions, and specific businesses). These stakeholders might expect effective relationships with government. Performance review and audit, and informal assessment methods might be appropriate in this case.

The stakeholders of a spatially enabled government, in this case a national government, the possible expectations of these stakeholders, and possible assessment methods to test these expectations, are shown in Figure 5.

The above discussion suggests that a framework to assess SEG is likely to involve assessment methods drawn from the public sector, and broader technology assessment methods. A framework to assess SEG is likely to require both formal and informal assessment methods. This suggests a multi-view and multi-discipline approach might need to be taken.

7. Future Direction

This chapter suggests that a multi-view framework of assessment be taken for SEG, drawing on public sector and technology sector methods of assessment, and taking formal and informal approaches to assessment.

Further development is required on this multi-view framework of assessment, in particular:

- The conceptual framework of SEG needs to be more completely described and tested;
- The technology assessment frameworks related to SEG, particularly the methods for assessing SDI, needs to be described in a more holistic and integrated way;
- The assessment framework for SEG itself needs to be more completely described, described in a more holistic way, and tested; and
- A toolbox for SEG assessment is needed to facilitate assessment for both high level (strategic) and low level (operational) purposes, and able to be used in both developed and developing countries (for example, the toolbox might be used to answer the questions how well is my government presently spatially, what options are available for me to improve my governments state of enablement, and how would I assess actions I might take to improve enablement).

The growing number of cases of SEG around the world provides a wealth of knowledge to test and improve any assessment framework on SEG.

Finally, developments in assessment frameworks for SEG need to take account of relevant developments in the spatial sciences, informatics and management science; and particularly developments in thinking on the issue of a spatially enabled society.

Stakeholder	Expectation		Assessment method
Citizens	Better services		Program evaluation
	Better communication with government		Program evaluation
Businesses	Better services		Program evaluation
	Better communication with government		Program evaluation
Government parliamentarians	Constituents and the country are better off		Policy evaluation
Accountable Government Ministers	Better policy outcomes		Policy evaluation
	Accountable operation of SEG		Audit
Government employees	Effective operations	Better business processes	Audit
		Effective structures (including linkages between departements)	Audit
		Effective skills (e.g. competency in the use of location knowledge)	Audit
		Effective systems (e.g. ICT, SDI, business systems)	Audit
			SDI, ICT etc assessment
		Effective governance arrangements	Audit
Other governments	Better policy outcomes		Policy evaluations
	Effective links between governments	Effective systems (e.g. ICT, SDI, business systems)	Audit
			SDI, ICT etc assessment
Suppliers of products and services	Effective product and service delivery		Audit
Partners	Effective relationships		Audit
	Effective systems (e.g. ICT, SDI, business systems)		Audit
			SDI, ICT etc assessment

Figure 5. Stakeholders of a spatially enabled national government, their expectations and assessment methods

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Spatially Enabling Society

Part 2

Regional Activities

Chapter 6

Spatially Enabled Societies: Asia and the Pacific

Abbas Rajabifard[1], Ian Williamson[2] and Sheelan Vaez[3]

1. Introduction

Spatial enablement is where data, information and related business services with spatial content become ubiquitous in the daily conduct of government agency business in the efficient and effective delivery of services and also in wider society activities. A spatially enabled government (SEG) is one that has ready access to the spatial or geographic or location based information and associated technologies that it requires and is applying these productively to government decision making and service delivery, including developing policy and supporting its own business processes. To do so also requires data and resources to be accessible and accurate, well-maintained and sufficiently reliable for use by the majority of society who are not spatially aware (Rajabifard, 2007).

According to the outcomes of the International Workshop on Spatial Enablement of Government and NSDI, Policy Implications conducted by Permanent Committee for GIS Infrastructure for Asia and the Pacific –Working Group 3 (2007), Seoul, Republic of Korea, Spatial enablement leads to:

- improved decision making;
- reduction of administrative costs;
- whole of government outcomes; and
- enhanced industry development opportunities.

In particular spatial enablement is usually used by a wide cross section of society in a ubiquitous and transparent manner. As a result spatial enablement demands a "whole-of-government" approach. Popular uses of spatial technology involve displaying imagery, and tracking assets and inventory through an increasing array of devices, the most common being the ubiquitous mobile phone. Remarkable as these applications are, spatial technology can be used in even more dynamic ways. Transformational use of spatial technology occurs when it is used to improve business processes of government and the private sector, including equitable taxation, allocation of services, conservation of natural resources, and planning for rational growth (Steudler, 2010). An SDI provides a foundation on which spatial enablement for both government and society can occur.

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The Asia and Pacific region is the largest region in the world with a vast area of land and water containing some 60 per cent of the world's population, and including 56 countries according to the United Nations. The countries span a wide part of the globe from Iran and Armenia in the West to French Polynesia in the East, from the Russian Federation and Japan in the North to New Zealand in the South.

This region is one of the first regions in the world that started to develop a Spatial Data Infrastructure (SDI) at its regional level. It has a complex social and political environment, typified by competing and often conflicting priorities and motivations. Every case in this region is unique because of its national context, language and characteristics (such as size, population, political systems, social and economic priorities, and varied infrastructures and skills), the national traditional and cultural attitudes, and the people who participate, develop and use SDIs.

With this development and strategy, spatially enable government and society is now part of Asia Pacific plans and intentions. These trends are coupled with institutional and structural reforms in the use of Spatial Information (SI) and SDI as an enabling platform. While SEG increasingly operates in a virtual world, we still have a long way to go.

The development of SEG was a key outcome of the 17th United Nations Cartographic Conference for Asia and the Pacific (UNRCC-AP) and 12th meeting of the UN supported Permanent Committee for GIS Infrastructure for Asia and the Pacific (PCGIAP) in September 2006 in Bangkok, Thailand. This prompted Working Group 3 (formerly Cadastre) of the PCGIAP to refocus its activities on Spatially Enabled Government as part of developing National Spatial Data Infrastructures (NSDI). In conjunction with the GSDI Association, WG3 (Spatially Enabled Government) of the PCGIAP held a dedicated workshop, "Spatial enablement of government and NSDI – policy implications" during the 13th PCGIAP meeting in Seoul, Korea on 12th June 2007.

The development of a SEG has also been highlighted in Australia, with the Australian Government conducting a conference on SEG in August 2007. This chapter presents and summarizes the outcomes of two major events which have been conducted in the Asia-Pacific region regarding spatially enablement and, also the activities of a working group on SEG through WG3 of the PCGIAP. Finally, the chapter outlines the opportunities, issues and challenges involved in the design and development of a SEG.

2. Asia and Pacific – Spatially Enabled Government Working Group

The Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) is a committee established in 1995 by a United Nations Resolution. Working Group 3 (WG3) of this committee was originally the 'Cadastre' working group and was established in 2000 based on a Resolution from the 15th United Nations Regional Cartographic Conference (UNRCC-AP) in Malaysia. As a result of the needs of societies and technological development, the importance and role that large scale spatial information now plays in SDI, and in order to align with this development and to leverage off the achievements of WG3 over the six years period between 2000-2006, WG3 re-named in 2006 "Spatially enabled government" and focused on the development of spatially enabled government. This was a key outcome of the 17th United Nations Cartographic

Conference for Asia and the Pacific (UNRCC-AP) and the 12th meeting of the UN supported Permanent Committee for GIS Infrastructure for Asia and the Pacific (PCGIAP) in September 2006 in Bangkok, Thailand. These movements prompted Working Group 3 to refocus its activities on SEG as part of developing national SDI. A new vision and objectives for its future direction and its activities was undertaken, which focused on the concept of spatially enabling government. The work plan for 2007-2009, included a Spatially Enabling Governments Project to develop a strategy and work plan to assist SEG implementation. This includes work on:

- Concepts and principles of SEG;
- Design requirements for SEG;
- Issues associated in the development of SEG including: institutional; technical; political and socio-economic dimensions;
- relationship between SDI and land administration (and particularly cadastre) to support SEG;
- Capacity building for SEG.

Furthermore, the 18th UNRCC-AP Resolutions in October 2009 emphasized disaster management as a tangible driver for SEG in the Asia and Pacific region (Scott, 2010). The resolution recommended that PCGIAP undertake a study to understand, compare and determine the state of SEG and society, including levels of maturity and governance of SDI, in the region.

3. International Workshop on Spatially Enabled Government, Seoul, South Korea

As part of the PCGIAP Working Group 3 work plan for 2007-09, an international workshop was conducted on the 12 June 2007 on the 'Spatial Enablement of Government and National SDI-Policy Implications'. The workshop was conducted in Seoul, Republic of Korea as part of the 13th PCGIAP Annual Meeting and in collaboration with the GSDI Association. The workshop was actively supported by the Centre for Spatial Data Infrastructures and Land Administration, the University of Melbourne. Over 120 people from 13 countries and 2 international organisations (GSDI and FIG) attended the workshop. The objectives of the workshop were:

- To commence dialogue at PCGIAP and better understand and describe spatial enablement of government;
- To gather preliminary data and refine the understanding of data requirements for the PCGIAP WG3 task of facilitating spatial enablement of government; and
- To better understand and describe the legal and economic issues in the development and implementation of SDIs as enabling platforms.

3.1 Workshop Outcomes

The workshop addressed the development of SDIs, including legal and economic issues at both a global and regional level to facilitate spatially enabled government and society.

Countries including Australia, the Republic of Korea, Malaysia, Singapore and Japan shared their experiences and knowledge of spatial enablement at the Workshop, with consensus on the need to develop a path to spatial enablement of government and society.

The workshop endorsed the concept of SEG as an important tool for governments to improve effectiveness, efficiency, better decision making, business processes, and policy implementation at national, regional and global levels. It highlighted that SEG builds on traditional uses of spatial information in mapping, positioning, asset management, visualization, web enablement, and GIS in supporting economic development and environmental management. Furthermore, it extends it across the whole of government into non-traditional areas such as taxation, health, human services, census, education, immigration, sustainability accounting, security and emergency response, in a transparent and ubiquitous manner (PCGIAP- WG3, 2007)

SEG can be built at different levels of government (such as local and state/provincial) to support thenational level, all playing an important and integral role in the development of an enabling platform. This includes all institutional, legal, governance, and political arrangements that facilitate the integration of built and natural environmental data together with all related non-spatial data such as demographic and census data to support sustainable development. In simple terms, SEG is about using SDIs to improve the operation and processes of government, and deliver better policy implementation and decision making by extending the use of spatial information to the whole of government and society.

The workshop also recognised SEG as an important part of countries' ICT, e-government and information sharing strategies, and a key activity that fosters innovation. SEG is an evolving concept that requires ongoing research and development by PCGIAP, the GSDI Association and member countries, in order to clarify and expand the principles and applications associated with a concept that involves policy, social, institutional, legal and technical dimensions, and to make the most from the concept. Most importantly however, SEG requires cooperation at all levels of government, from national to lower levels such as states, provinces, counties, municipalities (PCGIAP- WG3, 2007). The implementation of SEG requires:

- an enabling platform comprising institutional, collaborative framework, governance, legal and technical tools for data sharing as part of ICT, e-government and information sharing strategies; building on NSDI and related initiatives;
- using geocodes and "place" related information, such as national geocoded street address files;
- facilitating the use of legal land parcels and legal property objects to better manage all rights, restrictions and responsibilities relating to land;
- development of more holistic data models to integrate separate land administration data silos where they exist;
- maintenance of complete and optimally, continually updated national cadastral maps of legal parcels, properties and legal objects, as part of the NSDI; often re-engineering the institutions of government; legal frameworks to facilitate integration and management; activities on spatial data standards, interoperability and integratability; development of authoritative registers of key spatial information; research and development; growth in capacity at society, institutional and individual levels.

The workshop proposed several recommendations to PCGIAP in regards to the development of SEG. These recommendations were endorsed by PCGIAP in Korea. Due to the importance of the recommendations they were put to the next UNRCC-AP conference in 2009 as follows:

- PCGIAP and the GSDI Association re-endorse Resolution 4 of the 17th UNRCC-AP, Bangkok 2006 with regard to encouraging countries to explore the principles of spatially enabling government as they support the four dimensions of sustainable development: economic, environmental, social and governance.
- PCGIAP endorses the outcomes of the PCGIAP Workshop on "Spatial Enablement of Government and NSDI-Policy Implications" conducted jointly by the Working Group 3 and GSDI Association on the 12 June 2007 as part of the 13th PCGIAP meeting, in Seoul, Korea.
- PCGIAP and the GSDI Association encourage closer collaboration between national mapping/GI organizations and large scale land administration/cadastre/land parcel organizations, as a key aspect in promoting the spatial enablement of government.

WG3 continues to be active in SEG with the details of these activities and work plan found at the PCGIAP website (www.pcgiap.org).

4. Spatially Enabled Government Conference, Canberra, Australia

After the International workshop held in Korea in June 2007, and due to the increased international and national importance being placed on Spatial Enablement, the Australian Government conducted a dedicated conference with more than 200 practitioners and attendees on SEG in Canberra in August 2007. As part of the activities of PCGIAP-WG3 and in line with the objectives of WG3 on SEG, this conference was supported by the Centre for SDIs and Land Administration, the University of Melbourne and chaired by Ian Williamson, the Chair of WG3 (SEG) of PCGIAP.

The Australian Government released its e-Government strategy, "Responsive Government: A New Service Agenda", in March 2006. In announcing its release, the Special Minister of State, the Hon. Gary Nairn MP, stated that a spatially enabled government was likely to be an important contributor to the e-Government strategic outcome. The purpose of the conference was to highlight the importance of spatial information and promote spatial strategies and information as a vital tool for policy development and public sector decision making. The combination of strategies in the spatial enablement of government and mainstream e-Government are now an emerging trend in Australia and many other parts of the world. Further, the key message from the Conference was that SEG is here to stay and is rapidly offering new opportunities to government and wider society.

As now practiced in Australia, SEG is governed by a whole of government approach at the national and state levels and is increasingly operating in a virtual world. However, there is still a long way to go. Most uses of spatial information still focus on coloured maps, and do not use the full potential of spatial information to re-engineer the activities of government, though SEG is starting to be used to improve business processes in some non-traditional areas. In the next few years it is anticipated Australia will have to re-purpose spatial information to unlock knowledge.

In the context of the conference, spatial enablement uses the concept of place and location to organize information and processes and is now a ubiquitous part of e-Government and broader government ICT strategies. The Conference made it clear that the "where" is precious, and that "place" is a "magic joiner" – a boon in the past, now and in the future. It recognized that SEG promotes innovation. The importance of SEG in Australia is recognized by two initiatives as part of a wider strategy of the On-line and Communications Ministerial Council reporting to the Committee of Australian Governments (COAG) – the National Address Management Framework (NAMF) and the National Information Sharing Strategy (NISS) where the spatial information industry will be used as a test bed.

The public are now used to spatial information being available on-line and on-demand, a need satisfied by the large, private systems such as Google Earth and Maps, Microsoft Virtual Earth and other applications. On the local scene, the key to SEG lies in the Geocoded National Address File (GNAF) produced by Public Sector Mapping Agency (PSMA) Australia. GNAF is a key component of the Australian Spatial Data Infrastructure (ASDI). A good example of the pervasive use of GNAF is that some GPS car navigation systems in Australia can include an accurate and up-to-date cadastral map with accurate property boundaries for all land parcels in Australia (over 10 million parcles) all linked to GNAF, for as little as USD50! As the results of the International workshop in Korea show, spatial enablement needs to build on the development and implementation of spatial data infrastructures, with Australia a world leader in the development and implementation of SDIs.

4.1 Issues and Challenges

The conference discussed the issues and challenges in creating a spatially enabled government and society. Major challenges and issues identified included (Rajabifard, 2007):

- ***Broader appeal.*** The Spatial Information (SI) community needs to reach a much broader audience;
- ***Institutional processes.*** Significant inter-jurisdictional issues limiting spatial enablement in Australia with a key risk for implementation being institutional failure;
- ***Bandwidth.*** Australian limitations on bandwidth;
- ***Information policy.*** A key challenge lies in capturing historical hard copy spatial data and making it available in digital systems through the Internet;
- ***Research and education***. SEG is rapidly evolving and needs strong research and education/training support. For example Korea expends between 25-30% of its USD1.4 billion SEG strategy on research and training;
- ***Access issues***. The idea of providing information free or at low cost is now articulated in many countries, particularly the USA and more recently the United Kingdom - the contribution to the economy at large is considered far in excess of the retail price of the information. Moreover, the value of information in spatial systems is now being identified so that its significance as a major institutional asset is more fully recognized. The trend is to move from "on-line" to "on-demand";
- ***Standards***. These are a key enabler and facilitator of partnerships in SEG. Australia's capacity to develop standards is clear in the work of Australia and New Zealand

Land Information Council (ANZLIC) and other organizations. However the issue of metadata remains since it is often not systematically addressed. Most assume that metadata is available, useful and appropriate – this is not necessarily the case;

- ***Seamless platform***. There is a growing need to create a seamless SDI model to bridge the gap between the terrestrial and marine environments. The resulting spatially enabled land-marine interface will promote sharing of marine and coastal data and communication between organisations. The improved decisions will be more effective in implementing sustainable development objectives;
- ***Licensing***. Issues of licensing and the use of the Creative Commons are part solutions to issues of sharing data. Without these, complexity of current access arrangements to government SI will continue to restrict innovation and SEG;
- ***Risk management***. SI is one of the tools to combat tax and welfare fraud because of the ability to organize information in ways that are easily interpreted. On the positive side, spatial systems can help organizations manage their primary risk. The subordinate question of the risks inherent in the information itself, which is far from well managed in Australia, remains. These issues of liability are primarily handled through disclaimers and licence conditions, but need more effective strategies. There are also potential liability issues if SI is available and has not been used to prevent a disaster.

The drivers for spatial enablement were also discussed, with the focus of spatial information needing to be on users, with all strategic decisions in the use of spatial information being user driven with a business focus. While Australia leads in some aspects of spatial enablement, such as use of high integrity geocoded street addresses, it is behind leading international trends in creating an appropriate infrastructure for spatial enablement, and especially in promoting a single authoritative repository for each data set. Information policy, interoperability, access, licensing, standards, capacity and risk management all have unanswered themes.

In line with this, the federal government in Australia through its office of spatial data management (OSDM) has established a new conference known as spatial@gov to address the rapidly increasing demand for information on how spatial capabilities can enhance the ability of governments at all levels to develop policies, deliver services and streamline business processes. The inaugural spatial@gov conference was first initiated in 2009 in Canberra. The conference recognised that efficiencies in government operations and more effective service delivery can be achieved simply by connecting to the 'place' component of government information. This conference is now an annual conference which attracts government and non government spatial data practitioners and stakeholders.

5. Conclusion and Future Directions

Spatially enabling government is now part of the objectives of countries in the Asia Pacific region. The key message from the International Workshop, Conference and different initiatives on SEG in the Asia Pacific region is that spatial enablement is here to stay and is rapidly offering new opportunities for government and wider society in the use and development of spatial information. The ability to implement spatial enablement, particularly in relation to Australia, requires a range of activities and processes to be created across all jurisdictional levels. These include:

- an enabling platform comprising institutional, collaborative framework, governance, legal and technical tools for data sharing as part of ICT, e-government and information sharing strategies;
- building on NSDI and related initiatives;
- using geocodes and “place” related information, such as national geocoded street address files;
- facilitating the use of legal land parcels and legal property objects to better manage all rights, restrictions and responsibilities relating to land;
- developing more holistic data models to integrate separate land administration data silos where they exist;
- maintaining complete and continually updated national cadastral maps of legal parcels, properties and legal objects, as part of the NSDI;
- developing improved legal frameworks to facilitate integration and management;
- activities on spatial data standards, interoperability and integratability;
- development of authoritative registers of key spatial information;
- research and development – essential but often over-looked by government in the SEG;
- growth in capacity at societal, institutional and individual levels.

The development of a spatially enabled government and society is ongoing and multi-disciplinary; achieving it will draw on a wide range of experiences and disciplines from surveying and mapping, land administration, GIS, information and communications technology, computer science, legal and public administration and many more disciplines. Jurisdictions will need to work together over the long-term if the vision of a spatially enabled society is to become reality.

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Chapter 7

Spatially Enabled Government in Europe as a Basic Ingredient for Spatially Enabled Societies

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1. Introduction

In the definition of Spatial Enabled Society (Wallace, 2007), Spatial Enabled Society is "a scenario for the future as we are in an increasingly complex and rapidly changing world, societies can be regarded as spatial enabled where location and information are regarded as common goods made available to citizens and businesses to encourage creativity and product development." The authors in the article explain that the vast majority of the public are users of spatial information. One of the statements in this article is to make existing spatial data infrastructures (SDI's) more appropriate for spatially enabling government and society. Four strategic challenges are formulated as an important milestone for the successful realization of SDI implementation towards spatial enabling societies and governments. These strategic challenges can be summarized as follows: SDI governance for broad stakeholder involvement, promotion of data sharing, creation of enabling platforms and capacity building.

This chapter illustrates with examples that SDI governance and the use of spatially enabled platforms are fundamental conditions for successful partnership building in national EU Member States e-government programs. The entire issue of spatially enabled societies cannot be covered in one article due to the complexity of its theme. In the authors' vision, societies can also be spatially enabled without successful SDI's, because of the fast growing technological developments and the huge availability of spatial information from various media, mobiles, etc. National governments can, however, play an important role in providing successful SDI tools for the realization of efficient government performances as well as for business development and citizens' e-democracy issues. For that reason this article focuses on Spatially Enabled Government, as a crucial part towards optimizing the creation of a genuine spatially enabled society. More effort is needed how the SDI-community can contribute to other communities to optimize the use of each others' spatial data, such as the space community and the data collected by voluntary communities. Convergence between these communities at the strategic and operational level is a basic condition for optimized Spatial Enabled Communities. (The spatial data community in a broad sense).

A government can be regarded as spatially enabled when location and spatial information are considered to be common goods made available to citizens and businesses to encourage creativity and product development (Wallace, 2007; Masser *et al.,* 2008). Spatially Enabled Government is also defined as an innovator and enabler across society and a promoter of

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e-democracy. The Global Spatial Data Infrastructure (GSDI Association) works closely with the Permanent Committee on GIS Infrastructure for Asia & the Pacific (PCGIAP) in promoting the Spatial Enabled Government issue in the Asia Pacific Region. A common workshop was organized during the 13th PCGIAP meeting in Seoul, South Korea in June 2007. The heart of the workshop was the commencing dialogue in and a better understanding of the concept of spatially enabled government, and to better comprehend and describe the legal and economic issues and policies involved (Kok *et al.,* 2007; 2008)

Examples in Europe show that leadership, legal foundation, cooperation and commitment building platforms, communication visions and involvement in e-government programs are essential ingredients for successful SDI governance. These conditions will make current spatially enabled societies more aware of the use of reliable spatial information in a broader sense and context, at a time of huge information overload in our society.

2. Spatially Enabled Government in Europe

Current practices in Europe show that National Mapping, Land Administration and Cadastral Agencies (NMCA's) are important actors responsible for the creation, coordination and implementation of SDIs at (sub)national and international levels.

One of the key elements for the strategic role of NMCA's in SDI development and implementation is the fact that they provide well-maintained and up-to-date data and services, which feeds a nation's economic development. NMCAs are subsequently catalysts for the development of SDIs. They stimulate the exchange of core data with other organizations in the public domain, as well as data sharing and data integration. These activities can only take place when they align with government authorities for organizational and institutional arrangements. NMCAs play a vital role in helping to embed these arrangements in (sub-) national e government plans. These activities lead to spatially enabled governments and the creation of an enabled geospatial society by arranging partnerships with the geospatial technology sector. In particular in Spain, The Netherlands and the Nordic countries, NMCA's play a central role in the establishment of spatially enabled platforms. In this way they fulfil a key link between the geospatial community and responsible ministers. This matchmaking role is important for the provision of SDI-tools to national e-government policies and decision making processes.

At the EU level, high progress has been made during the last ten years. The successful INSPIRE Directive is an excellent example of dialogue between networks of policy makers and various European and Member State geospatial communities. In July 2004, the INSPIRE Directive was adopted by the European Commission (EC). On 17 March 2007, the Directive 2007/2/EC of the European Parliament and of the European Council of 14 March 2007 establishing the Infrastructure for Spatial Information in the European Community (INSPIRE) was published in the official Journal (European Commission, 2007). The INSPIRE Directive entered into force on May 15th 2007. It was developed over a relatively short time span. The legal impact of this Directive on the EU member states is that they are obligated to transpose the INSPIRE Directive principles into their national legislations. It contains a legal framework for implementation in the EU member states. It defines specific data themes which need to be used, contains implementing rules for data specifications, metadata, network services, data and service sharing, and monitoring and reporting. This legislation also requires that each EU country sets up a national geo-portal to provide access to geospatial data, and services.

The principles of INSPIRE are similar to the ones used in national SDI-processes. This means that data should be collected once, be combined with data from different sources and be available on conditions that are not restricting its effective use. The SDI-processes are smoothly proceeding thanks to INSPIRE's general rules on establishing a European infrastructure for geospatial information for environmental policies purposes. These general rules are based on existing national SDIs and operated by the member states. In a broader context our impression is that the interaction between the development of the INSPIRE legislation and the development of the implementing rules are proceeding well. It is a sophisticated and interactive approach between EU officials, professionals of the geospatial community, and NGO's throughout the European Union.

In the current stage of the implementation process, communication and interaction between the European Commission and EU member states is guaranteed by the INSPIRE Committee (IC), the National Contact Points (NCP) and the Initial Operating Capability Task Force (IOC TF). Their roles are respectively advising the European Commission in the adoption process of the Implementing Rules (IC), information provision in their EU countries related to the Directive and monitoring/reporting to the Commission on the implementation and use of their SDIs (NCP), and on the implementation of the INSPIRE Discovery and View Services (IOC TF).

At this moment, the European Commission has adopted INSPIRE's Meta Data Regulation, Network Services Regulation monitoring/reporting, and Regulation on Data and Service Sharing. Regulations regarding interoperability of geospatial data sets, and download / transformation services are currently in development.

The Spatial Application Division Leuven (2010) conducted a survey concerning the coordination, funding and sharing measures related to INSPIRE in EU member states, EU Candidates and EFTA countries. A detailed questionnaire was distributed in November 2009 related to the transposition of the INSPIRE Directive, its coordinating structures, strategies, funding measures and data/service sharing. The headlines of the survey's outcomes show that:

- About half of the EU member states have transposed INSPIRE in their legislations.
- Most of the problems during the transposition are related to institutional issues and coordination, the composition of platforms, the identification of the datasets in accordance with the INSPIRE legislation principles, INSPIRE data theme coverage, funding mechanisms and the lack of involvement of local governments.
- The variety of approaches dealing with legal, pricing, geospatial data policy issues across Europe is very high.
- The key successes of INSPIRE are manifold, such as the increase of geospatial/SDI-awareness, stronger drive for cooperation, legal basis, enhanced SDI capacity building and stronger support for e government.
- The NMCAs play a very active role in the INSPIRE implementation process.

Some European countries have contributed to INSPIRE's success through their excellent national SDI-initiatives. In many of these countries the availability of accurate and well-maintained land administration data, cadastral data, small scale and large scale topographic data sets provided by the NMCAs is the reason for the excellent SDI development and implementation processes.

These registrations are essential for sustainable economic development at (sub-)national level and the stimulation of better governments. Active contribution from NMCAs forms a key factor for INSPIRE-success as they provide the core datasets of the Directive, the so-called Annex 1 data themes (e.g. coordinate reference systems, and cadastral parcels).

3. Introduction to Countries

This section illustrates some successful SDI developments in EU countries and how NCMA's play a central role in the SDI implementation process. NMCAs have a leading coordinating role in these processes. Examples will show how the SDI became a vital part of their national e- government programs.

Denmark

Denmark has a well-developed national SDI due to the fact that their national mapping agency plays a central strategic role in the creation of e government strategies and plans. The Danish E-Government Strategy 2007-2010 is described in the document "Towards better digital service, increased efficiency and stronger collaboration" and published by the Danish Government, the Local Government Denmark (LGDK) and the Danish Regions (2007). The key essential issue of this strategy plan is coordination and creation of digitalization of improvements in services to citizens and businesses, as well as coordination and prioritization of digitalization in the public sector through cross-governmental collaboration. An important interdisciplinary priority area in this Danish e-government strategic plan is the creation of a community service responsible for the development of a digital framework for Geodata in Denmark at decentralized and national level. The Danish Minister of Environment Troels Lund Poulsen launched his policy plan "Redegørelse om infrastrukturen for geografisk information" in 2008 as a part of this e-government strategy. It contains a geographic basic framework as part of the e-government strategy plan. It is also to be used as a basis framework for the Danish environment policy development, implementation and monitoring processes for the Government and Danish Society (Miljøministeriet, Kort & Matrikelstyrelsen / Danish Ministry of the Environment, National Survey and Cadastre, 2008). The Spatial Data Service Community chaired by the National Survey and Cadastre is the platform for linking the geospatial dimensions with the infrastructure for Denmark's e-government (Spatial Data Community Service, 2010). This group stimulates that the Digital Framework for Geodata will be used effectively by all stakeholders in the public domain, the business community and citizens. The National Survey and Cadastre is the central public source for geographic data. They are coordinator for the registration of geospatial information and the National Authority for the NSDI, which is identical to INSPIRE's definition.

Article 19(2) of Denmark's Infrastructure for Spatial Information Act lays down that the National Survey and Cadastre is also responsible for the implementation of INSPIRE in Denmark and is designated as their contact point with European Commission. The Infrastructure for Spatial Information Act creates a connection to e-government. It was passed by the Danish Parliament in December 19th 2008 and came into force on May 15th 2009 (Danish Government, 2008; 2009).

Norway

The approach in Norway is very strategic. For more than twenty years the Norwegian Mapping Authority has been playing a leading role in the international standardization and innovation network. Partly based on this position, they developed a national SDI step by step in strong cooperation with other GI producers and regional and local authorities. The Norwegian Mapping Authority developed the virtual platform Digital Norway in cooperation with local and regional partners (almost 600 in total!) and introduced the Geodata portal Geonorge before the INSPIRE development started (Digital Norway, 2010). The participating institutions of Norway Digital bring their own data into the infrastructure. This information will be made available to all public producers, administrators and major national users of geographic information. The Norwegian Mapping Authority coordinates these activities. The Norwegian SDI policy plan and their implementation approach are laid down in the White Paper from the Norwegian Government approved by the Norwegian Parliament in 2003 (Norwegian Government, 2002). Digital Norway became a part of the Norway e-government. One of the objectives of the Digital Norway is the execution of their national Arealis Program. This is a Ministry of Environment Program focused on making environmental and land use information available at national, regional and local levels. The Norwegian Government's Policy Document for the Information Society Digital Norway (Norwegian Ministry of Modernisation, 2005) became one of the 21 initiatives for the period between 2005 and 2007 to be coordinated with relevant ICT initiatives as part of Government's Action Plan for Modernisation. This means that the geographic maps and data need to be made available to all in an administrative partnership through a common gateway. This service will also be commercially available and as a free information source for the general public.

Finland

In Finland the uniform national topographic map 1:20,000 was launched in the 1950's (Artimo, 1992) and their first portal was launched in the 1990's (National Land Survey of Finland, 2010a). Based on their long experience, it was obvious that the National Land Survey of Finland (NLS) took the lead in the development of the national Finnish SDI. The National Geo Portal pilot was launched by the NLS in July 2009 (Leskinen *et al.,* 2009). It can be considered the main access point for national - local geospatial datasets. A new version was launched in June 2010 (National Land Survey of Finland, 2010b). It is an important feature of the national basic information pool for e-government offering taxation, persons and corporate information. Because of their strong strategic network position and relationships with other agencies and regional authorities, the NLS fulfils the task of being secretariat for the National Council for Geographic Information according to the Law Geo-Information (Finnish Ministry of Justice, 2009). Members of the National Council for Geographic Information include 7 ministries, public agencies, cities, research institutes and private sector companies (Finnish Ministry of Agriculture and Forestry, 2010). The INSPIRE legislation has been transposed into Finnish legislation. The Government Bill for their SDI legislation was passed in June 2009 (Finnish Government, 2009a). The Act of January 2010 shows the SDI authorities (Finland's INSPIRE network) that need to be involved in the process (Finnish Government, 2009b). A broad range of state authorities are involved such as the Environmental Institute, National Land Survey, Meteorological Institute, Transport Agency, Geological Survey, Statistics Finland, Population Registry Centre, Agency for Rural Affairs, Natural History Museum, Game and Fisheries Research, Forest Research Institute, the National Forest Agency, the Food Safety Authority, Agriculture-Food Research, Agriculture and Forestry Information Centre, the Board of Antiquities, Defence Forces, Transport Safety Agency, the Institute for Health and Welfare, the Energy Market Authority and the Ministry of Employment and the Economy. As regional authorities 15 economy, transport and environment centres, 19 regional councils, 13 forestry centres and 22 search and rescue agencies are involved as well as the 326 municipalities. In the annual cycle for SDI strategy development (Finnish National Council for Geographic Information, 2004) and implementation of the Finnish SDI, the National Council for Geographic Information, ministries, public agencies, enterprises, the National INSPIRE secretariat and the National INSPIRE network work together on the development of roadmaps and annual action plans, communication strategies, and support for better decision making processes (Spatial Applications Division Leuven, 2005; 2007, Maa- ja metsätalousministeriö/Ministry of Agriculture and Forestry, 2010).

Sweden

In 2006 the Swedish Government commissioned the National Land Survey of Sweden (Landmäteriet) with the responsibility to formulate the Swedish Geodata Strategy (Landmäteriet, 2009) for the integrated information provision to the geodata sector, and the coordination and support concerning Sweden's INSPIRE-implementation. In fulfilling this task, the Geodata Advisory Board was installed by the government to support the Landmäteriet. Board members are the Landmäteriet, Swedish Environment Protection Agency, Geological Survey of Sweden, Vastra Gotaland County Administrative Board, City of Stockholm, Swedish Association of Local Authorities and Regions, Swedish National Road Administration, Swedish Development Council for Geographic Information, Swedish Meteorological and Hydrological Institute, National Maritime Administration and Swedish Armed Forces. The 10 year action plan of the Swedish Geodata Strategy aims to generate increased benefits for the society through the NSDI linking information resources to a network and providing services to public sector administration, private sector and Swedish citizens. The Swedish Geodata Strategy also deals with the implementation of INSPIRE (Spatial Applications Division Leuven, 2007; Landmäteriet, 2010) Besides the implementation of INSPIRE, Landmäteriet is also responsible for the implementation of Directives and initiatives regarding geo information, such as the EC Directive for the Re-Use of Public Sector Information (PSI), the EC initiative for the creation of a Shared Information System in the Environmental Sector (SEIS), and the Global Monitoring for Environment and Security (GMES). In the Geodata strategy plan a link is made to other policy issues, such as the Maritime Environment, Climate and Vulnerable Locations, such as contaminated areas with a potential threat in disturbing their large eco systems. Moreover, the plan also links to the government's action plan for e governance. Finally, the strategy consists of the following eight work packages: 1) Network cooperation as the infrastructure basis, 2) Information structure, 3) Technical infrastructure, 4) National metadata catalogue, 5) Geodetic reference systems, 6) Research, development and education, 7) Legal framework and 8) Funding and Pricing models. The National Geoportal has been launched and forms an essential feature in the Swedish national e government program.

Spain

In the Royal Decree 1545/2007 the strategic goals of the Spanish government for SDIs are written (Ministerio de Fomento/ Ministry of Infrastructure and Transport, 2007). The National High Council for Geography (2010) is responsible for the development of the Spanish SDI. Members of this Council are 7 ministries, 17 regional governments as well as associations of local authorities, The development of Spain's SDI strategy occurs in close cooperation with public agencies, private sector companies, research community and academia. Because of Spain's federal structure, cooperation is essential between the governments at the national level and autonomous levels. The legal basis for the cooperation structure is laid down in the Royal Decree 1999 concerning the establishment of the Spanish National SDI and the National High Council for Geography. The Spanish SDI aims to provide reliable geospatial data from multiple sources. Therefore, geospatial data harmonization is necessary as well as the national geo-portal for data discovery. The Spanish IDEE Geoportal is very successful (IDEE Spanish Spatial Data Infrastructure, 2010). It contains interfaces in seven languages, provides free access to numerous data from the national level to most of the autonomies, and offers a series of geoservices. Moreover, it appears that more than 100 local authorities make their geospatial data accessible via this web facility. Noteworthy is that the development of the Geoportal is strongly based on education, training programs, knowledge exchange and innovation. Another strength of the Spanish SDI is the evolution of participating public agencies by the use of innovative technologies. An example is the Spanish Cadastre's high business performance. The Spanish Cadastre's database includes physical, legal and economy data and it contains 32 million urban properties, 42 million rural parcels, 23.5 million cadastral owners in 7575 municipalities (Permanent Committee on Cadastre in the European Union, 2008). The Spanish Cadastre evolved from initially corporate systems to an integrated Cadastral Virtual Office providing 122 million maps in 2009. Finally, the Spanish SDI is strongly in line with INSPIRE, user-oriented to public administrations and citizens, and its technology is open for geospatial data producers and their clients (European Commission, 2009a).

The Netherlands

In 1984 the RAVI was founded as an Advisory Council (Eerste Kamer der Staten-Generaal, 1998) for the Dutch Minister of Housing Building, Spatial Planning and Environment (VROM), as coordinating minister for geo-information in The Netherlands (Van Loenen and Kok, 2004). In 1990 the Minister of Interior was appointed in the Decree IVR 1990 for the coordination of the information supply and responsible for the coordination of the government information provision in general (Netherlands Ministry of Interior Affairs, 1990). The Minister of VROM asked RAVI to investigate a desirable organization for land information supply in the context of an effective and efficient use of geo information in the Dutch public domain. They developed the Structure Plan for Geo Information in 1992 in cooperation with and with commitment from all stakeholders (RAVI, 1992). This plan was approved by the Council of Ministers in that same year. In 1993 RAVI became the National Council for Geo Information responsible for the implementation of the Dutch SDI, in particular activities related to increasing the compatibility and the exchange of data between the main core data sets such as defined in the Structure Plan for Geo-information. (population-, enterprises-, cadastre and title-, buildings- registrations, the 1:10,000 topographic data set, the 1:1000/2000 topographic data set and the register of addresses) (Tweede Kamer der Staten-Generaal, 1993).

In 1998 the Minister of Interior introduced an E-Government Action Program. The program was approved by the Parliament for implementation government-wide. The main parts of this Action Program were the Public Counter 2000 and the Authentic Registers (Tweede Kamer der Staten-Generaal, 1998).

The geo-information sector and the RAVI worked very closely together with the Ministry of Interior to include the Dutch SDI registrations in the e-government program. They developed an action plan together for the conversion of SDI registrations into Authentic Registers (AR) in their so-called streamlining core data set program (Tweede Kamer der Staten-Generaal, 1998).

AR status means that every government agency is obliged to use the data in this register. Special legislation for every authentic register is required. Their data need to be certificated as accurate and current, and the producer assumes all liability for its use by others. Each Register is assigned to a responsible ministry for maintenance and improvement. In the international domain the Dutch SDI approach is used as a good example for the creation of an INSPIRE infrastructure. The streamlining core data set program was realised on January 1st 2003. The Ministers of Interior, VROM and Economic Affairs announced in their letter to the Dutch Parliament to assign responsible Ministers for the further development of authentic registers (Tweede Kamer der Staten-Generaal, 2003; Rijksoverheid (2003). The legislation of the AR of Persons and Enterprises should be developed by respectively the Minister of Interior and the Minister of Economic Affairs. The legislation of the AR's of Cadastre, Buildings, Addresses and the 1: 10.000 topographic data set should be developed by the Minister of VROM. The minister recommended in his letter that investigation was needed to qualify the 1:1000/ 2000 topographic core data set (GBKN) as a future AR. Government stated that there was a growing interest in using the GBKN for their spatial planning processes and public safety and security objectives. The digital production of the large scale base map of The Netherlands was completed by a public-private partnership consortium consisting of the Dutch Cadastre, Dutch municipalities, utility companies and Dutch Telecom in 2002. The production cost amounted around 250 million Euros, and financed by the partners. Negotiations were needed on how these responsibilities should be transmitted to the Ministry of VROM and how the maintenance costs of the GBKN should be financed in the future.

In 2004 the Dutch Council of Ministers assigned to the Dutch Geo Information Sector 20 million Euros for the Geo-innovations programme "Space for Geo Information" to work on innovations and knowledge provision based on SDI achievements (RAVI, 2003; Kok, 2003; Den Boer, 2004).

The initiative role in the GI coordination process was changing, because of the importance of the implementation of the AR's. Leadership in this implementation process by the government was needed. For that reason another administrative organisation model for GI-policy making and GI implementation needed to created. The GI-Council was established in 2006 (Netherlands Ministry of Housing Building, Spatial Planning and Environment (VROM), 2006). The GI-Council became responsible for the strategic GI agenda and further GI-implementation in the public domain. High level representatives of Ministries and agencies became members of the GI-Council. The activities of RAVI were handed over to Geonovum (Tweede Kamer der Staten-Generaal, 2006). The activities of Geonovum were more focussed on the development of standards, access to geo data, and the implementation process of INSPIRE. The Geonovum platform currently works on the implementation of the VROM GI program "GIDEON" under the leadership of the Dutch GI-Council. The GIDEON program focuses on standardization and technological aspects in the AR's implementation process (Netherlands Ministry of Housing, Spatial Planning and the Environment (VROM), 2008). The second role is the implementation of the INSPIRE Directive into national technical infrastructures. The third role is to encourage the use of geo-information in numerous government policy and implementation chains, such as safety, sustainable living environment, mobility and area development. The fifth role is to encourage collaboration in knowledge, innovation and education related to SDI issues such as the continuation of the 40 million Euro innovation programme "Space for Geo Information" that was realized between 2004 and 2009.

The AR Cadastre and Topography came into force on January 1st 2008 (Staatsblad voor het Koninkrijk der Nederlanden, 2007). The impact is that these data needs to be obligatory used by all administrative bodies in the Netherlands

The AR Buildings and Addresses came into force on July 1st 2009 (Staatsblad voor het Koninkrijk der Nederlanden, 2009a). The Dutch NMCA plays an important role in the current implementation process of the Dutch SDI. The Dutch Cadastre currently maintains the key register for cadastre, and topography, and is distributor of buildings and address information.

A strategy group chaired by the Secretary General of the Ministry focuses on the transformation process of GBKN to a framework for legislation and implementation of an AR register (BGT). This transformation process is to be realised by the end of 2012 and the implementation is expected to take place in 2014.

On December 12th 2008 the Council of Ministers decided to make preparations for the development of an AR for sub soil information. Legislation will be developed and finalized in 2012.

The concept of the SDI, the introduction of AR's and the general GI standardization system was realized before the INSPIRE process started. That was one of the reasons that the INSPIRE Directive transposition process in Dutch Legislation and further technical implementation was a relatively easy process. The National Legislation implementation INSPIRE came into force on September 1st 2009 (Netherlands Ministry of Housing, Spatial Planning and the Environment (VROM), 2009a; 2009b; Staatsblad voor het Koninkrijk der Nederlanden, 2009b).

4. Observations and Findings

On the basis of the information presented so far, it appears that the developments concerning SDI-implementations are proceeding rapidly. One of the key reasons for these dynamic developments is the availability of a legal system for the implementation of the INSPIRE Directive in the 27 EU member states. It appears that the adoption of INSPIRE has stimulated awareness of the strengths of using geospatial data and spatial data infrastructures for policy making processes and service delivery in the EU member states, candidate and EFTA countries.

There are large variances in SDI developments among the EU Member States. In some countries, it was the active role of some NMCAs that made the difference (as we have seen in most of the Nordic countries, Spain and The Netherlands). In some cases, they were already active before the INSPIRE process even started.

In the case of The Netherlands, the SDI-vision was already laid down in the structure plan for geo information (1992), and the authentic registers approach (1998). The "Space for Geo Information" program results were used to optimize the Dutch spatially enabling society ambitions, such as disaster and security management and educational programs. These visions and concepts for core data management and standardisation were a partial starting-point for the INSPIRE preparatory plans. The Dutch NMCA was one of the key drivers in these developments.

In the case of Spain, the National Geographic Institute (IGN) was one of the key drivers behind the Spanish SDI development. This NMCA made excellent arrangements with agencies at the central level, played a leading role in the cooperation with the autonomous regions, research community and private sector, and succeeded in integrating SDI-components in geospatial technologies. These results worked as a catalyst for the INSPIRE development in Spain, and SDI-implementations at public authorities on different administrative levels.

The experience in Norway teaches that a strong international position of a NMCA on standardization (such as ISO and IHO) is essential to the establishment of a successful virtual technology network. Digital Norway became an essential part of the Norwegian White Paper of Public Information. Some of "Norwegian" standardization principles were used in the preparatory phase of INSPIRE.

Finally, some interesting examples of NMCA initiatives have recently happened since INSPIRE's early beginnings in 2001. In Denmark, through INSPIRE, the Danish NMCA became the coordinator for GI-implementation and partner in the Danish e government program. In Finland, again through INSPIRE, the Finnish NMCA NLS became Secretary of the National GI-Council. On the basis of NLS's large network, this NMCA played an important role in the communication and commitment building with all parties nominated in the SDI Act launched on January 1st 2010. The parties included are 21 state authorities, 69 regional authorities and numerous numbers of local authorities. In Sweden, the Swedish government commissioned Landmateriet with the task of formulating the National Geodata Strategy. It contains the INSPIRE implementation strategy, but moreover the establishment of a framework dealing with other EU directives and initiatives, and a strategic link with Swedish government's action plan for e government.

5. Towards Spatial Enabled Societies in Europe

The described examples in Europe show that their SDI results and national e-government progress are strongly interrelated and in some cases completely integrated, not only in a technical way, but also on the organisational and institutional level. These results are useful for the creation of more spatially enabled societies.

In Europe a lot of work needs to be done in the process for more optimized spatially enabled societies. On the other hand there are many opportunities. The program for the Spanish Presidency of the Council of the European Union "Innovating Europe" of 1 January- 30 June 2010 promotes the new 2010-2015 Strategy to Information Society, 2010 follow up, in the so called Internet of the Future program (Ministerio de Asuntos Exteriores y Cooperación / Ministry of Foreign Affaires and Cooperation, 2009).

In the Strategy Document 2010 of the European Commission one of the priorities is the Global Monitoring for Environment and Security (GMES) Program as an important monitoring instrument for analysing the impact of the world's climate change and a sustainable Europe (European Commission, 2009b).

Another important pillar is the 7th Framework Programme and especially their ICT Policy Support Programme ICT PSP) under the Competitiveness and Innovation Program established by Decision no. 1639/2006 of the European Parliament and the Council in 2006 (European Commission, 2010a). This Programme runs in 2009-2013 with a total budget of 730 Million Euros. The main objective of this program is to stimulate the innovation and competiveness by more intensive use of ICT facilities for citizens, private companies and public sector agencies. The program consists of six themes, ICT for a low carbon economy and smart mobility, digital libraries, ICT for health and inclusion, open innovation for future internet enabled services in smart cities, ICT for improved public services for citizens and businesses and multilingual web.

For the geospatial community there are many opportunities for participation, especially for the themes low carbon economy and smart mobility, and internet enabled services in smart cities. The spatial component is important for the realisation of these objectives.

In the ICT work program of the European Commission 2011-2013 "Internet in the Future" (28 October 2009, IP/DG/1596) 300 million Euros are available for research related to promote the use of internet for the future (European Commission, 2009c). The main cornerstone of this program is the focus on stimulating competition, transparency and standardization. A second cornerstone is a stimulus program for more citizen participation. A third issue is related to safeguarding the security and safety.

On November 18th 2009 the Ministerial Declaration on E-Government (Malmö Declaration) was adopted during the Ministerial Conference (Swedish government, 2009). One of the conclusions included stimulating a central role for citizens and businesses in e- government processes and the growing need in stimulating data interoperability among the EU Member States.

The authors' observation is that in these above mentioned documents no reference is made to the INSPIRE legislation and its implementation results. Research needs to be made on what the ideal institutional and organizational conditions are for a complementary approach in the use of the INSPIRE infrastructure and the involvement of the SDI community in the development and execution of the Digital Agenda program, as a part of Europe 2020 Strategic Document EU 2020 (European Commission, 2010b).

Other important topics for research include questions on which institutional and organisational arrangements need to be made for the realization of the convergence process between the SDI and space community. Important questions are how these instruments can be used for the execution of significant European programs, how the results of this convergence process between the SDI community and the space community can be used for the benefit of spatially enabled societies.

The progress made by the geospatial communities in Europe is outstanding, especially in some EU Member States. On the other hand a lot of (research) and policy work needs to be done on the European scale to keep pace with the agenda and activities of the EU 2020 program for the realization of a spatially enabled society.

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Chapter 8

Spatially Enabled Singapore through Singapore Geospatial Collaborative Environment (SG-SPACE)

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Abstract

Spatial Data Infrastructure (SDI) is developed in many countries to provide for efficient and effective usage of geospatial data and information, which underpinned analysis and decision making for environmental, social and economic growth. The SDI policies were also put in place to ensure that geospatial data are made available in high quality, interoperable and timely manner.

The Singapore's NSDI initiative which is known as the SG-SPACE (Singapore Geospatial Collaboration Environment) was launched in April 2008. The SG-SPACE is a cross-agencies program spearheaded by the Singapore Land Authority (SLA) under the Ministry of Law, together with the Infocomm Development Authority (IDA) under the Ministry of Information, Communications and Arts. The SG-SPACE aims to provide a platform and mechanism for government agencies to share and use geospatial data. Ultimately it facilitates better policy, decision-making and governance. Beyond data-sharing, SG-SPACE aims to create a sustainable environment where geospatial data is interoperable, accessible and usable by agencies in day-to-day operation. This geospatial data will eventually be extended to enterprises and citizens for value and knowledge creation.

This chapter describes the development of the Singapore's National Spatial Data Infrastructure, SG-SPACE.

Keywords: Spatial Data Infrastructure, Geospatial, Data Sharing

1. The Geospatial Landscape

The creation of a Land Data Hub in 1980 was the earliest geospatial data sharing initiative that resembled a National Spatial Data Infrastructure (NSDI) in Singapore. Since then, Land Data Hub has continuously evolved. Today, it is a one-stop online discovery, view and access portal for some government geospatial information.

However, there is more to be done beyond data sharing. We recognize that National Spatial Data Infrastructure (NSDI) is an important national initiative that can support and

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improve service delivery and policy planning for the government. Presently, we have silos of government data repositories including Land Data Hub, People Hub, Business Hub and Security Hub mainly serving the public agencies. The data contained in the Land Data Hub are spatial in nature while those in other hubs are not. Hubs are not linked; hence do not allow the use of spatial and non-spatial data in an integrated manner.

In April 2008, Singapore government embarked on its journey of developing the NSDI called the Singapore Geospatial Collaborative Environment (SG-SPACE). It is jointly leaded by Singapore Land Authority under the Ministry of Law and Infocomm Development Authority of Singapore under the Ministry of Information, Communications and Arts. The implementation of SG-SPACE will provide a coordinated effort on a national level to better govern the production, storage, dissemination and use of geospatial information across all data hubs – Land Data Hub, Business Hub, People Hub and Security Hub.

The use of geospatial information and technology has proliferated 35% of public agencies in the area of security, land and infrastructure development, environment, health and community development. However, the culture of data sharing amongst agencies still has room for improvement. A User Need Assessment (UNA) survey was conducted in October 2008 by SG-SPACE teams to assess the current situation on the supply, demand, sharing and applications of geospatial data within public sector. Through the survey, the team found that while most agencies recognise the value of geospatial information, they lack sufficient data and appropriate tools. The survey also revealed that despite the wealth of data collected by the agencies which can be spatially-enabled for analysis and decision making, many are unable to acquire data from the source agencies because they are unaware of the available data and a lack of a common framework of data sharing.

2. The Strategy Map For SG-SPACE

SG-SPACE is defined as "a national collaborative initiative to create and sustain an environment where geospatial data, policies and technologies are integrated to foster innovation, knowledge and value creation for the government, enterprises and community." We envision that SG-SPACE will strive towards creating "a spatially- enabled nation", where geospatial information will be available and used effectively by citizens and businesses for better decision making. It will reduce duplication of efforts in geospatial information collection, management and updating within the Singapore public sector and offer potential for new business opportunities. Over time, the benefits of this initiative will be extended to the nation's enterprises and citizens for value and knowledge creation.

A Strategy Map for SG-SPACE has been drawn as a blueprint towards its implementation (Figure 1). This Strategy Map is divided into three parts, namely the Outcomes, Success Factors and Building Blocks. The Outcomes reflect the desirable phenomena of the ideal outcome as stated in the Vision, i.e. "a spatially enabled nation". Three parties of beneficiaries are involved, including the government, businesses and individuals. The respective parties will enjoy the associated values created by SG-SPACE through effective exploitation of geospatial data. To deliver the Outcomes, 6 essential elements were identified as the key components. They are outlined as the building blocks.

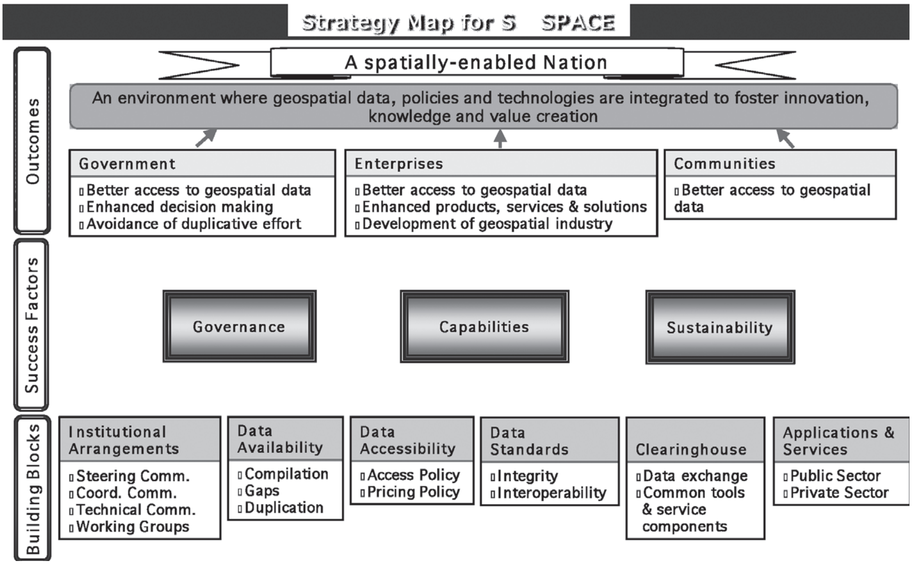

Figure 1. SG-SPACE Strategy Map

3. The Building Blocks

Building blocks in the SG-SPACE Masterplan refer to the specific deliverables in the medium term that are crucial to the achievement of the desired outcomes. These building blocks cover the governance aspects of the SG-SPACE initiative, its supply of data, and creation of a data exchange platform as well as increased use of geospatial data and tools. Namely, the building blocks include institutional arrangements, data availability, data accessibility, data standards, clearinghouse, applications and services.

In this regard, institutional arrangements refer to the setting up of various forums for decision making and issue resolution. These forums need to be present at all levels across different stakeholder agencies ranging from decision makers to working level staff. Each respective forum has distinctive roles to play, such as fund approval, setting strategic directions, data standardization and project piloting.

Data is one of the core elements in SG-SPACE. Data has to be available, accessible and usable. To make data available, we first need to compile the inventory, and then look for gaps, duplications and other issues if there are any. Data also needs to be easily accessible at the point of use. A set of principles, rules, procedures and guidelines need to be established and communicated to the relevant stakeholders. We tried to leverage on the existing government policy framework as far as possible, so that we can ride on an established enforcement mechanism for effective implementation. However, there is a limit to what policies can impose. It is the culture of sharing among the people that takes time to spread. In order to ensure data supplied by various sources are compatible and usable, a national standard for geospatial data needs to be established for the entire lifecycle of geospatial data from the collection, storage, access, dissemination and disposal. International data standards best practices need to be adopted for local adaptation. We need to be sure of the scope of data standards that we want to establish in the local context right from the start.

The Clearinghouse is a web-based infrastructure that serves as a one-stop data exchange platform for geospatial data. It allows the data suppliers to publish data and metadata. Data users can also make use of this platform to view, search, access and download required data. It is inevitable that building of this machine takes up a big portion of the SG-SPACE funding. However, success of the Clearinghouse is dependant of too many other factors because it needs good content as well as a great deal of users.

A more structured way of promoting the development of applications and services in this area is through providing central funding. There are many pre-requisites to the success of application development because the benefits must outweigh the costs before the users decide that it is worth spending the resources. In addition, the data have to be available and the users have to be trained to be competent and effective. When necessary, we need to identify the early adopters in some of the new areas and build the case in showcasing the value of geospatial data. This is to allow other disciplines to discover the untapped potential of geospatial data.

4. Challenges in Implementation of SG-SPACE

There are common challenges faced by all NSDI programmes and these apply to Singapore as well. We view our challenges from three perspectives, namely data suppliers, data users and SG-SPACE coordination.

The main challenge of dealing with data suppliers is the accessibility of data. There are times when certain classes of geospatial information collected by public agencies need to be withheld from access and usage due to reasons of privacy, security or commercial sensitivity. Currently, the criteria of confidentiality are subject to individual agencies' discretion. As a result, users have no access to information that may not be sensitive. Data can only add value to the decision-making processes when it fulfills certain quality standards. In general, government agencies are reluctant to make data available to other parties if the data that is shared will invite queries regarding its accuracy, currency and completeness. Data users who are unable to acquire data that meets their specific quality criteria will have to create their own data; this leads to a duplication of effort.

The Implementation of SG-SPACE is not a one-off but an on-going endeavour. To sustain the operations of various SG-SPACE components, we have to build a self-sufficient ecosystem within which the level of supply and demand of geospatial data is in equilibrium. In other words, the business models in the geospatial market have to ensure there is sufficient demand to achieve economies of scale in the data generation activities. SG-SPACE plays a vital role in creating an environment that allows industry to grow and businesses to prosper. The government will have to formulate policies that promote dissemination of non-sensitive government geospatial data to the public domain. Government should also provide the seed funding to help the startup companies that come up with brilliant business ideas to materialize their concepts. It remains as a daunting task to convince the top decision makers to be patient in seeing tangible outcomes of initiatives like SG-SPACE that focuses on building a long-term foundation rather than delivering short-term visible results.

5. GIS Projects Implementation in Government Agencies

The Survey Department has started to use GIS in early 1980s to manage and maintain cadastral survey information. Land Office also was early adopter of GIS in using the system to maintain sound land asset information. Land Data Hub was established in mid-80s to facilitate the land data exchange among government agencies. GIS was used to maintain a centralised system to support the data exchange.

SLA, formed in year 2001, is responsible for the administration and management of State land and properties. As the State agent of about 14,000 hectares of State land and 5,000 State properties, SLA is one of the heaviest users of geospatial information and technologies in its daily operations in the public sector. As a leading GIS agency in the Singapore public sector, SLA leverage on GIS to deliver its services and to make decision in daily operation. Over the years, many systems and infrastructure were developed leveraging on cutting-edge geospatial technologies.

INtegrated Land Information System (INLIS) was first introduced in 1998 to provide land information pertaining to land boundaries and ownership to the members of public. The major users are lawyers, real estate community, land surveyors, home buyers etc. This online system enables the government to make available property ownership information to the man in the street. In 2006, SLA rolled out its first online map services that allows members of the public to view street map and seek basic information pertaining to its ownership. The portal which is known as the StreetMap@Singapore allows public feedback to the authorities through its LandQuery module. Members of the public can direct the attention of relevant public agency to an issue at a specific location using the functions in LandQuery with ease. Since their launch in November 2006, the services have garnered more than 70 million hits per month.

The first initiative under the SG-SPACE was launch early this year, the OneMap portal. This is a government-wide initiative to give public and private sector a one-stop access to a wealth of government geospatial content from authoritative sources. It is a launch-pad for government agencies to build their own map services using an API through which a common and consistent look-and-feel map interface can be created. It will also be the gateway for the private sector to tap on rich government content and mash it up with their own collection of spatial information to create services and to support enterprises' business needs. Besides presenting public sector information, this intelligent map system will allow businesses and users to mash up some of the public spatial information via convenient technical interfaces such as APIs.

Internally in SLA, to deal with these increasingly complex issues, SLA piloted the use of mobile GIS and GPS in its daily land management operations. SLA's land management officers are all equipped with PDAs that are installed with system that allows them to locate and maintain state land and properties. SLA also piloted the use of GIS and statistical tools to identify locations in Singapore prone to slope failure. This project uses GIS-based coincidence modelling to prepare a Slopes Susceptibility Map (SSM) for spatial analysis. It allows preventive measures to be put in place to minimise damages and dangers and provides a longer-term solution to manage the risk of slope failure on State land.

The Singapore Satellite Positioning Reference Network, SiReNT was implemented by SLA in 2006. This Continuously Operating Reference System (CORS) has been in operation for more then 4 years and has gained much recognition as the authoritative Differential GPS (DGPS) infrastructure in Singapore. As a nation-wide system, SiReNT plays a significant role in the SG-SPACE as it is the national geographic reference frame which provides homogeneous coordinates system for a variety of positioning and geospatial needs. The system provides for fast, reliable, high quality and consistent geospatial data collection.

To encourage the use of GIS in schools, SLA started the Spatial Challenge in 2008 working closely with the Ministry of Education. The competition is organised for pre-university students, and encourages them to examine day-to-day applications with a spatial perspective and develop location-based solutions to tackle problems. Through this competition, SLA hopes to provide pre-university students an opportunity to gain insights into the growing geospatial industry and the opportunities that it presents. Since 2009, the SLA Spatial Challenge expended to include tertiary institutions such as National University of Singapore, Singapore Management University, Nanyang Technological University and various Polytechnics.

6. Conclusion

Developing a spatially-enabled nation is continuous and multi-disciplinary. Achieving the vision of SG-SPACE required a wide range of experiences and disciplines from surveying and mapping, land administration, GIS, information and communications technology, computer science, legal and public administration and many more. Hence, we should constantly emphasise on capacity building.

The success of SG-SPACE depends on the sustainable effort of a team of dedicated personnel who have the passion and a strong belief in the value of geospatial information and technology. There has to be a long-term plan set out with goals clearly spelled out, implemented through an incremental approach in phases, backed by the mandate from the top management and support from working level staffs.

Sharing of geospatial data and information is not just about building a clearing house. The most important issue is weather the geospatial data are indeed interoperable and ready for integration. To ensure sustainability, we need to create an eco-system and an environment where a strong framework is in place.

The challenge for SG-SPACE truly is getting people aware, interested, committed and involved within the government agencies, and eventually involving private sector and the community.

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Spatially Enabling Society

Part 3

Facilitating Spatial Enablement

Chapter 9

Automatic Spatial Metadata Enrichment: Reducing Metadata Creation Burden through Spatial Folksonomies

Mohsen Kalantari[1], Hamed Olfat[2] and Abbas Rajabifard[3]

Abstract

Metadata plays a key role in facilitating access to up-to-date spatial information and contributes to the finding and delivering of high quality spatial information services to users. In particular, metadata is an important element in functioning and facilitating spatial enabling societies in Spatial Data Infrastructure (SDI) initiatives. With huge amount of spatial information being generated, a spatial application must be sufficiently flexible to extract and update spatial metadata automatically.

Automatic spatial metadata generation framework includes three fundamental but complementary streams; automatic creation, automatic update and automatic enrichment of spatial metadata. This chapter explores the automatic metadata enrichment stream based on the tagging and folksonomy concepts. The chapter argues how folksonomies help bringing the vocabulary of spatial data users into play and using them hand in hand with those sometimes mysterious terms supplied by experts in metadata records.

The chapter then builds on the tagging and folksonomy concepts and proposes a conceptual model to employ them for spatial metadata enrichment. The chapter finally discusses advantages and disadvantages of this approach against formal type of organizing spatial metadata.

Keywords: spatial data, metadata, automation, tagging, folksonomy

1. Introduction

SDIs for spatially enabling societies are placed under pressure by a need for efficient and effective ways of indexing and organizing an increasing number of spatial datasets that are being added through both previously and recently created datasets. A well compiled metadata for datasets plays a critical role in searching and discovering spatial datasets. This is in particular essential for spatial data users in finding the correct datasets and for the spatial data systems such as geographical information systems and geo web services for interoperability.

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However authoring and compiling metadata for spatial datasets are often labor intensive and time consuming. Methods and approaches to overcome these issues are welcomed by the spatial industry. The concept of automatic spatial metadata generation research is rooted in automatic indexing, abstracting, and classification of spatial data content, which began with the need to organize increasing amounts of spatial related data and the inability of manual methods to cope with huge amounts of spatial metadata (Rajabifard *et al.,* 2009).

Today, automatic metadata generation should move beyond subject representation to encompass the production of author, title, date, format, spatial extension and many other types of metadata. In addition, thousands of spatial databases are now networked via the Internet, and information resources are frequently rendered in open and interoperable standards (e.g., eXtensible Markup Language or XML). These developments should enable automatic metadata generation systems to work on far larger spatial data directories.

Automatic spatial metadata generation research efforts are relatively new in the spatial field however a framework for spatial metadata automation which includes automatic creation, update and enrichment of spatial metadata is shown in Figure 1 (Kalantari *et al.,* 2009). This framework defines three fundamental but complementary streams that can be employed for metadata automation as described below.

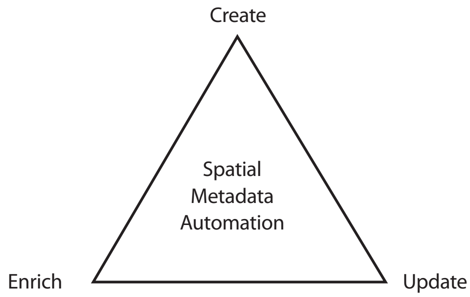

Figure 1. Spatial Metadata Automation Framework

1.1 Automatic Update

Automatic spatial metadata update or synchronization is a process by which properties of a spatial dataset are read from the dataset and written into its spatial metadata. Some software vendors such as ESRI conceptualize metadata automation as synchronizing the metadata content when values in the spatial data change. In this type of model, for instance when a change occurs with a spatial data property such as its projection, the metadata will be updated with the new information. Olfat *et al.* (2010) proposed a GML based approach to facilitate automatic metadata updates. In this approach GML is used as a medium for transferring metadata details from one file to another and monitor changes for automatic updating of the metadata content.

1.2 Automatic Creation

While automatic update and synchronization is suitable for updating an existing metadata record, there is a need for other methods when there is no existing metadata associated with spatial data. Humans create metadata by writing descriptions of resources either in a structured or unstructured form. Computer applications can then extract certain information from a resource or its context. This may simply involve capturing information that is already available, such as the format of the file, or running an algorithm to determine the subject of a textual resource by counting keywords or by checking and analyzing pointers to the resource.

1.3 Automatic Enrichment

The third aspect of metadata automation which will be further discussed in this article is automatic enrichment that involves improving content of the metadata through monitoring tags and keywords that are used by users for finding datasets. Creating metadata by monitoring user interaction is based on the Folksonomy concept, a concept that was first introduced by Thomas Vander Wal in (2004). He stated: "Folksonomy is the result of personal free tagging of information and objects for one's own retrieval. The tagging is done in a social environment (usually shared and open to others). Folksonomy is created from the act of tagging by the person consuming the information. The value in this external tagging is derived from people using their own vocabulary and adding explicit meaning, which may come from inferred understanding of the information/object. People are not so much categorizing, as providing a means to connect items (placing hooks) to provide their meaning in their own understanding. Vander Wal adds, "Folksonomy is tagging that works. This is still a strong belief the three tenets of a folksonomy: 1) tag; 2) object being tagged; and 3) identity, are core to disambiguation of tag terms and provide for a rich understanding of the object being tagged."

This chapter introduces and discusses concept behind the automatic metadata enrichment stream based on tagging and folksonomies and also compares this stream against the other information indexing approaches. The chapter then builds on the tagging concept and proposes a conceptual model to employ the tagging concept for spatial metadata enrichment. The chapter finally discusses the advantages and disadvantages of this approach against other formal type of organizing spatial metadata.

2. From Tagging to Folksonomies

Traditionally metadata is created by dedicated professionals (Mathes, 2004). Similarly in the spatial field, metadata experts create metadata, and this is the basis of most catalogues in SDIs. This often requires serious knowledge and background. The spatial industry in the metadata field has developed standards and schemes for cataloguing, categorization and classification of spatial data.

While professionally created metadata are often considered to be of high quality, it is costly in terms of time and effort to produce. This makes it very difficult to scale and keep up with the vast amounts of new spatial data being produced and updated, especially with new technologies like Global Navigation Satellite System, Satellite imagery, automatic map creation methods and in particular mediums like the World Wide Web.

An alternative is author created metadata. Original producers of the spatial data provide metadata along with their creations. The Dublin Core Metadata Initiative has been used with some success in this area (Greenberg *et al.,* 2001). Author created metadata may help with the scalability problems in comparison to professional metadata, but both approaches share a basic problem: the intended and unintended eventual users of the spatial information are disconnected from the process.

There is a third approach that can be utilized to capture spatial information users' notion of data and information to create metadata for the spatial information. Users will use their own language to describe the spatial information. This can go even deeper and they can express their comments not only about the data title but also on the other aspects of the metadata. In a sense this is a way of connecting users of spatial data to the process of creating spatial metadata. Sharing spatial datasets in SDIs and allowing users to write notes about them, tag them and even share their notes with the other users opens another horizon for automation of spatial metadata and efficient using of them. This section provides a background review of tagging and folksonomy concepts to explore the potential of them in spatial metadata automation.

2.1 Tagging Concept

Returning to the history of the web technology, web browsers have allowed a user to "bookmark" a web site and organize these bookmarks into hierarchical file folders similar to the filing systems they use with paper files and the electronic files on their computer. As the web grew, filing bookmarks in one's browser became unwieldy. Sites like Delicious.com allow users to save the URL for a web site; provide an annotation if desired; supply a number of tags that will help to retrieve it again; and group similar URLs together. These tags can be whatever or how many associations the user wishes to make with the URL. In this way, the URL can be associated with many concepts at once. This ability to use tags to bring out different aspects of a resource is a major advantage of tagging over formal systems of classification and taxonomies (controlled vocabularies)(Thomas *et al.,* 2009) which can be adopted for spatial metadata automation.

According to Shirky (2005), traditional classification methods for information resources attempt to systematically organize knowledge by providing a single classification for a resource. For instance, in spatial information one can classify geo-coded features together with the addressing layer in a single classification as landmarks. Otherwise they can be separated into two different classification administrative and landmark layers.

Shrinky (2005) further argues that the free associations made by taggers are the only appropriate way to organize resources on systems as large and chaotic as the web for three reasons: classification fails to allow more than one place for an item; it is impossible to keep a classification system stable over time; and it is also impossible for an expert to truly predict how a user will search for something. This cannot be entirely relevant to SDIs but to an extent in spatial arena with an increasing number of spatial data layers, users and applications. First, it is difficult to stabilize a classification of information, secondly (and more importantly), it is impossible to predict how increasing number of interested users and applications might name or interpret a spatial data set.

The tagging approach provides more freedom for users, because when tagging, the user does not have to make a decision and restrict the resource to just one or two formal terms from a controlled keywords they may or may not be familiar with. Instead the users supply their own terms which are meaningful to them (Shirky, 2005). For instance, spatial data users can select different tags to describe the same item. Items related to scale may be tagged "500", "1:500", "1/500". This flexibility allows users to classify their collections of items in a way that they find useful and users also have to decide whether each tagged item is actually relevant to what they're looking for.

Sinha (2005) performed a cognitive analysis of tagging, stating that it works well for users because it lowers the cognitive cost of making decisions on how to categorize a resource. It is easier for people to assign and remember their own terms for later retrieval. According to Mathes (2004) and Shirky (2005) tagging works by lowering the barrier to participation. Users do not have to be experts and learn complex rules and specialized vocabulary in order to tag as they do when applying a controlled vocabulary (Mathes, 2004).

The ease and freedom with which one can apply tags explains why tagging is so popular and form folksonomies which will be discussed in the next section.

2.2 Folksonomies

Besides identifying different functions for tags, Golder and Huberman (2006) also describe collaborative tagging systems. Users tag primarily for themselves but the software makes it possible to see all the tags used for a resource so that a user may utilize tags from other users.

In this fashion, the folksonomy becomes a common vocabulary grown from the ground up. As the number of uses increases, each resource develops a "tag cloud" or a cluster of tags denoting popularity. Furthermore, the most popular resources are tagged the most frequently which, in turn, influences other users in their choice of tags.

Actually, the most popular tags for a resource turn out to be an accurate representation of the resource, exhibiting a power law distribution, with common descriptive tags being used in far greater proportion to the more varied or personally oriented tags (Golder and Huberman, 2006). The system then will be operating on a folksonomy basis.

Users, tagging for themselves, collectively create useful sets of subject descriptors in the form of tags for the resources they are tagging and this user-added metadata can then be leveraged for information retrieval on a general as well as a personal level.

Having described tagging and folksonomies, the next section lays the ground work for metadata enrichment using these concepts towards automatic metadata creation.

3. Automatic Spatial Metadata Enrichment

Considering spatial metadata's small size compared to the data it describes, it is more easily shareable (ESRI, 2002) and is considered as the surrogate of a spatial dataset which is referenced to its related spatial dataset. Hence, in a networked environment such spatial surrogates are discovered by the users seeking out required spatial datasets through catalogue systems, web services and the user interface. The user interface usually supports making a variety of queries (via basic and advanced searches) on spatial metadata records to retrieve the characteristics of the most appropriate datasets for end users.

These queries are generally based on the keywords or phrases used by the spatial data users. The keyword element is also one of the mandatory elements recommended by the ISO 19115 Metadata Standard which is embedded into each spatial metadata file and is defined as "commonly used word(s) or formalized word(s) or phrase(s) used to describe the subject"(ISO, 2003).

In this regard, finding effective keywords to describe the spatial data sets is fundamental within any sharing platform. The right keyword for any spatial data set means the keyword which is consistent with the content of the data set and can reveal its essence and applications. In addition, a good keyword should be comprehensive and address the probable queries made by users from diverse categories. Moreover, a keyword should be popular meaning that most of the users agree on that keyword.

The new form of metadata that are created by users, the Folksonomy introduced earlier, can facilitate the generation of good keywords for any sharable resources. Folksonomic metadata consists of words that users generate and attach to content, which are well known as tags (Alexander, 2006).

"Geo-tags" might be the good example of tags as the keywords linked to a concrete position (Heuer and Dupke, 2007). Geo-tagging allows for easily combining attributive information with spatial location. People share their geo-tagged contents on platforms like Flickr or the Google Earth Community.

However, the tagging concept is new in the spatial arena and can be considered as one of the potential ways to enrich the spatial metadata content. As a result of this, the automatic spatial metadata enrichment, as one the main streamlines of spatial metadata automation (Kalantari *et al.,* 2009) involves improving the content of metadata through monitoring the popular searched keywords and tags used for finding the spatial data sets to their related metadata records.

Generating this kind of spatial metadata can help describe a data set and allow it to be found again by browsing or searching easily and quickly. These tags will be chosen systematically or informally and personally by the spatial data publisher or by its users, depending on their use. On a spatial data directory where many users are allowed to tag much spatial data, this collection of tags can become a spatial folksonomy, that is, a method that can collaboratively create and manage metadata to annotate and categorize spatial data.

It is arguable that tagging and folksonomies are only workable in large scale information resources such as broader WWW with huge number of users rather than relatively small scale networks such as SDIs. Addressing this argument, the next section proposes a mechanism to directly and indirectly involve the users in the tagging process and capture their knowledge in the system to create a spatial folksonomy for SDIs. The folksonomy then created can be used to enrich the metadata content of spatial datasets.

4. Conceptual Design for Automatic Metadata Enrichment

As discussed above, tagging and folksonomies can be employed to help automate metadata by enriching the content. In this space, there are two complementary approaches for metadata enrichment; system and user oriented approaches.

Consequently, to implement the automatic spatial metadata enrichment concept based on tagging, two models have been designed. The first model is indirect tag generation for spatial data sets based on system oriented approach and the second model is direct tag generation by engaging the spatial data users in tagging process. These streams are discussed below:

4.1 Indirect Automatic Enrichment Model

The system oriented design is concentrated on monitoring tags that are employed by spatial data users, analyzing them and then employing the tags to enrich the content of metadata.

The indirect automatic enrichment model is streamlined in three stages (Figures 2, 3, 4):

- Monitoring keyword;
- Recording keyword;
- Assigning keyword.

Stage 1: Monitoring Keyword

The data catalogue systems consisting of data and metadata repositories (distributed or centralized) typically provide the users with the services to discover and access the data. As mentioned earlier, through these systems one of the common ways of data discovery is to query the metadata records via searching using keywords. Then, the discovery service will search and retrieve all the corresponding metadata records with that keyword. The users will be able to view the results by opening the metadata files and deciding on which data is more suitable for their needs. Finally, through the access service they will be able to access the required data or be aware of the access policies and rules.

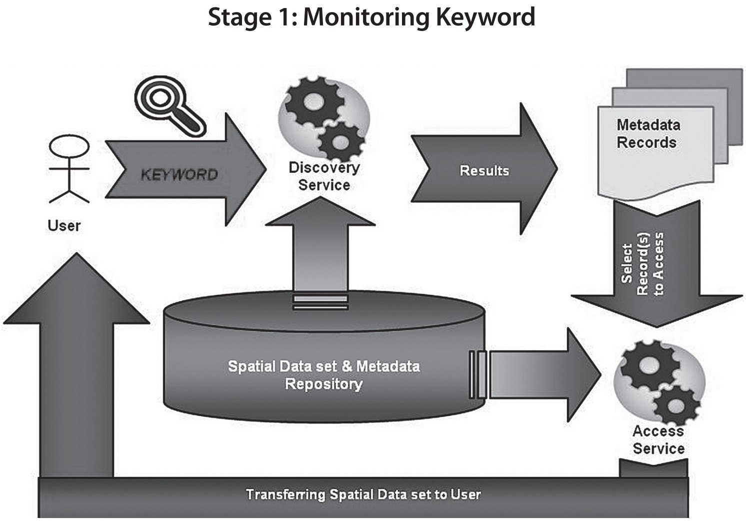

Figure 2. Stage 1/ The Automatic metadata automatic enrichment flow

The main aim of Stage 1 is to identify the keywords used by the users which allow them to utilize the search process. To do so, any used keyword is monitored during the process of data discovery and access. This stage is based on the assumption that any keyword directing the user to the final required data may be used in the future by the same user or other users; thus it should be recorded by the system (Figure 2).

Stage 2: Recording Keyword

In this stage, any keyword relevant to any spatial dataset which has been identified in Stage 1 would be recorded in a temporary database. This database is related to the corresponding metadata records through data fields such as "Metadata ID", "Spatial Dataset Name", "Keyword" , "Number of Repetition" etc. The main aim of this stage is to recognize how many times any keyword is used in the discovery process for the same spatial data set. Increasing use of the same keyword illustrates its popularity (Figure 3).

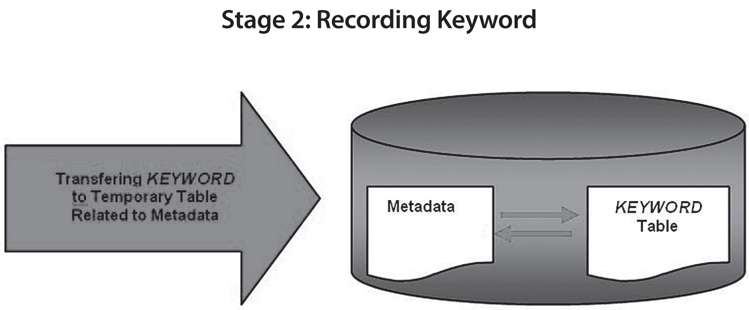

Figure 3. Stage 2/ The Automatic metadata automatic enrichment flow

Stage 3: Assigning Keyword

Among the keywords recorded in Stage 2, any of them which have a specific value of repetition will be assigned to its spatial metadata file and stored in its keywords field. Indeed, the new keyword will be added to the spatial data set.

Through indirect enrichment process, the popular keywords used for finding spatial data sets are identified and shared between users. In addition, this process will facilitate the spatial data discovery within data catalogue systems. This process enriches the metadata records related to spatial data sets through applying and refining the appropriate keywords (Figure 4).

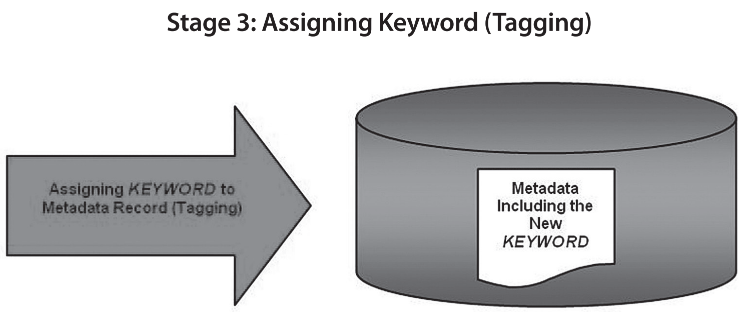

Figure 4. Stage 3/ The Automatic metadata automatic enrichment flow

4.2 Direct Metadata Enrichment Model

Contrary to the indirect metadata enrichment model based on the system oriented approach, in the direct model to enrich the spatial metadata content a tagging process by the users is also considered. This is in fact a feedback mechanism after presenting the result of a user query. Through this process, the spatial data users tag a data set with words they feel best describe what it is about. Accordingly, they will be involved in the enrichment process and the knowledge of the users about spatial data sets will be shared. Moreover, the tagging process will help the users easily and quickly find their tagged data sets again within the spatial data catalogue.

The users will tag the data sets according to their awareness of data and also the intention of using that data which is usually related to their circumstances. These tags are visualized by "Tag Cloud" in the spatial folksonomy. Within the tag cloud, the tags which are used more frequently by the users will be highlighted and shown in a bold format (Figure 5). For instance, the tagging process for 1:2000 map of Melbourne city can be imagined here. The users of this map can be Melbourne citizens, tourists, students, or decision makers from different organizations.

Figure 5. The Tag Cloud for Melbourne Map 1:2000

The users are also able to agree and disagree with the existing tags in the tag cloud by clicking or not clicking on the tags. Having designed the model for metadata data enrichment through folksonomies the next section discusses the efficiency of a system based on folksonomies.

5. Enrich or not to Enrich by Tags

A spatial metadata enrichment system based on tagging and folksonomies will benefit both spatial data publishers and users in terms of facilitating the data discovery process, involving users in metadata creation and enrichment, making the data catalogue systems more user-friendly, and sharing the users' knowledge about spatial data sets.

A disadvantage of a spatial tagging system could be where there is no information about the meaning or semantics of each tag. For example, the spatial tag "Melbourne" might refer to the Central Business District of Metropolitan Melbourne or Metropolitan Melbourne itself and this lack of semantic distinction can lead to inappropriate connections between spatial data.

All tags have this problem of ambiguity. Different users may use the same tag to mean different things because they are applying it in different contexts to different resources. For instance, one user may assign the tag "Property" to a resource about generic cadastral layers while another user may use the same tag to refer only to parcel layers.

Tags can be applied at different levels of specificity by different users (or even by the same user at different times). Besides different terms may be used for the same concept (again by different users or by the same user – users will not necessarily be consistent) (Hayman, 2007).

Typically, no information about the meaning of a tag is provided although the indirect metadata enrichment model, proposed earlier, makes sure the user is tagging in defined framework. The user will be provided with a number of suggestions, however still will remain independent deciding on labelling a data set.

However, larger-scale spatial folksonomies can address some of the problems of tagging, as users of spatial tagging systems tend to notice the current use of "tag terms" within these systems, and thus use existing tags in order to easily form connections to related items. In this way, spatial folksonomies collectively develop a partial set of metadata standards through ongoing involvement of non-expert spatial users (Kalantari *et al.,* 2009).

6. Conclusion

With increasing amount of spatial information being generated, SDIs must sufficiently manage updating spatial metadata automatically. This chapter built on folksonomy and tagging concepts and proposed a solution for metadata automation by enriching the content of metadata through monitoring keywords used and tags allocated by users. A brief introduction to tagging and its evolution towards folksonomies in the first part of the chapter outlined the weaknesses of expert generated keywords which are the strengths of folksonomies.

Through the conceptual design of automatic metadata enrichment process the chapter illustrated there is a fundamental difference between browsing and finding in spatial data discovery. Browsing tags in folksonomies is valuable for unanticipated discoveries of related datasets. That is a much different task than searching for every data layer in an SDI area using a specific term.

Folksonomies directly reflect the vocabulary of users instead of using the sometimes mysterious terms supplied by experts. Keywords in metadata records over time become rigid, out of date, and distant from the every day language of the growing number of users.

However, it should be emphasized that folksonomies and controlled keywords have different strengths which can complement each other since the strengths of one are the weaknesses of the other. Keywords and standards enable uniform access and interoperability. Folksonomies on the other hand, brings user language, perspective, expertise, and eventually will lead towards more user oriented metadata. This article is based an ongoing research in the area of metadata automation and recommends combining folksonomies with controlled keywords in SDIs, to create richer metadata.

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Chapter 10

Volunteered Geographic Information in Spatial Data Infrastructure: An Early Look at Opportunities and Constraints

David J. Coleman[1]

Abstract

Advances in personal positioning, Web mapping, cellular communications and wiki technologies have surpassed the original visions of the architects of spatial data infrastructure programs around the world. Using GPS-based cellphones and personal navigations systems, people now view their own position (and those of others) in real time on a backdrop of georeferenced maps and/or imagery. Similarly, they can share location information describing points of interest, places visited, recent construction, and corrections to out-of-date feature attributes. This capability to "view and provide contributions in context" is fundamental to the vision of a spatially enabled society.

By tapping the distributed knowledge, personal time and energy of volunteer contributors, GI voluntarism has the potential to relocate and redistribute selected GI productive activities from mapping agencies to networks of non-state volunteer actors. However, if we are to design strategies and systems to maximize its advantages and minimize the risks to authoritative mapping programs, we must have a clear understanding of the people and technologies involved.

This chapter describes a program of research led by the author in examining the risks and opportunities created by the emergence of Volunteered Geographic Information (or "VGI") as a viable means of updating and enriching authoritative geographic information databases maintained by public and private sector providers. After briefly summarizing early research into the nature and motivation of contributors, the author develops a framework to compare three very different programs driven by volunteered contributions in Australia, the United States, and internationally Geological Survey . Finally, the author describes early empirical accuracy testing results and important questions to be posed by authoritative data providers when considering VGI as a source of data updates.

Keywords: Volunteered geographic information (VGI), spatial data infrastructure, crowd-sourcing, urban sensing, national mapping organizations, location-based services

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1. Spatial Data Infrastructure Research at UNB

UNB GGE faculty members were early investigators and proponents of the spatial data infrastructure movement (e.g., McLaughlin, 1991; McLaughlin, Nichols *et al.,* 1993; Coleman and McLaughlin, 1994) convinced that the impact of GPS and Location-Based Services was being underestimated in mapping- and Web-centric SDI initiatives. Coleman (1999) presented an early taxonomy that attempted to classify the possibilities emerging in a broader spatial data infrastructure that encompassed such services.

While most widespread LBS applications at that time enabled people to know their own location or that of specific objects, that paper predicted, safely, that future applications would move beyond this to provide things with the same knowledge. More contentious at the time, the paper went on to predict that these developments would have a significant impact on the nature and direction of future partnerships between federal and provincial government data suppliers, as well as potential third-party distributors and strategic industrial partners. Even then, however, I clearly underestimated the extent to which spatially-enabled individuals would become both sophisticated users of and contributors to future public and private spatial data infrastructures.

Follow-on UNB research in network-based GIS and subsequent contributions to early commercial Web mapping systems evolved into developing and investigating the impact of enhanced collaborative Web mapping and database systems on multi-participant production workflow (Li, 2001). More recently, UNB researchers have focused on investigating means of measuring public acceptance of new Web-based public participation GIS prototypes (Zhao and Coleman, 2006; Tang and Coleman, 2008). Developed and refined by two MScE students, the GeoDF prototype software (Figure 1) represented one of the first working prototypes integrating off-the-shelf Web 2.0 interactive mapping, markup, and discussion forum capabilities.

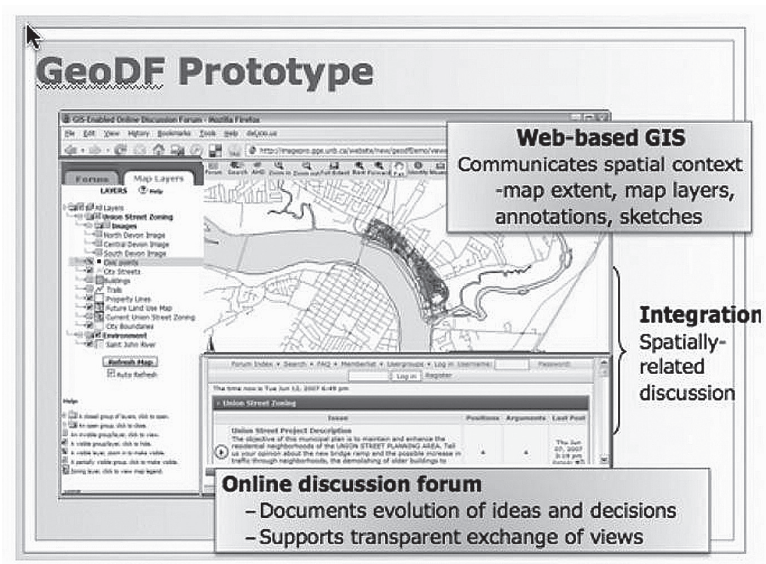

Figure 1. GeoDF: Integrating Web Mapping and Internet Discussion Forums

In both cases, the emphasis of my group has been on working in collaborative environments where participants contribute to shared databases. The research discussed in this chapter builds on those experiences with collaborative systems, mapping, workflow analysis, and geospatial data infrastructure, and focuses on the increasing convergence of three phenomena: (1) the widespread use of GPS and image-based mapping technologies by professionals and expert amateurs; (2) the emerging role of Web 2.0, wikis, and standards based authentication processes to contribute information to the Web; and (3) the growth of social networking tools, practices and culture. In particular, it investigates how contributions from both individual citizens and professional mapping projects may be authenticated, processed and employed to populate new open-source and commercial databases.

2. Context of Current Research

Numerous articles and examples since 2006 have introduced us to the terms "neogeography" (Turner, 2006), "produsers" (Bruns, 2006; Budhathoki *et al.,* 2008), and "volunteered geographic information" or VGI (Goodchild, 2007). Collaborative Web-based efforts like Open Street Map, Tagzania, UCrime.com, Wikimapia, Wayfaring, People's Map, Foursquare, Trapster, and Waze all enable amateur enthusiasts to create and share georeferenced point- and line-based data. Citizen inputs from personal GPS receivers and cellphones inform members of their social network of up-to-the-minute traffic conditions, as well as strengthened emergency response efforts to storm surges in Louisiana, wildfires in California, and the recent earthquake in Haiti.

State governments in Victoria, Australia and North-Rhine Westphalia, Germany employ volunteered input to their mapping programs, and the U.S. Geological Survey was an early examiner of the technology as well (Coleman *et al.,* 2010). Commercially, firms like Tele Atlas, NAVTEQ and TomTom use Web-based customer input to locate and qualify mapping errors and/or feature updates required in their road network databases. Google Map Maker now provides to citizens in 180 jurisdictions (Figure 2) with the ability to help populate and update Google Maps' graphical and attribute data (Google, 2010). In October 2009, Google announced it would be foregoing relationships with a traditional supplier for its U.S. data coverage as it increasingly relies on its own capabilities and volunteer base.

Early temptations to characterize such contributions in terms of coming from "amateurs", "non-experts" or "non-professionals" and dismiss them accordingly have been provocative, but have done little to rationally examine the potential and risk management issues at hand. Papers by Coote (2008) and Goodchild (2009) have offered more balanced and reasoned starting points for discussion of the opportunities and constraints.

What motivates individual citizens to voluntarily contribute such information? Can such contributors be trusted? How are their contributions to be assessed and, if acceptable, incorporated into authoritative databases? VGI updates may represent a real opportunity to keep mapping data up to date. If the private sector is already using this, what's holding back the majority of budget-strapped public sector mapping programs?

These questions form the basis of a research program underway at the University of New Brunswick. This chapter builds on research by the senior author in reviewing and classifying both VGI contributors and the nature of their contributions (Coleman *et al.,* 2009; 2010a; 2010b). Drawing upon lessons learned in other types of user contribution systems, the author

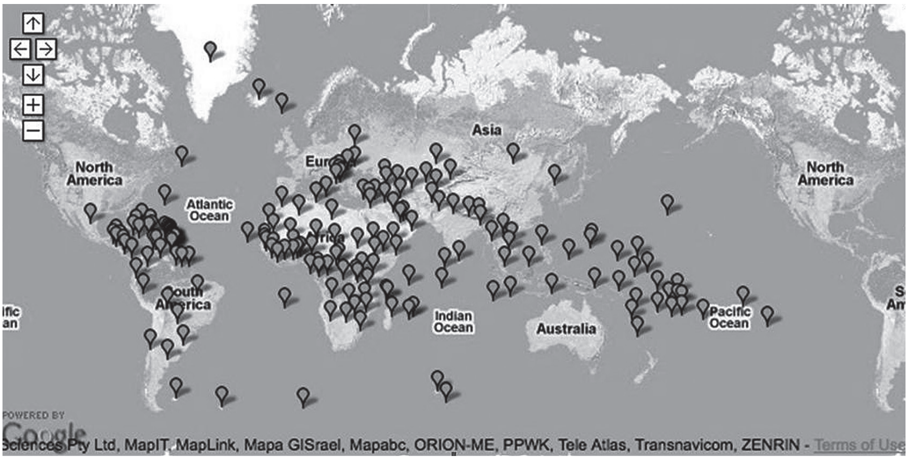

Figure 2. Countries in which individuals collect and edit their own data using Google Map Maker as of May 2010 (Google, 2010)

employs a framework to describe how contributor motivations and their contributions may influence the design of more sustainable re-engineered mapping programs in future. He then compares three very different programs driven by volunteered contributions in Australia, the United States, and internationally Geological Survey. Finally, the author describes early empirical accuracy testing results and important questions to be posed by authoritative data providers when considering VGI as a source of data updates.

3. Characterizing Volunteers and their Contributions

The concepts of "user-generated content", "user-created content" and "consumer-generated media" are nothing new (O'Reilly, 2005; OECD, 2007; Shirky, 2008). Cook (2008) and others document a long history of both passive and active "User Contribution Systems" in the consumer market. Early lessons and analogies may be drawn from broader GIS and spatial data infrastructure research and crowdsourcing/VGI-specific work now underway in key centres in (especially) North America and Europe (e.g., Harvey, 2003; Kuhn, 2007; Bishr and Kuhn, 2007; Craglia *et al.,* 2008; Budhathoki *et al.,* 2008; Elwood, 2008 and others). Finally, more in-depth analyses of the both the accuracy of contributions and demographics of VGI contributors are just beginning to appear (e.g., Haklay (in press); O'Donovan, 2008; and Goodchild, 2008).

Results of early research into the nature and motivation of contributors are discussed in depth in Coleman *et al.* (2009). If VGI *does* represent a potential opportunity for large mapping organizations with respect to the authoritative databases they manage, how are they to evaluate the advantages and risks involved? Important questions remain to be answered. For example:

(1) Can it be assumed people will want to contribute to government in the same way they contribute to social networks and even to commercial databases from TomTom, Navteq and others?
(2) What questions should an organization ask in determining how, if at all, it should employ geographic information provided volunteers?
(3) How does an organization assess the credibility of a new contributor and the degree of trust it can place in that person's contributions?

and

(4) How do organizations attract new volunteer contributors? How do they keep existing volunteers "engaged" -- or is it assumed they will cycle in and out?

Coleman *et al.* (2009) consolidate and summarize the observations of research into what motivates people to make contributions to efforts like *Wikipedia* and Open Source Software development. From this work, they offer the following list of motivators for individuals to make contributions. On the constructive side:

(1) *Altruism*;
(2) *Professional or Personal Interest;*
(3) *Intellectual Stimulation*;
(4) *Protection or enhancement of a personal investment*;
(5) *Social Reward*;
(6) *Enhanced Personal Reputation*;
(7) Provides an *Outlet for creative & independent self-expression*;
(8) *Pride of Place*.

And, on the negative side…

(9) *Mischief;*
(10) *Social, economic or political agenda; and*
(11) *Malice and/or Criminal Intent.*

Interestingly, Craig (2005) describes variations on three of the constructive motivators — calling them "Idealism" "Enlightened Self-Interest" and "Involvement in a professional culture" — as motivators for 'white knight' champions leading development of spatial data infrastructure-related initiatives in the United States

The contributions these individuals make may also be sorted into either "Constructive" or "Damaging" categories, including the following:

Constructive

- Legitimate new content;
- Constructive amendments, clarifications and additions;
- Validation and repair of existing entries; and
- Minor Edits and Format Changes.

Damaging

- Mass Deletes – Removal of all or nearly all of an article's content;
- Nonsense – Text that is meaningless to the reader and/or irrelevant to the context of the article;
- Spam – Advertisements or non-useful links incorporated into the article;
- Partial deletes – Removal of some of an article's content, from a few sentences to many paragraphs;
- Misinformation – Clearly false information, such as changed dates, subtle insertions or removal of certain words which change the meaning of a passage.

There are corresponding geographical examples of all four types of Constructive Contributions. In terms of damaging contributions, the possibility of a Partial Delete to a map database could have serious consequences. While they may occur, the likelihood of not easily detecting and correcting Mass Deletes or Nonsense contributions (e.g. GPS Art) to a map database would be low. "Misinformation" may fall into two categories. *Unintentional* misinformation may be provided where someone genuinely believes they are providing reliable new information or updates but, due to procedural errors, innocent misinterpretations, or reliance on false second-hand information, incorrect information is provided. Contributions of deliberate or *intentional* misinformation are usually driven by a conscious agenda.

While far from foolproof, there *are* tools now being developed that can at least ostensibly help identify the location of the computer from which a contribution is being made. Using technologies similar to *WikiScanner* (Borland, 2007) may enable organizations to match Web-based contributions to a specific IP address, at least giving each entry a nominal geographic location.

4. Early Lessons and Follow-Up Case Studies

What early lessons may be drawn from this review of volunteered contributions to other on-line communities? How may these lessons influence the design and implementation of VGI efforts in authoritative mapping databases in government or industry?

First, volunteer contributors clearly desire some recognition of their contribution. For example, this recognition may range from early recognition of the contribution by a return e-mail message. (TeleAtlas acknowledges such contributions to their MapInsight Website.) Second, contributors want to see their contribution used -- and quickly. Case studies cited from both the Wikipedia and the Open source Software communities identified the importance of contributions being acted upon and either incorporated or refuted quickly.

The third lesson learned is that there are ways to validate contributions of spatial information and their contributors. There are definite spatial and temporal considerations that make VGI contributions unique, and these may be used to support or refute the credibility of a given contributor (Bishr and Kuhn, 2007; Coleman *et al.,* 2009). For example, while anyone from anywhere may be in a position to contribute to an article on "Mozart" or "Orienteering", a volunteered contribution of mapped information covering a new subdivision in Ottawa, Canada may be justifiably flagged at least for review if the contribution is found – through WikiScanner or an equivalent technology – to originate from a contributor PC based in China.

Also, the date and time at which a volunteered contribution is made concerning (e.g.,) a given segment of highway may have a bearing on its credibility – especially when trying to assess the reliability of two or more competing or contradictory contributions.

Finally, as pointed out by both Shirky (2008) and Bruns (2008), in an environment where many people have access to inexpensive means of "production" – be it a keyboard, cellphone camera, camcorder, or GPS in a PDA – the emphasis of both consumers and professionals understandably shifts away from production and towards *filtering*. Further, depending on the type of information being collected, there may in future even be a mix of responsibilities when it comes to determining who actually performs such filtering or quality control – trained professionals or a network of informed consumers. Much will depend upon program design and acceptance criteria and, if the variety of examples already on the Web is any indication, the situation will likely be different from organization to organization. Phased approaches can be accommodated.

UNB researchers followed up this research by investigating how three different public and private organizations incorporated volunteered contributions into their production workflow. Investigations by Coleman *et al.* (2010) detailed how three programs driven by volunteered contributions: the State of Victoria's Notification and Editing Service in Australia (Figure 3), the National Map Corps Initiative of the United States Geological Survey (Figure 4), and TomTom's MapShare™ Service (Figure 5) – all appealed to specific motivators defined in the earlier research.

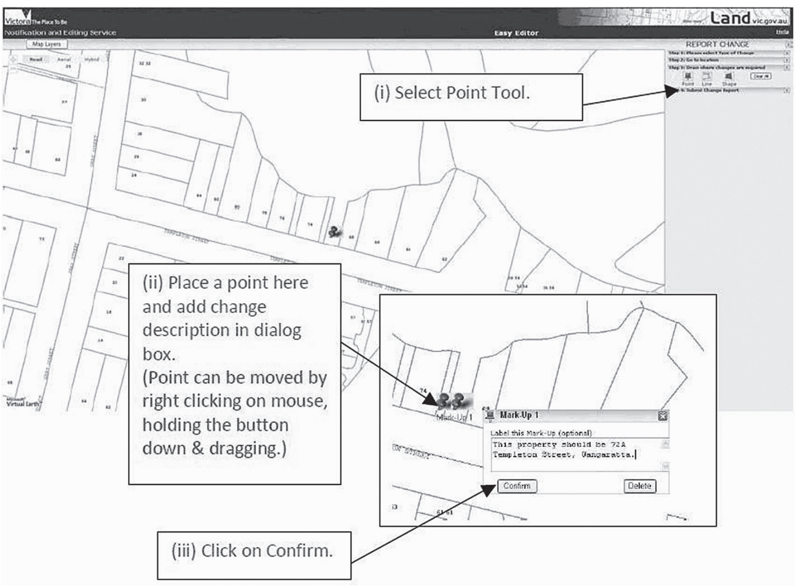

Figure 3. Amending Road Centreline Data (NES, 2009b)

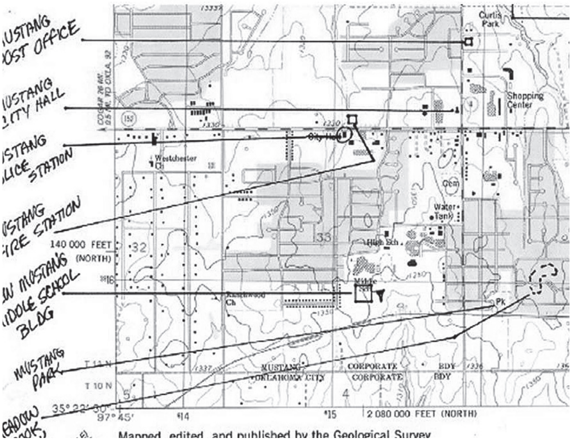

Figure 4. Volunteered updates to hardcopy USGS Mapping (Bearden, 2007)

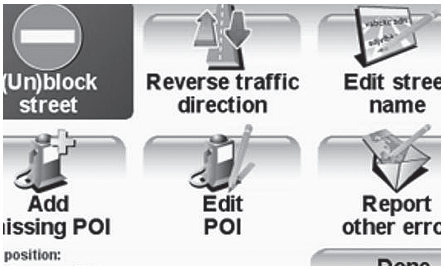

Figure 5. Early examples of TomTom MapShare edit capabilities (Club TomTom, 2007)

5. Assessing the Accuracy of VGI

Once authoritative mapping organizations better appreciate the motivations of potential volunteer contributors, they require a more in-depth understanding of the potential accuracy of the contributions. Assuming the feature is being identified and mapped properly (not always a safe assumption — see (Bearden, 2007) for this discussion), then the accuracy depends on the technologies and processes employed.

A research project conducted at UNB from mid-2008 through mid-2009 investigated the extent to which GPS-enabled cellphone and handheld devices commonly used by VGI contributors were compliant with Canadian Geospatial Data Infrastructure (CGDI) accuracy standards (Sabone, 2009). This work involved: (1) identifying and characterizing three leading LBS positional technologies and most common VGI data types; (2) developing criteria which assess VGI quality in terms of positional and attribute accuracy; (3) testing VGI against criteria and comparing with CGDI data and accuracy standards/specifications; and (4) designing a framework that seeks to integrate VGI with CGDI datasets that satisfies the criteria and CGDI data accuracy requirements.

In her research, Sabone (2009) assessed the degree to which VGI data contributions could meet Canadian National Road Network (NRN), National Topographic Data Base (NTDB) and CanVec specifications covering positional and thematic attribute accuracy. Using this criteria, it was hypothesized that VGI should be capable of meeting NTDB mapping specifications which state that 90% or more of all well-defined features in the dataset should be within 10 metres of their true position.

For making positional accuracy comparisons with VGI samples, NRN road, street and points-of-interest data was downloaded from the GeoBase portal. Table 1 gives a summary of the datasets collected and used for analysis, and Figure 6 shows a map of the areas in which data was collected.

Dataset and Area	Source	Date Collected/Obtained
Points of Interest (Downtown Fredericton)	• Garmin GPSMAP 76CSx • Garmin eTrex • Topcon RTK GPS	• (February/09) • (June/09) • (August/09)
Residential Streets (Skyline Acres)	• GPS track from Garmin GPSMAP 76CSx • GPS tracks from iPhone • GPS tracks from Garmin eTrex • GeoBase National Road Network • OSM streets	• (February/09) • (February/09) • (April/09) • (February/09) • (June/09)

Table 1. Summary of Datasets Collected

Figure 6. Data Collection Area in Fredericton, New Brunswick, Canada

Sabone used two approaches to assess the positional accuracy of VGI features. First, a methodology developed by Goodchild and Hunter (1997) and Hunter (1999) was employed to assess the percentage of VGI linear features that fell within the accuracy criteria specified. Second, to develop an even more in-depth assessment, the "mean separation" between corresponding VGI and NRN road centrelines were also measured for road segments across the project area. This comparison was carried out by sampling points along the tested sources

(VGI street data) and in each case measuring the distance to the closest point on the reference source (i.e., the NRN data).

For the first approach, 10-metre buffers were generated around the NRN vector data (See Figure 7), and the VGI linear data was then overlaid on these buffers to determine the percentage of such VGI features fell within 10 m. of the more accurate NRN representation of the roads and streets. From this, the percentage of VGI street data within 10 m of the same line in NRN data was determined. (Haklay (in press) adopted the same approach for his comparisons of OpenStreet Map and Ordnance Survey datasets in Great Britain.)

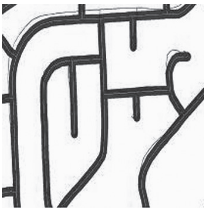

Figure 7. VGI Road Centreline Data overlaid on 10 m buffers generated around NRN Data

For the second approach, positional differences between representations of the same linear features in the VGI and NRN datasets were measured manually to obtain the mean separation between corresponding street features within the datasets. Street data from three different VGI datasets were compared using this approach: (1) data downloaded from OpenStreetMap; and data collected using (2) iPhone; and (3) Garmin eTrex. Points were sampled along the streets in the VGI datasets at 50 m intervals. Perpendicular distances (or "separations") were then measured interactively between each of these points in the VGI datasets and points on the same street in the NRN dataset, and the "mean separation" for each street was calculated and plotted. (See Figure 8 for an example of one of the plots.)

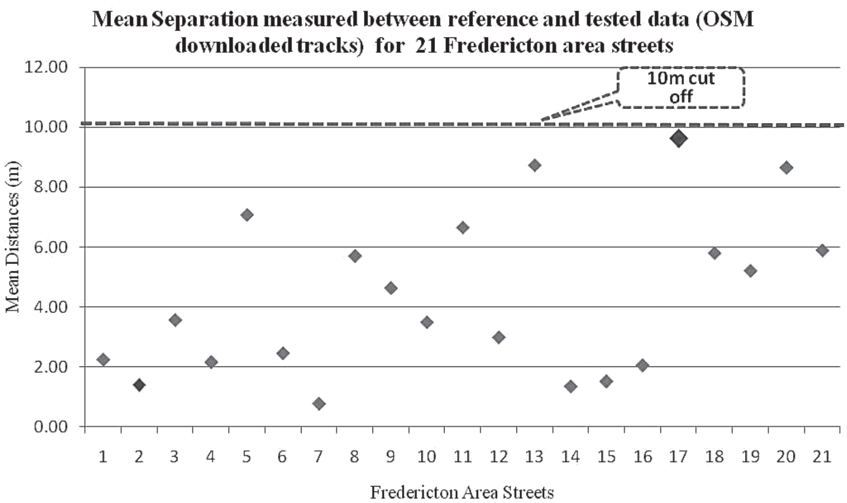

Figure 8. Example of Mean Separations between OSM and NRN Street Data

Table 2 shows results from carrying out the Buffer Comparison method described above. Street data downloaded from OpenStreetmap (OSM) was the most accurate in terms of having the highest percentage of its within the buffer zone, followed by the eTrex, GPSMAP and iPhone streets respectively. The higher accuracy of the OSM data could be a result of data sources from which the data is derived: OSM contributors may use GPS receivers *or* digitize road centrelines directly from online aerial orthophoto imagery provided through Yahoo.com. Also, the wiki-style process of editing and reviewing by peers in the OSM online community could contribute to higher accuracy in the data as errors are usually detected and removed. Unfortunately, since there is no metadata indicating from which sources the data came from or if any subsequent editing took place, there is no way to identify the factors contributing to the higher accuracy of the OSM data.

VGI Street Centreline Data Source	Percentage Within 10m
iPhone	82%
OpenStreetMap	94%
Garmin eTrex	90%
Garmin GPSMAP 76CSx (Edited)	89%
Garmin GPSMAP 76CSx (Unedited)	90%

Table 2. Percentage of VGI streets within 10 m of NRN Streets

Coleman *et al.* (2010b) presents further information and discussions concerning the procedures and results of the accuracy testing undertaken. The full set of results and more in-depth discussion may be found in Sabone (2009). The future is bright in this regard: impending improvements the accuracy of data collected by GPS-enabled cellphones and personal devices quickly improves will result in both a variety of innovative new end-user applications and more reliable contributions from individuals to the authoritative databases that make up today's spatial data infrastructures (Gakstatter, 2010).

6. Managing the Risks

One of the major concerns of using VGI as a source of input to authoritative databases is how to assess the credibility of contributors and the reliability of their contributions (Nkhwanana, 2009). The successes of leading e-Commerce projects such as *eBay.com* and others could hold a key to building trust approaches for handling VGI. Different lessons can be learned from existing handling of e-Commerce initiatives and also from leading wikis such as *Wikipedia.org*. Wikipedia originally relied solely upon the "wisdom of the crowds" to evaluate, assess and, if necessary, improve upon entries from individual contributors, usually with great success. However, recent contributions of deliberate misinformation to specific entries have caused Wikipedia to re-assess its approach. Beginning in December 2009, it has relied on teams of editors to adjudicate certain "flagged entries" before deciding whether or not to incorporate a volunteered revision (Beaumont, 2009).

Using a different approach, eBay users who login to purchase items online may leave feedback for the sellers and future purchasers based on the success of the transactions. eBay then uses a centralized user reputation system that drives its inputs from buyer ratings of the sellers. Social networking sites which make use of VGI contributions of point- and route-based data have adopted similar approaches and in some cases, automated the ways in which improvements can be noted and incorporated.

TomTom's online MapShare™ Service is one of the best operational examples of how one large commercial data supplier manages risk in terms of assessing volunteered contributions and disseminating such non-certified updates to its customers (Club TomTom, 2007). The Company employs a graduated approach to sharing, assessing, and using the volunteer-provided updates. First, MapShare contributors have choice of only using their updates themselves, within their own group, or with the general TomTom community. Second, TomTom itself assigns a progressively higher level of credibility through independent confirmation of a given update by: (1) more than 2 independent contributors; (2) many independent contributors; (3) a "trusted partner" or corporate user; and finally (4) its own crews or contractors in the field. Finally, it allows its customers to interactively select the "level of trust" they desire for the data used on their navigation unit (Figure 9). Customers may elect to use only updates reported by TomTom/TeleAtlas field crews, by trusted commercial partners and many customers, by only a few customers, or even only by themselves.

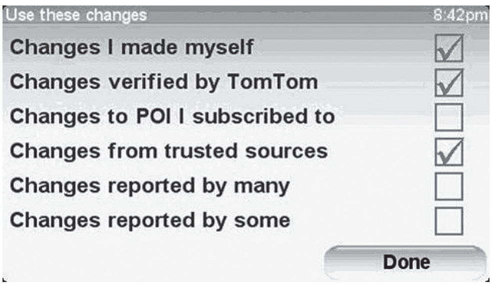

Figure 9. Customer choices in selecting MapShare updates to be used on own TomTom unit (Club TomTom, 2007)

According to TomTom, the MapShare service has been very successful. By December 2008, within 12 months of launching MapShare, TomTom reported that 5 million map improvements uploaded by TomTom customers (TomTom, 2008). Over the same time period, there had been a marked decrease in map-related questions to TomTom's Customer Support Unit.

7. Important Questions to be Considered by Geographic Information Organizations

Public and private mapping organizations have some fundamental questions to ask themselves when considering the opportunities and risks posed by introducing and employing VGI in their production processes (Coleman *et al.,* 2009). For example:

(1) *What is the rationale for VGI in this context? What problem or objective is being addressed here?* Considering VGI just because the potential exists will result in inconclusive pilot projects at best. If the organization has clear requirements in terms of faster updating cycles, a requirement to gather additional attribute information, reduced funds available for in-house production, or a strong need to involve the user community for other reasons, then alternative approaches involving VGI may be objectively assessed and compared in terms of characteristics, strengths and weaknesses.

(2) *To what extent, if at all, should VGI be adopted?* To address the problem or objectives defined above, is it necessary to solicit and incorporate VGI updates directly into a database or use it only as a more user-driven means of change detection?

(3) *How may credible VGI contributors be distinguished from those who may be incompetent, mischief-makers, or outright vandals?* Developing a better appreciation of potential contributors and their motivations is a start. Again, research underway by Bishr and Mantelas (2007), Budathoki *et al.* (2008), Elwood, (2008), Flanagin and Metzger (2008) and Coleman *et al.* (2010a) all speak to this, and technology tools mentioned earlier are available to help in this regard.

(4) *How much control over content and quality are such organizations prepared to relinquish? Who makes the final decisions regarding the reliability of a given update?* These are not new questions. The same kinds of questions over control were posed 30-40 years ago when Canadian federal and provincial government departments began shifting from purely in-house mapping operations to a balance of in-house plus contract production by suppliers from the private-sector and from other government organizations. The focus of in-house expertise in many of these organizations was forced to shift from a pure production orientation to one of quality control and filtering. The same will be true here. The extent to which control is held by the contributor, by the institution, or by "the crowd" of contributors assessing each other's contributions will be different in each organization.

(5) *Will individuals remain interested in making contributions? Should an organization try to sustain a contributor's interest or assume most substantive content contributions will be made by "one-time-only" contributors?* The response to this question will drive the look and feel of the "front-end" of the contribution channels put in place. Assuming a small number of "elite contributors" or power users suggests a more sophisticated interface to a complex and multifunctional system. Satisfying a large number of "one-time-only" contributors will require a much simpler interface and more extensive post-processing behind the scenes.

8. Concluding Remarks

The program of research summarized in this chapter draws from wider investigations into user contribution systems to describe a taxonomy of volunteered contributions and potential motivators influencing the contributors. This taxonomy was then employed to examine the approaches of three different programs involved in soliciting, assessing, and disseminating volunteered geographic information in order to identify potentially successful versus unsuccessful strategies. Follow-on research has examined the positional accuracy of VGI in specific circumstances and determined that, at least when populating mapping datasets requiring positional accuracies of ±10m or less, portable data collection technologies widely available to individual citizens are able to deliver the required accuracy. Finally, an examination of risk management approaches employed by other major Web services suggests that good examples to manage risk in both assessment of contributors and dissemination of volunteered information already exist.

Members of the spatial data infrastructure community have made serious contributions to making personal mapping technologies inexpensive and easier to use. We have now reached the point where these tools and services become invisible, ubiquitous, and embedded in everyday tools. Today, only the narrowest definitions of "spatial data infrastructure" would not include the range of mapping and location-based services now spatially enable citizens in both developed and emerging nations. Extending these services to permit incremental updates to existing databases should be considered a logical progression, yet one that remains daunting to some authoritative mapping organizations for institutional rather than technological reasons.

If volunteers are encouraged appropriately, if the processes managed wisely, and if the potential and the limitations of their contributions are understood and used in the proper context — our research suggests the opportunity to produce and enjoy richer and more up-to-date databases than we have ever seen in the past.

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Chapter 11

Towards Service Level Agreements in Spatial Data Infrastructures

Bastian Baranski[1] and Bastian Schäffer[2]

Abstract

In the past, Spatial Data Infrastructures (SDIs) as enabling platforms for Spatially Enabled Societies (SES) focused on the interoperable exchange of spatial data via open standards based (web) services. Since spatial data becomes more and more an important part of our daily life, the quality aspect of spatial services is of great importance. Service Level Agreements (SLAs) are contracts between service consumer and service providers about offered and guaranteed service qualities. The integration of such contracts in today's SDIs could be a substantial step towards SES in which spatial information is regarded as a common good that is made available to citizens and businesses in an efficient and economic manner. This chapter presents an approach for the seamless integration of SLAs in SDIs. The requirements for the integration of SLAs are analyzed and a classification of potential SLA elements for SDI services is provided. A SLA-aware architecture including a description of interactions between the different actors and entities is specified. Since guaranteed service qualities are monitored and SLA violations are reported to all contractual parties, the proposed architecture provides an appropriate tool for SDI service consumers and SDI service providers to manage SLAs. The presented concept is verified by a proofofconcept.

Keywords: Spatial Data Infrastructure, Service Level Agreement, Quality of Service, Geoprocessing, Grid Computing

1. Introduction

Geographic Information Systems (GIS) have been under constant development in recent years. Emerging web services technologies and the SOA paradigm (Erl, 2005) encouraged the evolution from classical desktop- and data-centric GIS to distributed and loosely-coupled architectures composed of open and interoperable web services merged into the Spatial Data Infrastructure (SDI) concept (McLaughlin *et al.,* 2000). In the past, open standards based SDIs - for instance based on standards developed by the Open Geospatial Consortium (OGC) - focused on the retrieval, portrayal and processing of geospatial data through web services (Kiehle *et al.,* 2006). They have shown a great potential for enabling the market value of geospatial data as for instance presented in Fornefeld *et al.* (2004). Moving towards Spatially Enabled Societies

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(SES), geographic information technologies and especially open standards based SDIs play an important role in allowing governments, local communities, non-government organizations, the commercial sector, the academic community and common people to access spatial related information and to make progress in addressing many of the world's most pressing problems.

Current SDI development faces different challenges as for instance an increasing amount of available data due to advanced data acquiring technologies. While SDI development was previously accomplished mostly by governments, this is no longer the case. All sectors of society are becoming spatially enabled and an increasing amount of potential users requesting geographic information could be observed for instance due to pervasive mobile and location-aware technologies. Along with emerging laws and provisions these challenges result in ambitious requirements regarding the reliability, performance and scalability of geospatial services. The Infrastructure for Spatial Information in the European Community (INSPIRE) directive for instance defines specific Quality of Service (QoS) goals such as a maximum response time and average availability for the so-called INSPIRE View Services (INSPIRE, 2009). Furthermore, monitoring the performance of loosely-coupled web services in distributed infrastructures and the ability to react quickly on service quality fluctuations is an essential skill for service providers in future and highly competitive GIS markets. From the service consumer perspective, the QoS-aware service discovery and the benefit-cost ratio analysis of different service providers is an important key aspect.

To ensure that service providers fulfill promised QoS guarantees, normally a formal contract between service consumers and service providers - a Service Level Agreement (SLA) - is concluded (Lee, 2002). Such contracts formalize business relationships and enable contractual parties to measure, manage and enforce certain QoS guarantees. Although the application of classical paper-based SLAs is not novel to the mainstream IT-world, the on-demand negotiation of electronic SLAs via the internet is not common and has not been widely examined. Furthermore, existing OGC standards do support neither SLA nor QoS functionality. Therefore, attaching SLA capabilities to OGC Web Services (OWS) will be a substantial step towards an infrastructure that is prepared for future GIS business models on a technological and economical level.

Based on the OGC Technical Baseline, this chapter aims at identifying and developing an architecture in which QoS can be measured and managed by attaching SLA capabilities to OWS. The presented architecture is developed with respect to previous efforts on attaching licensing functionality to OWS and without replacing existing OGC standards. Furthermore, the SLA4D-Grid project is introduced in which a proof-of-concept implementation of the presented architecture is demonstrated in a real-world geoprocessing use-case.

The remainder of this chapter is structured as follows. Section 2 introduces useful background information such as the concept of SLAs and reviews relevant related work. Section 3 analyzes the requirements and constraints for the integration of SLAs in SDIs. Section 4 describes the developed architecture. Section 5 introduces the SLA4D-Grid project and the proof-of-concept implementation. Finally, Section 6 concludes the findings and gives an outlook about open issues.

2. Background

This section introduces important background information such as the concept of SLAs and reviews relevant related work from the licensing context in SDIs.

2.1 Service Level Agreements

A Service Level Agreement (SLA) is a negotiated contract between a service consumer and a service provider that formalizes a business relationship (Lee, 2002). Such contracts emerged in the early 1990s as a way for IT departments and service providers within computer networking environments to measure and manage the service quality they were delivering to their customers. They are important for cost-performance ratio transparency and for monitoring promised service qualities.

A SLA consists of several distinct parts (OGF, 2007). The context part contains general information such as details about the contractual parties and the lifetime of a SLA. The service part contains domain-specific information about the services to which a SLA is related and a set of domain-specific measurable and exposed properties associated with these services. These service properties are key elements in a SLA and are denoted as Key Performance Indicators (KPI). The guarantee part references to the KPIs and specifies the service quality goals that the parties are agreeing. The service quality goals are denoted as Service Level Objectives (SLO). The guarantee part also defines consequences of not meeting the stipulated SLOs. Each violation of a guarantee term may cause for example a certain penalty.

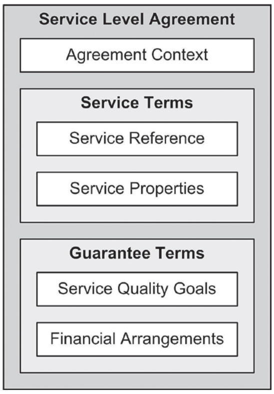

Figure 1. Content and structure of a Service Level Agreement (SLA)

The SLA negotiation process is normally initiated by the service consumer and starts with the delivery of one or more SLA templates from the service provider. These templates specify the structure of a SLA and define the services and the KPIs which can be negotiated. After filling out a SLA template, the service consumer submits a SLA offer to the service provider who is either accepting or refusing it. When the service provider accepts the SLA offer, the negotiation process is finished. The concluded SLA should be stored at a trustful third-party for monitoring the fulfillment of the guarantee terms. During the whole lifetime of an agreement each guarantee term has different runtime states (e.g. 'fulfilled' or 'violated') which can be observed from all contractual parties at any time.

2.2 Related Work

Various strategies to enhance and monitor web service quality and performance are presented in Tian (2005), Zeng *et al.* (2007) and Garcia *et al.* (2006). Quality-aware web service discovery was conducted by (Kalepu *et al.,* 2004). An architecture for QoS-aware discovery and composition of geospatial services is presented in Onchega (2004; 2005).

The licensing aspect of geospatial services is partially covered by the OGC Geospatial Digital Rights Management (GeoDRM) Reference Model (OGC, 2006). In Schaeffer *et al.* (2010) a security enabled architecture is presented, in which geoprocessing services can be enhanced in order to support adhoc licensing, without any prior offline negotiated licenses being necessary between service consumer and service provider.

The Open Grid Forum (OGF) Grid Resource Allocation Agreement Protocol Working Group (GRAAP-WG) develops the Web Services Agreement Specification (WS-Agreement), a set of specifications which describe methods and means to establish SLAs in distributed environments (OGF, 2007).

3. Requirement Analysis

This section analyzes requirements for the seamless integration of SLAs in SDIs. The different SDI actors and entities as well as their interactions during the SLA negotiation process are identified. Furthermore, the SDI-specific elements of SLAs are illustrated. Finally, some important technical constraints are discussed.

3.1 Actors and Entities

The overall activity in SDIs is the retrieval, portrayal and processing of geospatial data through interoperable web services above organizational boundaries. Most SDIs implement the publish-find-bind pattern in which three different actors could be identified: service provider, service broker and service consumer (Massuthe, 2005). The service provider publishes his services to a service broker. The service broker manages the service registry and helps service consumers to find service providers. The service consumer performs service discovery operations on the service broker to find adequate service providers (according to functional or non-functional service requirements) and finally uses the provided service metadata to bind to a service.

From this simple point of view, the service provider hosts the geospatial data in his own organizational boundaries and operates the services on his own computing infrastructure. Considering the fact that geospatial data is mostly collected by other actors than the service provider, the data provider could be identified as another additional role in SDIs. Furthermore, the general trend in the mainstream IT (e.g. emerged in the Cloud Computing paradigm) hints into a future where services and data are hosted on third-party infrastructures (Foster, 2008). Therefore, the infrastructure provider could be identified as another additional role in SDIs.

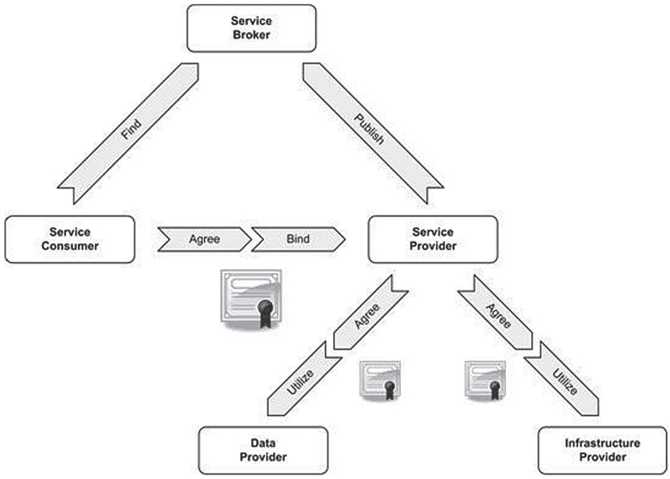

Figure 2. The publish-find-agree-bind pattern incorporates a more fine-grained view on SDI roles

These SDI actors are able to realize and offer different service qualities. The service provider offers for instance specific web service functionality, the data provider specific data quality and the infrastructure provider specific infrastructure reliability. Since the service usage should be performed under the terms of a previously concluded SLA, the basic publish-find-bind pattern now must be enhanced to with an 'agree' phase in which the service consumer and the service provider agree to certain service qualities and service usage costs. Figure 2 illustrates the identified roles and shows a publish-find-agree-bind pattern could be implemented.

The presented list of actors is sufficient to highlighting all important aspects of SLA contracting in SDIs, but could potentially be extended with a more fine-grained view on GeoDRM roles as for instance presented in (OGC, 2009).

3.2 Service Level Agreements

As mentioned in Section 2, a SLA consists of several distinct parts. The context part is very generic and not necessarily special in the SDI context. The service part contains a service reference, some additional domain-specific information about the service and a set of domain-specific measurable and exposed properties associated with the service. The reference to the service could simply be implemented through the definition of an URL to the SDI service. The most challenging aspect in defining the content of SLAs in SDIs is the definition of the domain-specific information and the definition of the measurable and exposed properties of SDI services. Since current SDIs are mostly based on common web services technologies, the potential SDI service properties could be differentiated into functional and non-functional web services properties.

Functional Service Properties

Depending on the service type - for instance if the service is responsible for data portrayal or data processing - the following important functional properties could be identified.

The Supported Standard describes whether a web service is compliant to a specific version of an OGC standard. The Supported Operations describes which (optional) operations of the specified standard are implemented. The Supported Formats describes the data encoding formats that are supported. The Supported Layers describes the geographic layers that are offered. The Offered Algorithms describes the algorithms that are offered.

All these functional properties are for instance covered by the GetCapabilities operation that is mandatory for all OGC service implementations.

Non-Functional Service Properties

Non-functional service properties are often referred to as Quality of Service (QoS). It is defined by the International Telecommunications Union (ITU) as ″the collective effect of service performances, which determine the degree of satisfaction of a user of the service″ (ITU, 2001) and it ″is characterized by the combined aspects of service support performance, service operability performance, service integrity and other factors specific to each service″ (ITU, 1994). The quality aspect of geospatial data has been widely examined, mostly with a focus on data accuracy (Subbiah, 2007) and its fitness-for-use in an application context. But a data-centric definition of quality in SDIs is limiting and does not encompass the dynamic aspect of online access, processing and dissemination of geospatial data and services (Onchaga, 2003). Furthermore, legally bindings such as INSPIRE define specific requirements to supported functionality and provided QoS.

Considering common QoS attributes for web services (Lee *et al.,* 2003; Ran, 2003), geospatial data (Subbiah, 2007; Donaubauer *et al.,* 2008) and geospatial services (Onchega, 2004), the following classification of non-functional service properties for geospatial services could be identified.

Runtime Related Properties - The Performance of a web service could be measured in terms of Response Time, Latency, Throughput, Transmission Delay and Processing Delay. The Availability of a web service describes whether a web service is present and ready for use without a measurable delay in a given time intervall. The Accessability describes whether a web service is capable of processing a request. The Capacity defines the ability of a web service to handle a minimum number of simultaneous requests in a given time interval. The Scalability of a web service represents the capability of increasing the computing capacity on-demand to process more requests in a given time interval. The Reliability describes whether a web service is capable to perform its required functions under stated conditions for a specified time interval. The Robustness (sometime referred to as Flexibility) represents the degree to which a web service can function correctly even in the presence of invalid, incomplete or conflicting input data. The Accuracy represents the mean error rate produced by a web service.

Data Related Properties - The Covered Area describes whether the delivered data covers a defined area. The Accurateness describes the fitness for using the delivered data in certain fields of application. The Resolution refers to the amount of detail that can be determined in space or time. The Completeness refers to the absence of omissions in the delivered data. The Up-to-Dateness describes whether the delivered data is gathered after a specific date. The Level of Detail describes whether the delivered data is available to a certain degree of complexity.

Security Related Properties - The Authentication defines whether service consumers should be authenticated. The Authorization defines whether only authorized service consumers should be able to access the web service. The Confidentiality defines whether data should be treated properly so that only authorized service consumers can access or modify data. The Accountability defines whether service providers can be hold accountable for their service provisioning. The Traceability (sometimes referred to as Auditability) defines whether it is possible to trace the history of a web service when a request was processed. The Data Encryption defines whether the communication with the web service should be encrypted. The Non-Repudiation defines whether it is possible to ensure that a service consumer cannot deny requesting the web service after the fact.

Infrastructure Related Properties - The Computation Capacity describes the available computational capacity for processing a request (e.g. the number of CPUs). The Available Storage describes the available storage for storing or creating data in the web service hosting environment.

Business Related Properties - The Usage Costs refer to the price charged to the service consumer for executing a specific operation on certain.

In addition to the mentioned properties, some Transaction Related Properties (such as the Integrity, Atomicity, Consistency, Isolation and Durability of message exchange) are potentially of importance.Furthermore, some of the mentioned service properties are fuzzy, overlapping, depending on each other, are convertible or declare same meanings with different measurement units. Although the presented list of non-functional properties is quite comprehensive, it is not complete. Especially the infrastructure related properties could be specified more detailed. An overview about such properties is given in the Job Submission Description Language (JSDL) specification (OGF, 2008).

3.3 OGC Standards Baseline

The OGC Reference Model (ORM) describes the OGC Standards Baseline and plays a major role in today's SDIs. It consists of several widely adopted service interface descriptions and data encodings. Therefore, an approach for attaching SLA capabilities to OWS must consider the following important aspects.

Existing OGC service interface specifications could be extended in such a way to enable them to support the whole SLA negotiation process (including SLA template discovery and SLA conclusion). But such a redesign of all service interface specifications interferes with the huge number of existing OGC-compliant server and client implementations. The probability of obtaining a broader acceptance of such a radical solution in the community standardization process and from government agencies appears to be very low. Therefore, a solution based on common policy-based management architectures (Yavatkar *et al.,* 2000) seems to be an appropriate approach for the seamless integration of SLAs in OGC-based SDIs without replacing existing OGC specifications.

The usual OGC Standards Baseline communication pattern becomes a technical constraint since the interaction between OGC-based services (and clients) is typically realized through plain XML-message exchange based on HTTP-GET/POST communication. Sophisticated message transportation protocols (e.g. the SOAP message protocol or the REST architecture style) are not part of most OGC service specifications. The approach for wrapping OGC HTTP-GET/POST services with SOAP presented in OGC (2008a) describes a foundation for realizing a policy-based architecture based on the OGC Standards Baseline with advanced web services technologies such as SOAP and WS-Policy (W3C, 2007).

4. Agreement Integration

An abstract architecture for the seamless integration of SLAs in SDIs requires components for SLA negotiation, service monitoring and SLA status evaluation. This section describes the components of the proposed architecture and specifies how the interaction between the components is realized. Furthermore, some hints on how to implement the proposed architecture are given.

4.1 Architecture

As depicted in Figure 3, three different domains could be identified.

The service consumer domain consists of the Service Consumer who interacts with a SDI Client to access the SDI Service. Since the SDI services are hidden behind a proxy component (which restricts the service access to service consumers who concluded a SLA), the service consumer domain contains a (web- or desktop-based) SLA Client which enriches the SDI client with SLA capabilities.

The service provider domain consists of a SLA Proxy, which acts as a Policy Enforcement Point (PEP). The SLA proxy is an OGC-compliant proxy component which enriches the SDI service metadata with (SLA) precondition elements and decides - by utilizing a Policy Decision Point (PDP) - whether the service consumer is allowed to access the SDI service under the terms of the previously concluded SLA.

The SLA negotiation and management tasks should be implemented by a trustful third-party that consists of a SLA Broker and SLA Manager. The SLA broker provides SLA templates for each service and accepts (or rejects) SLA offers from the service consumer. If a SLA offer is accepted, the SLA broker stores the SLA at the SLA. The SLA manager allows the service consumer and the service provider to check the status of concluded SLAs. The trustful third-party domain internally uses a SLA Monitor, SLA Evaluator and SLA Reporter. The SLA monitor monitors all services and logs the measured QoS (e.g. the service response time). The SLA evaluator analyzes the previously concluded SLAs under the terms of the measured QoS and updates the status of the guarantee terms of all concluded SLAs in the SLA manager. If a SLA run the risk of violation or is already violated, the SLA evaluator advises the SLA reporter to notify all contractual parties about the (potential) SLA violation.

Some additional components are required for service discovery and accounting. Service discovery could be implemented - independent of SLA aspects or in a QoS-aware manner as for instance presented in Kalepu *et al.* (2004) - by a simple service registry component. To realize accounting, an additional e-commerce component for creating invoices and charging the service consumers account is required. Such a component will be notified by the SLA reporter if guarantee terms are violated, a payment period or the SLA duration ended.

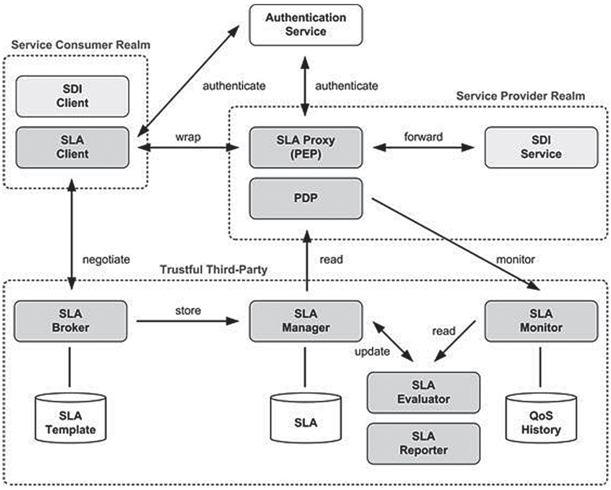

Figure 3. Overview about the architecture for the integration of SLAs in OGC-based SDIs

4.2 Interaction

Figure 4 and Figure 5 show the interaction between the components during the SLA negotiation process and the following service usage.

First of all, the service consumer requests metadata of the original SDI service (e.g. through the common OGC GetCapabilities operation). The SLA proxy intercepts and forwards the request to the original SDI service. The returned metadata is enriched with additional precondition elements. These precondition elements define which conditions must be fulfilled

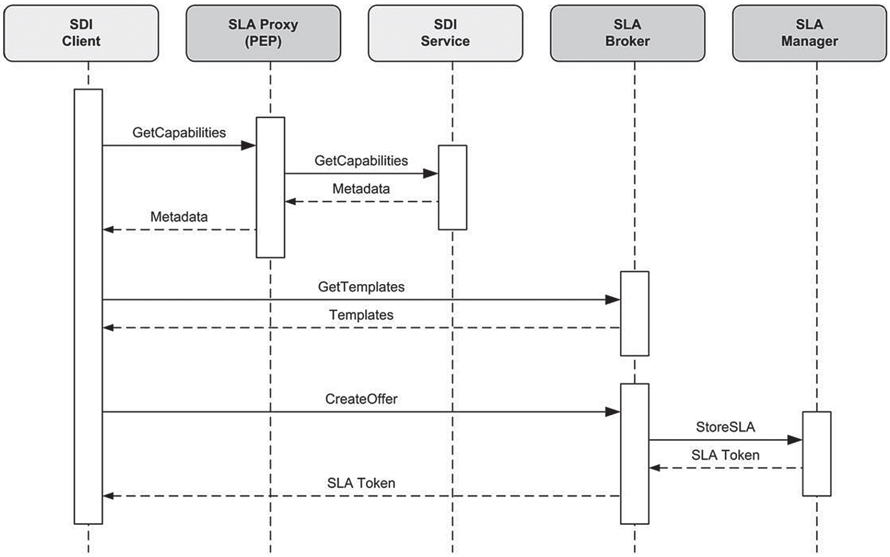

Figure 4. The communication workflow during the SLA negotiation process

before the service consumer finally can invoke the original SDI service. In terms of SLAs, there is a SLA Token as a mandatory precondition element. Such a SLA token must refer to a previously concluded SLA for that specific SDI service. Additional precondition elements (e.g. an identity token for authentication purposes or a digital signature of the request for nonrepudiation purposes) are optional.

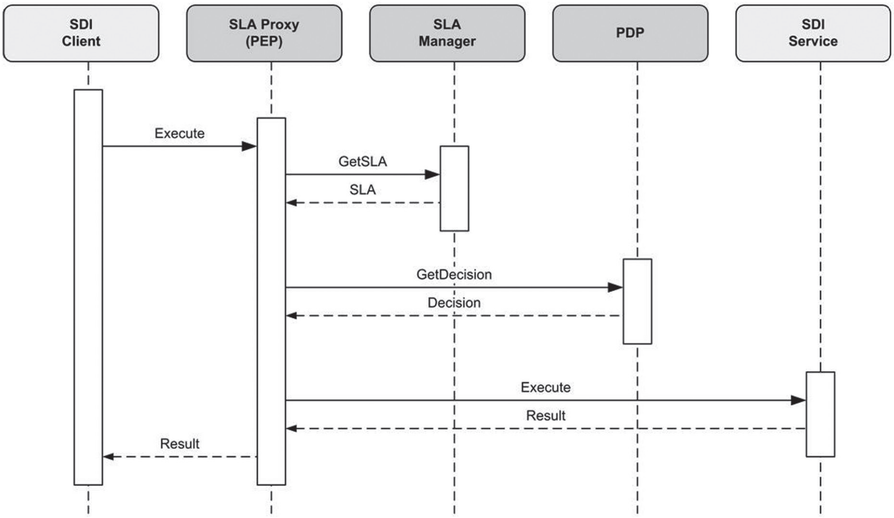

Figure 5. The communication workflow during the SDI service usage

Now, the service consumer must obtain the required SLA. Therefore, the service consumer requests the SLA broker (based on the URL denoted in the precondition elements) for all available SLA templates for the SDI service he originally wants to invoke. After filling out a certain SLA template, the service consumer sends a SLA offer to the SLA broker. If the SLA offer is accepted, the SLA broker stores a SLA at the SLA manager. The SLA manager stores the SLA and returns a SLA token (a reference to the stored SLA) to the SLA broker. The SLA broker directly forwards the received SLA token directly back to the service consumer.

After the SLA negotiation is finished, the SLA token is used to invoke the SDI service. Whenever the service consumer sends a request to the SDI service, the SLA client wraps the (OGC-compliant) service request, enriches it with the SLA token (plus other optional tokens) and sends it to the SLA proxy. Based on the SLA token, the SLA proxy receives the previously concluded SLA from the SLA manager. The internal PDP checks whether the SLA is valid or not (e.g. depending on the SLA runtime). In case all checks are successful, the SLA proxy is allowed to forward the request to the original SDI service and the SDI service response is returned directly back to the service consumer.

After the SLA negotiation is finished, the services are permanently monitored by the SLA monitor and the stored SLAs are permanently evaluated by the SLA evaluator. The permanent monitoring and evaluation enable all contractual parties to get the latest SLA status information.

4.3 Implementation

The presented architecture is technology independent on the conceptual level and could be realized by means of common web services technologies. The communication between SDI client and SDI service could be wrapped with SOAP as for instance presented in Schaeffer *et al.* (2010). The WS-Policy standard could be used by SDI services to advertise their policies and the SAML (OASIS, 2005) standard could be used for SLA encoding. In the SLA4D-Grid project (see Section 5) a REST architecture approach and WS-Agreement for SLA encoding is used.

However, since the presented concept is based on a policy-based architecture and the SLA-specific communication parts could be wrapped and encapsulated by OGC-compliant proxy components, there is no need to modify OGC standards and therefore OGC-compliant client and server implementations remain unchanged.

5. The SLA4D-Grid Project

The aim of the SLA4D-Grid (Service Level Agreements for the D-Grid) project is to design and realize a SLA layer for the Germany's national Grid Computing infrastructure D-Grid. The developed SLA layer offers resource usage under given QoS guarantees and predefined business conditions. By means of the SLA layer and with the assistance of other D-Grid services, such as monitoring and accounting, SLAs can be automatically created, negotiated and monitored. Therefore, the D-Grid can potentially be used by academic and industrial users in an economically efficient manner, in accordance with their respective business models.

One important use-case in the project is the distributed and parallel execution of geoprocessing tasks in the D-Grid infrastructure (SDI Infrastructure Provider) under the terms of a previously concluded SLA. The geoprocessing use-case is based on the OpenLayers client for displaying map data in the browser. SDI services could be incorporated and the delivered data could be analyzed and processed by means of a WPS (SDI Service Provider). A WPS plugin for the OpenLayers client is provided (see Figure 6) in which the complete SLA negotiation process is covered.

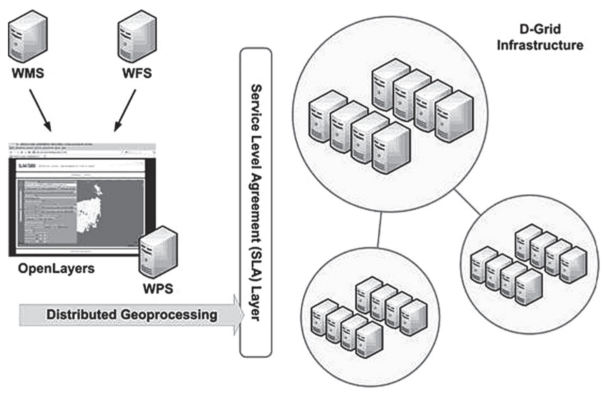

Figure 6. The geoprocessing use-case in the SLA4D-Grid project

Since the project is in an early stage, there is just a first proof-of-concept implementation of the proposed SLA architecture available. At the end of the project all developed components will be available at the 52°North Open Source platform.

6. Summary and Outlook

This section concludes the findings of the presented work and gives an outlook about remaining open issues for future research.

6.1 Summary

Geographic information technologies and especially Spatial Data Infrastructures (SDIs) play a critical role in allowing different communities to access spatial related information and therefore to make progress in addressing many of the world's most pressing problems. Current SDI development faces different challenges as for instance an increasing amount of available data due to advanced data acquiring technologies and an increasing amount of potential users requesting geographic information for professional or just use. Against this background, Quality of Service (QoS) aspects and the ability to negotiate electronic Service Level Agreements (SLAs) on-demand via the internet are of great importance.

This chapter describes an abstract architecture for the seamless integration of Service Level Agreements (SLAs) in SDIs based on standards developed by the Open Geospatial Consortium (OGC). A classification of common Quality of Service (QoS) attributes in SDIs is given and important conceptual and technical constraints for a successful solution are presented. The proposed abstract architecture covers the complete SLA negotiation process between SDI service consumers and SDI service providers. Functional and non-functional service properties are monitored. Depending on the current service health and depending on previously negotiated SLA guarantees, critical service states or SLA violations are reported to all contractual parties. The presented abstract architecture provides an appropriate tool for SDI service consumers and SDI service providers to manage SLAs. Even though the presented abstract architecture is mostly technology independent, an implementation could be realized with common web services technologies. The presented concept is realized as a first proof-of-concept in the SLA4D-Grid project, which is currently still under development.

6.2 Outlook

For every business transaction, security and trust are crucial parts. The SLA negotiation can be regarded as such a business transaction. Authentication, authorization, confidentiality, integrity, non-repudiation, protection and privacy are important aspects (Hafner *et al.,* 2009; Kanneganti *et al.,* 2008) and it is clear that service consumers must trust service providers to provide the negotiated QoS. As described in Section 3, trust can be also an element of a SLA. However, these aspects - especially the establishment of trust - are subject to future work.

Interoperable standards have been the most important key factor in the successful history of SDIs. Therefore, a standardized and widely adopted SLA encoding format and SLA Broker interface specification are required to ensure real interoperability. An OGC Application Profile for the WS-Agreement specification is going to be developed in the SLA4D-Grid project.

Advanced engineering methods for a predictable SOA are required by SDI service providers to guarantee specific service qualities. The SLA4D-Grid project utilizes Grid Computing resources to increase the performance of geoprocessing tasks. Cloud Computing is one of the latest trends in the mainstream IT world and hints at a future in which the storage of data and the hosting of applications are no longer performed on local computers, but on distributed third-party facilities. On the one hand, it offers a technical opportunity for the on-demand provisioning of sufficient resources for computing-intensive algorithms. On the other hand, if offers an economic opportunity to support future SDI business models. Therefore, new concepts for realizing reliable (pay-per-use) revenue models in SDIs – based on SLAs as a contractual foundation - are subject to future work.

Finally, there are still many issues and challenges which need to be overcome in order to have fully Spatially Enabled Societies (SES). One challenge is how data sharing between different kinds of organization could be organized (security and trust) and another important challenge is how geographic or location based information and associated technologies could be made available for instance in Third World Countries. In contrast to the presented technical concept for the integration of SLAs in SDIs, most of the remaining challenges are of organizational character.

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Chapter 12

Legal Interoperability in Support of Spatially Enabling Society

Harlan J Onsrud[1]

Abstract

Spatial data is critically important for the wellbeing of society. Yet appropriate spatial data is often very difficult to find and, when found, the legal ability to use it is often in question. Lack of an operational web-wide capability allowing users to legally access and use the geospatial data of others without seeking permission on a case-by-case basis remains as an entrenched major impediment to general spatial enablement for all sectors in society. This chapter presents a legal interoperability vision for offering, acquiring, and using spatial data and proposes an operational environment for gaining much greater legal clarity and efficiency in wide scale sharing and licensing of such data.

Keywords: Legal Interoperability, Licensing, Usage Rights, Open Access, Commercial Licenses

1. Introduction

Society and science have a problem. Spatial data is critically important for the wellbeing of society. It is used by all sectors of society including by individuals, businesses, non-profit organizations, and local, state, national, and international government agencies and organizations. These entities use it for addressing challenges and solving problems related to transportation, housing, disasters, health, energy, climate, water, weather, ecosystems, agriculture, and biodiversity. It is used daily for immediate pragmatic decision-making and for more thoughtful long-term planning. In short, we use spatial data and services pervasively across all sectors to satisfy immediate needs and to address our most pressing long-term societal challenges.

Yet appropriate spatial, geographic or location data is often very difficult to find. If and when found, the suitability of the data for specific uses is often unknown, whether one can legally use the data is frequently in question, integrity is not typically traceable and liability exposure in using the data is often problematic. These challenges need to be addressed before effective use of spatial data and services can fully develop to spatially enable citizens more broadly in every day living and business.

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One of the reasons that spatial data is so difficult to find is that current search engines process words, phrases, and sometimes embedded code. However, spatial data does not consist of words or phrases nor has identifying code yet been deployed generally in spatial data sets to aid in finding them. That is, one cannot ask a search engine to find all image and vector datasets that contain the visible outline or representation of a particular building and expect a germane listing of datasets to result. However, lack of ability to readily find through word searches resources such as geospatial data sets, location-referenced data and scientific and technical datasets in general existed long before the Internet. As a result, the geospatial community in conjunction with the information and library communities has developed processes for reporting metadata, services and products and further capabilities for finding the reported works. The language of repositories, portals, clearinghouses, registries and archives permeate disciplinary discourse. This imposition of creating and reporting metadata and supporting registries and repositories creates a cost or overhead that many in the community resist, particularly if the primary benefits in enhanced ability to find data and resources accrue to others.

Regardless of these challenges, the technological means for achieving interoperability of many forms of geospatial data, products and services, establishing viable registries, and enhancing findability are within sight and deemed achievable by many within the technical community. What is not yet in sight for many is the means or ability to achieve legal interoperability.

I define legal interoperability for data as a functional environment in which

- differing use conditions imposed on datasets drawn from multiple disparate sources are readily determinable, typically through automated means, with confidence,
- use conditions imposed on datasets do not disallow creation of derivative products that incorporate data carrying different use conditions, and
- users may legally access and use the data of others without seeking permission on a case-by-case basis.

When these characteristics exist, the legal use conditions outcome for a derivative dataset or product may be automatically computed. Lack of an operational web-wide capability allowing users to legally access and use the geospatial data of others without seeking permission on a case-by-case basis remains as an entrenched major impediment to general spatial enablement for all sectors in society (National Research Council, 2004).

2. The Technological Vision

Assume that in an ideal operational environment, a potential user searches for and finds seven geo-referenced datasets out of thousands accessible over the Internet that each meets her requirements for geographic coverage, subject material, resolution, and technical standards compatibility. By extracting all or portions of these seven data sets, perhaps using a web mapping or feature service, she creates a new product or map that meets her needs and which she desires to further distribute and make available on the Internet and through other publication avenues. As noted, many in the technical community are striving towards achievement of a technological vision that would allow such actions to better take place.

While the vision is laudable, it fails to take into account and automatically assess whether the seven found data sets are legally interoperable as well as technically interoperable. This is a substantial world-wide problem that will continue to undermine and impede the ability of individuals, businesses, non-profits, and government agencies to use the geospatial data of others even when technical interoperability is a much more prevalent operational reality. The operational vision of the geospatial community needs to be expanded.

3. The Problem[2]

Copyright automatically exists in expression upon creation of that expression in tangible form whether the creator wants it or not in most jurisdictions. This means that for most works discovered on the Internet or elsewhere one should assume that some party has an ownership right in the work. Just because one finds a music file readily available on the Web does not mean that legal authority has been granted to download it or to incorporate all or part of the file content into a derivative work. The same general rule applies to geographic data files.

By far the greatest legal liability exposure for those pursuing exchange and integration of geographic data in a networked world of interoperable web services and data mining is incurred through the violation, whether intended or unintended, of copyright, database legislation, and similar intellectual property protections. Such laws are in place and are being continually strengthened by international treaties and by national legislatures around the world.

Therefore, if someone creates a story, song, image, or dataset and places it openly on the Web, it is not necessarily free for anyone to copy without permission. C*ommon practice*, *not getting caught*, or *small likelihood of being sued* are not equivalent to having a clear legal right to copy. The lawyerly response to the question of whether one can copy particular data or datasets is that the answer will depend on answers to several additional questions. As a general proposition, however, there will be some legally protected originality in the vast majority of digital works made accessible through the Internet. If legal originality exists, the law assumes one must acquire permission from the copyright holder to copy, distribute, or display the work, or to generate derivative products from it.

One might argue that "data" or "empirical values" drawn from a database are all legally equivalent to "facts", and therefore are not protected by copyright in many jurisdictions. Even if that were true in a specific jurisdiction in a specific case, the creative selection, coordination, and arrangement of "facts" is protected by copyright in most jurisdictions. Further, the explicit legal tests for qualifying for, or determining what is protected by, copyright vary from jurisdiction to jurisdiction. Some jurisdictions protect *sweat of the brow* and *industriousness*, even absent originality or creativity, and many jurisdictions supply protections for datasets and databases that extend well beyond those granted by copyright (e.g., database protection legislation, unfair competition regulations, moral rights, catalogue rules, etc.).

Our hypothetical user searched for and found seven web accessible geo-referenced data sets she wants to use. Many of us might assume that contributors to the seven sites from which

[2] This section summarizes and directly extracts from Onsrud, 2009.

she downloaded the datasets, all or in part, probably placed their datasets on the Web and are adhering to data format and other interoperability standards so that others might freely benefit from their postings. Yet, the laws of most nations generally hold that we must *not* make this assumption. The likelihood is high that one or more of those seven sites has posted terms of use that one or more of her intended uses breaches. Furthermore, the posted contract or license provisions of some of the sites are very likely to be in conflict with each other.

Some of the seven sites will have no license language or use restrictions posted. In those instances, the intellectual property laws of some particular nation will apply by default. A user is required to meet the national requirements of all of the involved sites unless the user has explicit permission stating otherwise.

Copyright liability is a *strict liability* concept in many jurisdictions: no intent to break the law, or even having knowledge of breaking the law, is necessary to be found guilty. Even innocent or accidental infringement may produce liability (e.g. DeAcosta v. Brown, 1945). For each violating extraction or copying, the potential damages are huge, and the possibility of incurring damages is having a chilling effect on using the geographic data of others.

4. An Expanded Vision Incorporating Legal Interoperability

In an ideal legal interoperability vision, when the user in our hypothetical finds the seven geo-referenced data sets that ideally meet her thematic and technical interoperability needs, she would be informed automatically of the legal status of each data set that she desires to use in her web mapping application. In fact, she could limit her search to report back only those data sets that meet her specific legal requirements in addition to her technological requirements.
For illustrative purposes, however, let us assume she has searched based on only technical and thematic constraints and now discovers the legal status conditions for each of seven technically ideal data sets as set forth in Table 1. An appropriately designed web-wide metadata reporting and search environment provides her with the search result that the seven found data sets each has a different legal status as shown. The legal status of each dataset would be automatically identified either through embedded code in the dataset and/or through the metadata for the data set.

Seventh Data Set: The seventh data set represents the status quo for most geographic datasets accessible through the Internet today. That is, the user has little to no indication as to the legal status of the data set. As noted in the previous section, this means she has a legal obligation in this and the vast majority of similar circumstances to find the owner and seek the owner's permission to use the data set as a component or part of the expression in her derivative product. This is true even though the data set may be openly posted on the web with no technological restrictions on gaining access to it. To use the data set without such explicit permission greatly increases liability exposure for the user. She does so at her peril.

First Data Set: Assuming an appropriately designed information infrastructure supporting consistent legal status reporting, the potential user now has a clear indication for the first data set that a purported owner has made the data set legally available to the world by dedicating the data to the public domain or, in the event that a public domain dedication is

Discovered Dataset	**Type of License**	**Suggested Specific License***
1.	Dedication to the Public Domain (cc 0)	cc ZERO
2.	Attribution License (cc by)	cc BY
3.	Attribution Non-Commercial License (cc by-nc)	cc BY NC
4.	Standard Industry-wide License: User Selection of Applicable Conditions	
5.	Offeror License: Idiosyncratic to offering firm, agency, group or individual	
6.	Conditions of Use Published	
7.	No Legal Status Information Provided	

Table 1. Legal Status of Seven Source Geospatial Data Sets

* Creative Commons, 2010. Additional licenses under categories 1 and 2 respectively that would largely have the same ramifications include Public Domain Dedication & Licence (PDDL) (http://www.opendatacommons.org/licenses/pddl/) and Open Data Commons - Attribution License (ODC-By) (http://www.opendatacommons.org/licenses/by/)

not enforceable under the laws of some nations, waiving all copyright and other rights to the greatest extent possible allowed by law in the contributors jurisdiction.

Second and Third Data Sets: In the second and third data sets the potential user now has a clear indication that purported owners have made the data freely available for her and anyone else to use in derivative products as long as she lives up to the provisions in the standard open access license language. That is, if she uses the second data set she must provide attribution to the party that has affirmatively licensed that data to the world. If she uses the third data set she must give attribution to the contributor as well as not use the data for a commercial purpose. Note that the licenses for the first three data sets are legally interoperable with each other in that if a derivative product is created from the three data sets, the provisions of all three licenses may be supported. Assuming that significant portions of each of the source data sets are expressed in the derivative product, the license with the most stringent conditions would control the use of the derivative work. That is, our hypothetical user would not be able to use her derivative map or other product for a commercial purpose even though only a portion of it was derived from the data source with the commercial restriction. If she wanted to use the derived map for commercial purposes she legally would need to acquire permission of the owner of the third data set to do so or find an alternative to the third data set without the restriction.

In this instance let us assume that the user wishes to use the resultant derivative work for non-commercial purposes. Thus, in the present case, if she uses only these three data sets, she knows she has an affirmative legal right to use all three of them. No case-by-case human communication was required to gain legal clarity in her derivative product and she knew the legal status of her derivative product automatically and almost instantaneously.

Fourth Data Set: The fourth data legal status result assumes that the global market for geographic data has become much more unified through a global approach to open intellectual property rights management. The geospatial data sales and services market is extremely fragmented currently. Offering a global and industry consistent suite of standard commercial data license options in a web-wide deployment would make the commercial market much more transparent and efficient and allow large numbers of suppliers of geospatial data to better compete with each other in offering data and services. This would likely grow the demand for such products. To date, commercial companies and those government agencies across the globe pursuing data sales economic models have not sought to unify or grow the market along these lines. One might think of this as an E-Bay model for selling geographic data in that the very smallest to the very largest sellers could make their offerings available in a consistent manner through such an operational environment.

In the proposed approach, any data producer would click through an extensive list of universally consistent standard commercial license provisions and provide a matrix of prices for data offerings based on the volume to be licensed by a user and on various combinations of restrictions imposed on the data. An interested user would click to remove only those license restrictions on the data that would allow them to use the data for their intended purpose. The fewer restrictions the user removes with a click and the larger the quantity/coverage/themes purchased, the lower the price would be typically in acquiring the data set. The pricing matrix would be defined by the owner/offeror when making their geo-referenced data available and the pricing matrix could be changed by the owner at any time in order to support ready flexibility in responding to changing marketplace conditions. A specific data supplier might disallow the removal of some provisions at any price. By example, many data suppliers might not allow removal of standard risk allocation provisions (e.g. liability waivers) except through direct negotiations.

An additional concept here is that after an initial dataset download is made by a user upon payment, technology is used not to lock out use or access by other than the purchaser but technology is instead used to make purchasers accountable. It does so by attaching personally identifiable information to purchased files so that those who blatantly and widely abuse the license by distributing their purchased file to others in violation of the license provisions can be identified and pursued (Onsrud, 2008).

Again, in this instance, no case-by-case human communication was required to gain legal clarity in her derivative product. Upon clicking the licensing terms she needed and paying the fee by credit card, our user was able to download her desired dataset within minutes and knew the clear legal status of both her downloaded data set and that of her derivative product automatically and almost instantaneously. If designed appropriately, these commercial license variations would again be legally interoperable with the licenses of 1 and 3 in that if a derivative product is created from the first four data sets (assuming that the user is automatically notified that an exception must be acquired for the non-commercial use provision of 3), the provisions of all four licenses of the source data sets will be supported and again the license with the most stringent conditions would control the use of the derivative work.

Fifth Data Set: The metadata or embedded code for the fifth data set indicates that the dataset is offered under a publicly published non-standard license that may be unique to the particular firm making the offering. It might be the "standard license" offered by the firm but would not be "standard" in a global commercial sense. An appropriately designed web-wide metadata reporting and search environment should lead any potential user of this geo-referenced data offering to the URL where the user may read the explicit terms of the full license. Notice here that the web mapping exercise or other derivative product generation needs to halt from a legal perspective until either human discourse takes place and an agreement is reached or the user reads the full license and agrees to it, typically through a "click license" process.

At this point, automated determination of legal interoperability is no longer realistically possible. The full license must be read by the human user and an evaluation made by the human reader to determine whether any of the license provisions are incompatible with any of the licenses under which datasets 1 through 4 were offered. By example, the licensing language applied to data set 5 may require something that one of the previous licenses explicitly bans. Thus, the licenses are incompatible and the only way to resolve the inherent conflict is to negotiate an alternative for one or both of the conflicting licenses. This need to stop and humanly read a non-standard license and potentially negotiate new licenses greatly impedes the generation of products by potential users. As such, our hypothetical user may want to avoid dealing with the supplier of data set 5 if she has any alternative data set that might meet her technical needs, even if less optimal technically and even if more expensive, if it was legally interoperable.

When licenses are incompatible it is often very difficult and sometimes next to impossible to identify one or more creators that can authoritatively negotiate an alternative for the conflicting provisions. Crowd sourced geospatial resources are particularly problematic. Open Street Map (OSM) has recently addressed this problem by requiring recently joining contributors to grant to the OSM Foundation authority to be able to grant exceptions.[3] In this way, those who are unable to live with the no-derivative works provision of the standard OSM license now have a single authority to petition that may grant an exception, at least for more recent contributions.

Although data set 5 may not be interoperable legally, having in the search results a direct link to the full and complete standard license of the company, agency or crowd-sourcing group is at least a significant improvement over the current situation of having little to no idea of the legal status of the dataset after finding it through a search. This eliminates the often arduous step of tracking down the standard license or sales contract offered by a firm. The standard contract and license offerings of many firms may not even be publicly available or openly posted for a wide range of reasons.

Sixth Data Set: The sixth data set that our user found in her search has recorded in the meta-data a link to the general conditions of use for the data set. Although not expressed in conventional contractual or license language and although the user is not forced technologically

[3] For OSM contributors joining on or after May 11, 2010, the OSM Foundation should be able to grant the exception for their specific data contributions. See "What is the licence for OpenStreetMap's geodata?" at http://wiki.openstreetmap.org/wiki/Legal_FAQ

to agree to anything before downloading the data set, these posted conditions may be viewed by the courts as implied or actual contractual offers depending upon the jurisdiction. As such, if the user downloads and uses the data without gaining explicit permission of the provider to alternative terms, the user may be held by the courts to have impliedly or actually consented to the provisions. Again the onus is on the user to explore whether the conditions of use of this particular dataset inherently conflict with any of the other licenses. Similar to the conditions of datasets 5 and 7, the additional overhead burden in investigating and resolving the legal status may make the data too onerous to use.

5. Conclusion

To spatially enable all sectors of society to better address immediate and long-term challenges related to transportation, housing, disasters, health, energy, climate, water, weather, ecosystems, agriculture, and biodiversity, there is a need to greatly enhance ready ability to find and use relevant geospatial data and services. While substantial progress is being made in achieving these goals in terms of technical interoperability, we have yet a long road ahead in achieving legal interoperability. Lack of an operational web-wide capability allowing users to legally access and use the geospatial data of others from wide-ranging sources without seeking permission on a case-by-case basis is a major impediment to general spatial enablement for all sectors in society.

"A legal commons has been created for creative works on the Web through the use of Creative Commons (CC) licenses. With a few clicks, in less than a minute, one may create ironclad licenses for creative work to make it practically and legally accessible to others. Well over 200 million such open access licenses have already been created, and the advanced functions of most major web search engines allow one to restrict web searches to return hits to only those sites with the standard CC license specified in the search." (Onsrud *et. al.,* 2010)
An analogous global legal commons and marketplace environment for geospatial data and services could result by implementing clear and simple licensing provisions using the recommendations in this chapter. Success or failure would be easy to measure. A successful implementation would be one in which, within five years, millions of geographic data sets become available to all through standardized open access and commercial licenses and readily findable through web wide searches. Widespread spatial enablement of society among all sectors will require that the practitioner, business, government and research communities join together to pursue such an approach.

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Spatially Enabling Society

Part 4

Practices towards Spatial Enabled Societies

Chapter 13

Spatially Enabling Land Administration: Drivers, Initiatives and Future Directions for Australia

Jude Wallace[1], Brian Marwick[2], Rohan Bennett[3], Abbas Rajabifard[4], Ian Williamson[5], Nilofer Tambuwala[6], Katie Potts[7] and Muyiwa Agunbiade[8]

Abstract

Spatially enabled societies demand accurate and timely information about land. Australia's land administration systems are state and territory based, administered by independent agencies. These arrangements have served the nation well. However, Australia's increasingly national economic, environmental, and social management priorities challenge their design and capacity. Land management issues now require approaches based on need, not jurisdiction. Information to found sound policymaking at a national level is also essential. Indeed, a national infrastructure for managing land information is an obvious tool needed by governments at all levels: national, state and territory and local. Given Australia's complex federal arrangements, an infrastructure built on existing systems that negates the need for a new national federal agency appears to be the optimal approach. In order to achieve this workable national infrastructure, eight design elements must be developed: a shared vision, a common language or ontology, a governance framework, a business case for change, selection of a data model, an accompanying technical infrastructure, an implementation/maintenance model, and an international compatibility framework. An analysis of the key national drivers and emerging international initiatives is needed to ensure that these elements, and any others that are identified, suit national needs. Extensive future research is required to achieve each of the eight design elements in the context of drivers and global trends.

Keywords: spatially enabled society, land administration, land information, national infrastructure

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1. Introduction

Spatially enabled societies demand accurate and timely information about land: land information provides the link between people and activities. In Australia, land administration has always been a state responsibility: information relating to tenure, valuation, development and land use is neither created nor managed at the national level.

This situation presents challenges when issues requiring national land datasets emerge. For example, it is difficult to conduct an effective national census without an authoritative geo-coded register of addresses and land parcels. Verification of where people live is difficult and the extensive analytical possibilities provided by the spatial attribute are not available. Australia now possesses these national datasets. However, many other instances where national, timely land information is essential still exist. Australia, and all nations, requires national land information frameworks if they desire to achieve spatially enabled societies and the greater goals of sustainable development and good governance.

Australia already has a number of building blocks in place for a national land information framework. Strong relationships between the states and the federal government are fostered through the Australian New Zealand Land Information Council (ANZLIC). The Intergovernmental Committee on Surveying and Mapping (ICSM) coordinates the development of national technical standards relating to data production, storage, and dissemination. Management of relationships among the key agencies by the PSMA Australia Limited (PSMA Australia), an unlisted public company owned by the governments of Australia, has delivered national datasets by coordinating the aggregation of state datasets. Information sets include administrative boundaries, cadastral parcels, addresses, topography, postcodes, points-of-interest and transport (Paull, 2009).

These building blocks have served Australia well over the last decade; however, they are only a starting point. Large amounts of disaggregated land data and transaction processes remain at the state and local levels. Moreover, as spatial technologies become more ubiquitous, many new initiatives are emerging from the federal government, the private sector, and national coordination bodies, sometimes in non-traditional land administration sectors. Any new concept of a national infrastructure for managing land information must be built on existing achievements. While acknowledging the success of Australia's spatial industry, a clear national vision or framework for organizing land information appears to be lacking.

This chapter aims to explore the need and nature of a national land administration infrastructure in the Australian or federated context. While the need for these systems is generally agree upon at different levels of government across different countries (c.f. United States), the drivers and design elements have not been researched quantitatively or qualitatively in the Australian context. The chapter uses an exploratory research method to understand the nature and design of a national infrastructure for managing Australia's land information. The drivers requiring national datasets and the activities and changes required to deliver them are studied. The land datasets and administrative processes requiring aggregation also receive attention. To deliver new services and products on a national scale, policy, legal, institutional, and technical elements of a suitable framework are also investigated.

2. Designing the Infrastructure: Method and Approach

Preliminary studies have been undertaken into the nature and design elements of a national infrastructure for managing land information within Australia. They are based around an exploratory case study, as opposed to descriptive and explanatory case studies (c.f. Yin, 1993), of the Australian context. The case study was qualitative in nature. First, it focused on identifying national and federal drivers through analysis of prominent problem cases emerging from reports by peak industry bodies (e.g. Real Estate Institute of Australia) and parliamentary inquiries conducted by the Australian Federal Parliament over a period of five years (2005-2010). Second, Australia's existing land administration arrangements were reviewed to identify limitations and opportunities. Third, emerging technologies and their applicability to the Australian context were studied. This lead to the creation of the design elements and determination of future research directions (Figure 1).

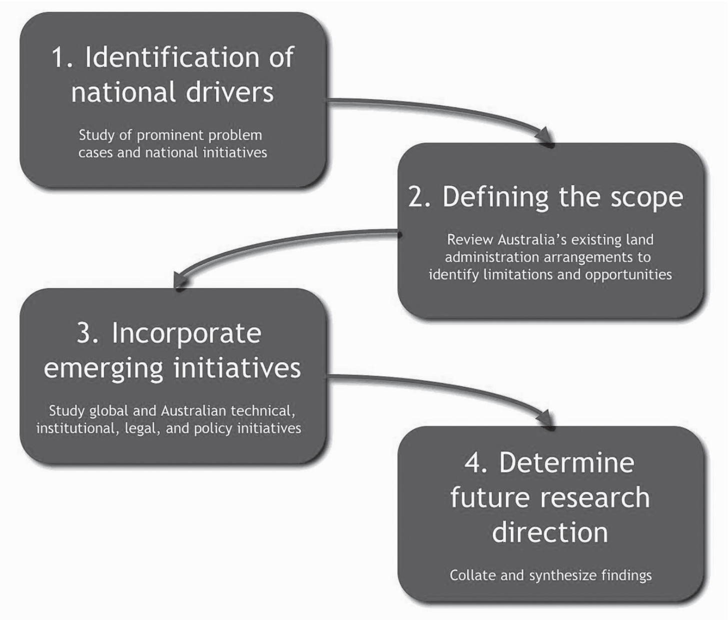

Figure 1. Research approach

3. Identification of the National Drivers

The drivers for a national land information infrastructure are complex and change frequently, as political, scientific and environmental debates raise policy issues. For convenience, the drivers can be classified into the following categories: economic management, environmental management (built and natural), social management, harmonized governance, and technological possibilities (Figure 2).

Figure 2. National drivers for an infrastructure to manage Australian land information

3.1 Economic Management

Land in Australia is a fundamental resource for economic activity. Land as a physical commodity is subject to economic forces of supply and demand similar to any commodity or service (Jeffress, 1991). The greater the demand for land, the higher the value of the land. The economic theory of derived demand suggests that the demand for land information and public access to the information is tied to the increasing value of land and increasing complexity of the land related commodities. The increased value of land information should lead to improvements in recording procedures to deliver more cost effective access to land information resources.

In Australia, trends towards sharing land information are more obvious than ever before. Institutional barriers to SDIs are rapidly diminishing. The need to share data to solve state and federal issues is increasingly recognised. For example, a seamless national economy such as that espoused by the Council of Australian Governments Reform Council (COAG Reform Council, 2009) demands data sharing by those contributing to and governing the economy. Information sharing was also recognized in the 'National Market for Retail Leases' report prepared by the Australian Government's Productivity Commission (Australian Government Productivity Commission, 2008). From an economic perspective, the need to present land and property information on a coherent national scale is now undeniable. A national infrastructure for land information in Australia is the next step to achieving greater economic efficiency in land administration.

The transferability of rights in land underpins an active and secure land market that plays a key role in the country's economic situation. However national banks, insurers, property and superannuation funds, and developers struggle with the jurisdiction based laws and processes in a market that is increasingly national in focus. Australians are increasingly mobile and expect land markets to have similar features throughout the nation. At the macro-economic level organizations such as the Reserve Bank of Australia (RBA) require national property information to make informed decisions about national monetary policy. Currently, authoritative land transaction and ownership information is the domain of the states: there is no requirement for the states to deliver this information to national agencies. A more collaborative solution appears necessary.

Another example is taxation of land. Australia collects tax from land at all three level of government: through Capital Gains Tax (CGT) and Goods and Services Tax (GST) at the federal level, Land Tax and Stamp Duty at the state level, and Council Rates at the local level. Effective land taxation requires reliable information about property location, ownership, values, and the people and entities who enter or intend to enter the market, either as owners or renters. The federal level has no jurisdiction over these datasets. A good example of potential stress on the existing system involves the levying and collection of CGT, a tax paid on devolution of assets such as property levied according to increases in value. The levying relies on access to authoritative property information, however, the federal government, not the states, collects CGT. The Australian Tax Office (ATO) does not have authoritative and direct access to the ownership information held by the states. Therefore, the successful levying of capital gains tax in relies on taxpayer reporting and second level information sets accumulated by the federal government.

Australia has "unbundled" interests in land and resources, and enjoys multiple markets in complex commodities related to land (Wallace and Williamson, 2006). This modern land market needs seamless national datasets for economic management. Unbundling has opened up new sources of economic activity for the nation. Ownership information for the complex rights, restrictions and responsibilities (RRRs) associated with land is critical in the enforcement of a wide range of laws and regulations (Bennett *et al.,* 2008). Additionally, assignment and maintenance of ownership information are important administrative tasks required to support marketing and exchange of property rights in biota, carbon, water, environmental interests, conservation arrangements, property investment schemes and more.

These initiatives must be accommodated within a nationally consistent land tenure infrastructure in order to sustain a globally competitive land market that continues to attract international investment and reasonably priced credit. These increasingly global markets in money and property demand that the cadastral structure of land parcels be refocused to deliver information about new property objects at a national level.

3.2 Natural and Built Environmental Management

Environmental management also requires access to national datasets: the natural environment does not respect state borders. The administrative arrangements in the Murray-Darling Basin provide a good example of the irrelevance of jurisdictional borders. Effective management of cross-border situations increasingly requires access to national land data sets.

Drought relief provides another example. The Australian Government provides financial assistance to farmers affected by prolonged drought, in the form of a 'Farmers Income Support Payment'. To be eligible for this assistance a farmer must be living in an 'exceptional circumstances' declared area. Centrelink, an agency operated by the Commonwealth government, is responsible for allocating the assistance. Centrelink, like the rest of the federal government, has limited access to parcel and property information. To fill the gaps, farmers who apply for an exceptional circumstances income support payment are required to provide Centrelink with the addresses of their farms (accompanied by rates notices), and a hand drawn maps of its location (including property boundaries, roads, and towns all with approximate distances). This immature spatial representation is used by Centrelink to verify that location of farms within exceptional circumstances drought declared areas. In the past, these inadequate arrangements led to difficulties in validation of claims and identification of fraudulent claims.

Drought relief examples bring into focus the broader case of disaster management. Many Australian disasters, including floods, cyclones, bushfires, locust plagues, and spreading livestock disease, are unconstrained by state and territory borders. However, they continue to be managed within jurisdictional confines. These land administration inadequacies combine with jurisdictional, institutional, and human obstacles to impact on disaster management at all government levels. In many cases, access to a national land information framework would radically improve disaster mitigation, preparedness, response and recovery.

Management of the built environment also requires national land information. In December 2009 COAG called for all Australia's capital cities to have strategic development plans in place by 2012 (COAG, 2009). These plans will be used by the Commonwealth to ensure that federal spending on city infrastructure is appropriate and strategic. To analyze these strategic plans, the federal government will require integrated land information from all states.

The dynamics of housing provision also shed some light on the need for a national framework to manage land information. Processes of adding housing units to existing stock require the collation and analysis of several data sets throughout various hierarchies of government - federal, state and local. These processes strike disparate land use planning strategies that might be better integrated into a national approach involving both land use planning strategies and information management. Ultimately the national scale approach would improve understanding of how strategies influence agencies and people engaged in housing production including land owners, developers, financial institutions, planning authorities, building contractors, professionals in the building industries, and their parties that might be impacted by development proposals.

Identification and mitigation of risks to infrastructure and the natural environment along the coastal zone also demand aggregated land and property information at the national level (DCC, 2009). Indeed, the Australian Parliament's Standing Committee on Climate Change, Water, Environment, and the Arts recently recommended the development of a national coastal land information database (SCCCWEA, 2009; COAG, 2009).

3.3 Social Management

Governing the activities of people and communities also demands access to land information on a national scale: land information allows people, communities, and their activities to be linked. Responding to organized crime on a national level (e.g. stolen vehicle syndicates) and allocating welfare and relief funding demand such an approach. The requirement was perhaps first made clear prior to the Sydney Olympics in 2000 and after 9/11 when the need to monitor potential terror cells demanded access to national land information sets.

Law enforcement and emergency management are state activities. The agencies responsible for these activities are usually restricted to their own jurisdiction. The datasets these organizations hold are often rarely aggregated, impeding the operation of national law enforcement and emergency management agencies. Law enforcement and emergency management responses are reliant upon the parcel and address layers: they link people and activities to an identifiable position. A national infrastructure that links state land information would also act as a platform for a wide range of other non-land related activities (e.g. law enforcement) and datasets to be linked.

The current federal government's desire to include 'Social Inclusion' principles in all decision making will also need to be underpinned by national datasets that link people, place, and societal activities. For example, on the pro-poor scale, Australia's capacity to analyze housing needs (numbers, type of housing, and preservation of land for essential food production) is also in need of improved demographic information with geocoded analytical facilities.

3.4 Harmonized Governance

Good governance is often described as the fourth pillar of sustainable development. Increasingly, harmonized governance is seen as being an important part in delivering good governance. Harmonized governance attempts to reduce legal and administrative complexities for citizens by demanding that different arms and levels of government integrate their responsibilities and administrative process. The need to harmonize the governance systems of different states and the federal governments is recognized by most stakeholders. Harmonization can save millions of dollars and radically improve the ability of businesses, communities and governments to operate on a national level (SCLCA, 2006; SCLCA, 2008). Meanwhile, private sector frustrations about inadequate and out of date arrangements continue to grow. The national umbrella organizations all see benefits in more timely and seamless spatial and land information.

3.5 Technological Possibilities

Spatial information and technologies are changing the way business and governments manage activities and solve problems. Much information relates to place and locations. Some of this is spatial information, but a great deal is information that can be organized according to its impact on a place.

Global technology companies such as Google and Microsoft are the popular players in this paradigm shift (Butler, 2006; Bennett, 2007). Google's easily accessible Web 2.0 friendly web mapping platforms have commoditized once complex and expensive GIS processes. Additionally, freely available high-resolution imagery and 3D visualization tools have demonstrated the power of spatial information. Users of government information systems increasingly demand this level of visualization and functionality.

The contemporary information revolution is not only about merging phones and computers. The commoditization of spatial information management platforms allows SDI practitioners to move their focus from organizing spatial information to *spatial organization of information*. This involves using place information as a sorting and accessing method for handling masses of other information.

These emerging spatial technologies potentially expand the capacity of governments. They provide possibilities for ordering information that are profoundly world changing. The more difficult task involves embedding new technologies into the most conservative and fundamental processes in land information and management of the land market, particularly, into the land registries. Regardless, the opportunities provided by emerging technologies are driving changes in the way governments interact with their citizens, principally in initiatives to spatially enable their processes, as well as their information.

4. Defining the Scope and Components

Based on the analysis of national drivers, at least eight design elements are required to deliver a national infrastructure to manage land information in the Australian context (Figure 3).

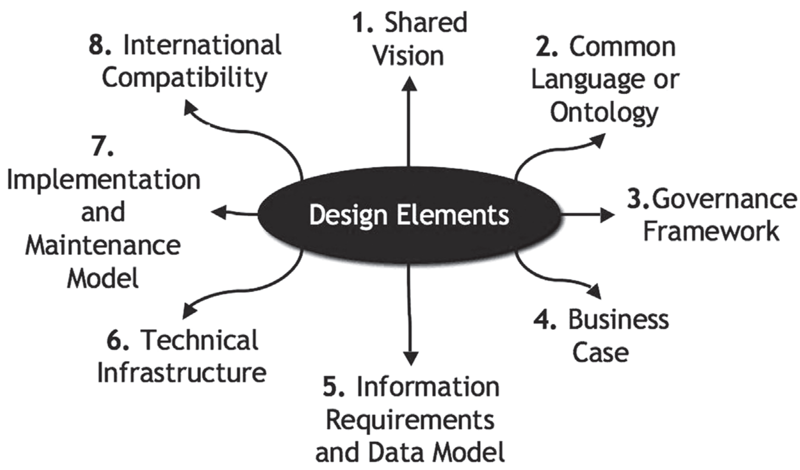

Figure 3. Design element for a national infrastructure to manage land information

4.1 Shared Vision

While the need for a national infrastructure is now clear, its characteristics and functionality are not. How the underlying policy, legal, institutional, and technical components should be built and governed remains unresolved. Some suggestions envisage a relatively simple postbox system for lodging land registrations to the respective state based systems using a single point of entry and streamlined, single electronic data entry building on national electronic conveyancing ideas. This is not dissimiliar to the approach used successfully by PSMA Australia where the States and Territories lodge their respective datasets for integration and dissemination on a national basis. More radical visions involve integrated transaction management delivering authoritative information relating to addresses, valuations, tenures, development processes, planning systems, and the management of complex commodities. Integration of land information with other datasets covering people, business and legal entities, vehicles, and others, following the European Union idea of authoritative registers, is also worth considering. Australia's existing successes suggest a middle ground opportunity that utilizes pre-existing initiatives into a coherent framework shared by key stakeholders. Issues of data inclusion, data currency and data authenticity all need assessment. The development of this vision will require relationship management beyond state and national governments, and should include local governments, and private sector stakeholders in community and business sectors.

4.2 Common Languages or Ontology

Attempts by researchers and jurisdictions to create ontological frameworks for management of land information are now common. The European Union developed a process-based ontology for managing property transactions through comprehensive activity diagrams that allow comparisons in EU countries (Hess and Schlieder, 2009). These analyses of property processes allow a seamless approach to the local detail in each jurisdiction, overcoming the differences between land registration and deed registration approaches in property sales and mortgages. The idea is particularly fertile for Australia.

An example in Australia of similar activity is ANZLIC's efforts through its Standing Committee for Land Administration and Property Rights (SCOLA) which has been working for some time on establishing a national set of principles for consistent characterization of property interests to facilitate electronic enablement and Web-based access. Work of this nature is critical to developing the necessary common language to support a national infrastructure.

4.3 Governance Framework

A governance framework is essential. The nature of this framework needs determination. Arrangements relating to policy, legal, and institutional aspects must survive changes of government, administrative fashions and budgetary priorities. In relation to policy, the guiding principles of the framework need determination. Legal principles to guide changes to existing legislative frameworks need to be articulated. For example, the ability to use the data as evidence in Australia's courtrooms and tribunals is essential. Whether a minimalist or maximalist approach to legal changes is best also needs analysis. This also applies to institutional arrangements, should a new framework attempt to reorganize the functions of entrenched land administration agencies. The preferred relationship between three levels of government, peak national bodies, and the private sector needs to be determined, as does the role of public/private partnerships.

4.4 Business Case

Satisfactory performance of the infrastructure is crucial to its sustainability and must be underpinned by a strong business case. The infrastructure must be financially attractive to use and simultaneously assured of sufficient income to expand incrementally in terms of its usage and data sets. Whether the national approach focuses on providing information or delivering transaction capabilities needs to be determined. The efficiencies and cost savings for participants, users and customers will need to be quantified and assessed against the cost of all proposed systems.

4.5 Data Typologies and Data Model

In the longer term the ideal situation would see all forms of land information seamlessly integrated into a national framework. Data relating to tenure, valuation, development, planning, the environment, topography, demographics, imagery and the land market would be included. A subset of this information would form candidates for initial consideration.

Emulation of the PSMA Australia model of cooperative relationship management could build on their existing product base of information relating to cadastral parcels, addresses, and administrative boundaries.

A data model is also required. Australia through ICSM has already developed the Harmonized Data Model in order to standardize state, land related datasets. However, the applicability of the Harmonized Data Model still requires testing in a range of contexts. In Europe, the Core Cadastral Domain Model or Land Administration Domain Model has been in development for almost a decade (van Oosterom *et al.,* 2009). The move in this model towards property objects as opposed to land parcels greatly strengthens the model particularly in its ability to support the management of property rights, restrictions, and responsibilities (RRRs) and other non-parcel issues. Processes are currently being undertaken for this model to gain ISO accreditation. The applicability of this model to the Australian context requires investigation.

4.6 Technical Infrastructure

A technological infrastructure to enable the data sharing is an essential design feature. The role of next generation web mapping tools, open source land administration architectures (Hall and Hay, 2009), and 3D visualization platforms need careful evaluation: these tools will be integral parts of any solution over the next decade. An assessment of the appropriateness of tools ranging from LandXML, which simply allows land information to be shared between applications, to OWL, the Web Ontology Language, designed for use by applications that need to process the content of information, also needs to be made.

The integration of the proposed framework with the existing infrastructure currently utilized by each of the states and territories such as Western Australia's Shared land information platform (SLIP) and PSMA Australia's LYNX platform, the National Electronic Conveyancing system currently being established, and the National Address Management Framework (NAMF), also needs exploration.

4.7 Implementation and Maintenance Models

A plan for implementation identifying costs involved and timelines needs to be articulated. Given Australia's complex federalism, achievement of a functional national model within a single project is impossible. An incremental growth plan driven by successful modules to perform identified functions may be the ideal approach.

The maintenance of any new infrastructure is problematic. Historically, outputs of many national projects cease on completion of the construction phase because insufficient planning and resources are not available to ensure sustainability. Great care is needed to preserve in-house competence and ownership of the all parts of any national infrastructure, including budget allocations among the partners and related agencies for national priorities. Similar issues also emerge if existing institutions and agencies are reconstructed, particularly the loss of the internal knowledge base. Systems for maintaining and, especially, updating any new infrastructure need to be identified in at the initial conceptual stage and built to deliver sufficient institutional, financial and human capital for the long haul.

4.8 International Compatibility

Designers of a framework for integrating national land information must look beyond Australia's borders and ensure interoperability with international standards. Whilst not essential in the current context, the ability for land information systems to interact on a global level will become increasingly important, particularly as global land markets mature.

5. Incorporating Emerging Initiatives

The analysis of the Australian and international contexts revealed a range of initiatives relating to national or standardized approaches to managing land information. The Australian, European, and United States contexts are discussed here.

5.1 Australian Initiatives

Australia is at the forefront of integration of information. Agitation for a national framework to manage land information is evident at both state and national levels. The importance of information about the built environment held by local governments is increasingly recognized. Components of the framework are also emerging from a range of private sector interest groups and even community organizations. Table 1 provides a preliminary list of major state, federal, and peak national bodies already involved in developing a national framework for managing land information. These organizations and associated initiatives need incorporation into any new vision.

Australia's pragmatism in the face of complicated federalism has delivered solutions to the land information problems. PSMA Australia successfully produces national scale integrated information services. The most well known and appreciated is the Geocoded National Addressing System. G-NAF is special because it pioneered the connection between text information and geocodes to provide a multi-purpose tool capable of being used whenever a person or organization needed to use addresses. The product carried a high level of functional accuracy because it was built on the basis of cadastral parcels, and properties reflecting actual occupancy of land. This accuracy is functional, not precise, given precision in cadastral information in Australia is a remote (and arguable) goal.

Another major initiative that has the potential to impact on activities is the ANZLIC Spatial Marketplace. The marketplace is focusing on developing an infrastructure that is at once accessible to non-specialist users, is capable of supporting transactions between suppliers of data and users, and allows easy publishing, distribution and discovery of and access to spatial information. The marketplace must be able to support: finding and accessing spatial resources (data, products, services, processes), publishing and marketing these resources, and gathering of intelligence from the spatial market place to facilitate bringing together suppliers and users for the development of new spatial resources.

Level	Organization
State and Territory Government Agencies	The Land and Property Management Authority, New South Wales Government
	Landgate, Western Australian Government
	Department of Sustainability and Environment (DSE), Victorian Government
	Planning and Land Authority, and the Office of Regulatory Services (Department of Justice and Community Safety), Australian Capital Territory Government
	Northern Territory Lands Group, Department of Planning and Infrastructure, Northern Territory Government
	Department of Environment and Resource Management, Queensland Government
	Land Services Group, Department of Transport, Energy and Infrastructure, South Australian Government
	Property, Titles and Maps Group, Department of Primary Industries, Parks, Water and Environment, Tasmanian Government
Federal Government Agencies	OSDM (Office of Spatial Data Management)
	ABS (Australian Bureau of Statistics)
	Centrelink
	ATO (Australian Tax Office)
	Australian Post
	CSIRO
	BoM (Bureau of Meteorology)
	GeoScience Australia
	DAFF (Department of Agriculture, Forests, and Fisheries)
	DCC (Department of Climate Change)
National Alliances and Related Projects	ANZLIC Australia New Zealand Land Information Council
	ICSM (Intergovernmental Committee on Surveying and Mapping
	COAG (Council of Australian Governments)
	PLRA (Property Law Reform Alliance)
	NECS (National eConveyancing System)
	DAF (Development Assessment Forum)
	CRC-SI (Collaborative Research Centre for Spatial Information)
National Interest Groups	Australian Property Institute
	Property Council of Australia
	Real Estate Institute of Australia
	Australian Property Law Group (Law Council of Australia)
	Australian Institute of Conveyancers
	Australian Institute of Quantity Surveyors
	Royal Institute of Chartered Surveyors Oceania
	Australian College of Community Association Lawyers
	Facility Management Association of Australia
	Master Builders Association
	Shopping Centre Council of Australia
	Spatial Industries Business Association
	Urban Development Institute of Australia
National Data Providers	PSMA Australia

Table 1. Major Australian organizations already contributing to a national infrastructure for managing land information

5.2 European Union Initiatives

Similar efforts come from other federated states and the European Union. The INSPIRE initiative to create a European Union (EU) spatial data infrastructure was implemented by the European Union in 2007. The aim of INSPIRE is to enable the sharing of environmental spatial information among public sector organisations and better facilitate public access to spatial information across Europe. It with be implemented incrementally across 34 spatial data themes with full implementation scheduled for 2019.

5.3 United States Initiatives

In the United States private sector solutions to land information problems remain a popular approach. A plea for building a national cadastral database (a tool Australia already enjoys) is eloquently presented to the US Congress by in paper titled National Land Parcel Data: A Vision for the Future (National Academy of Sciences, 2007)

Meanwhile global initiatives undertaken by Google, Microsoft Maps, and Yahoo have popularized spatial information with the special capacity to integrate place or geocoded information with images and pictures, and even live videos. These systems are highly commercial and increasingly well organized and popular with users.

6. Determining Future Research Directions

6.1 Furthering the Design Elements

Testing these design elements against emerging global initiatives reveals future research directions involved in designing a national infrastructure for managing land information (Table 2).

These design elements in Table 2 appear onerous. However, Australia already has a firm foundation upon which to build. Numerous initiatives provide attractive opportunities for agencies to use and contribute to sharing platforms (e.g. SLIP, PSMA Australia's model). Additionally, within the spatial sector, spatial capacity and geocoding are seen as a means of ensuring with on-ground functional "truth". Also, reorganization of information processes and, more recently, business processes by using geocoding and the visualization of information is occurring.

Vital, but largely unacknowledged contributors to these successes, are the land registries of Australia. Thus far land registries have concentrated on conservative management of private land information to deliver security of tenure for marketable commodities in highly active land markets. The performance of this role changed dramatically with the introduction of standard technologies that permitted acquisition of much more data, interoperability of data, quarantining of specific information to ensure privacy, and public access to information. The next generation of developments of registry roles will be pushed by spatial enablement of government overall and increasing nationalization of land information.

Design Element	Future research direction	Comment
1. Shared Vision	Determine the vision in the Australian context.	Determination on whether the system delivers information management, transaction management or is simply service provider is required. Collaborative workshops between key stakeholders are required.
2. Common Language or Ontology	Investigate an ontological system to facilitate integration of Australian land information.	The development of nationally applicable ontologies is notoriously difficult. Significant advances are already evident in national addressing system. Tenures, valuations, development, and planning need work.
3. Governance framework	Determine policy, legal, and institutional configurations that work in a complex federation.	Various models for overcoming the rigidity of state legal and financial arrangements are used. The most successful to date is PSMA Australia.
4. Business case	Examine customer expectations and needs.	Delivery of outcomes needed by the various constituencies is essential.
5. Information requirements and data model	First, conduct a systematic examination of standards and uses of information. Second, investigate existing models in LandXML, Harmonized Data Model, and the Core Cadastral Domain data models	It will be necessary to clarify a series of issues about accuracy, reliability, precision, status as court evidence, and privacy protection. In relation to data models, significant work in data modeling for land administration already exists in Europe.
6. Technical infrastructure	Investigate applicability of existing and developing systems. (e.g. LYNX developed by PSMA, and Shared Land Information Platform (SLIP) of WA	A variety of technical options already exist. New web technologies however also offer opportunities for reconstruction of information. Leading innovators are South Korea and Singapore.
7. Implementation and maintenance models	Investigate costs and time requirements required to deliver system. Additionally, develop a robust maintenance regime.	Maintenance, capacity building, education, financial robustness will be essential considerations for any model to be an ongoing success.
8. International compatibility	Examine trends in leading nations and international organizations. Additionally, examine the "Social Inclusion Agenda" and the "Seamless Economy" of federal administration, along with the spatial enablement of all levels of government	The Europeans continue to develop approaches for land administration including authoritative registers. In USA, the lack of a national cadastre is addressed by private sector innovation in web-based land information systems. PSMA Australia's signing with Euro Geographics a memorandum of understanding to collaborate, cooperate and exchange information is further evidence of international collaboration.

Table 2. Features of a national infrastructure to manage land information

6.2 The Role of Research Institutions

Research is essential to overcome limitations of vision and management restraints found in agencies and to negotiate with international colleagues who share similar journeys. Any research approach must be also neutral in terms of preferred technical solutions and capable of assessing a range of solutions.

The Centre for SDI and Land Administration at The University of Melbourne designs new solutions that can predict the future, merge within the global trends, build on existing capacity, and change paradigms of operation of agencies and businesses. It is an ideal research model to develop the national land information infrastructure (cf. Williamson *et al.,* 2010).

7. Conclusion

Land information now assumes far more significance that it did in the comparatively simple times of 19th and 20th centuries when it was collected and maintained in silo agencies. Land information must now be shared across agencies and throughout a nation to enable the delivery of spatially enabled societies. The challenge to land registries are not new: in all the democracies, these agencies are being asked to accept radical change in order to meet social and economic needs. Many nations, including Australia are seeking solutions. Many international initiatives attempt to use and integrate information sets generated by land administration activities. These initiatives are worthwhile in themselves but they remain limited.

The national infrastructure to manage land information is in its early days. Agencies that hold key land information are now driving efforts to define a new paradigm in land information management that can take Australia to the forefront in the search for an infrastructure. A great deal of effort will be required to engage the broad base of stakeholders who have needs that must be met. A shared vision and common language will be essential elements. A governance framework and business model that enables the cooperation of existing players must also be encouraged so that the successes of pragmatic relationship building are enhanced. Information requirements, data models, technical standards, and maintenance models all require further assessment and development as does the longer term requirement for international interoperability. If these design elements can be further developed they will set the stage for new roles for land registers as the key players in national land management and delivery of sustainable development and good governance.

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Chapter 14

UDOP: A Collaborative System for Geospatial Data

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Abstract

The aftermath of Haiti's January 12 2010 earthquake typified disaster relief in that efficiency and situational awareness were reduced by the chaotic, uncoordinated influx of relief and aid. The lack of an environment in which information could be shared was a major component of this chaos. The application of geographic information (GIS) technology was a significant contribution to the relief efforts due to the centrality of location to issues of danger, resources, safety, communications, and so on, and due to the universal understanding of information rendered geospatially using 3D globes.

Concerned that existing solutions were restricting, U.S. Southern Command (SOUTHCOM) engaged Thermopylae to build a user-friendly GIS tool to reach a wide user base, fuse data from disparate sources, and immerse users in relevant content. The resulting SOUTHCOM 3D User-Defined Operational Picture (UDOP) united over 2,000 users to create, add, edit, update, and share data aggregated through GIS tools, existing databases, mobile applications and other resources, geospatially.

The UDOP was built on the enterprise geospatial framework, iSpatial™, which interacts with the Google Earth Plug-in™ browser application programming interface and provided SOUTHCOM's Joint Intelligence and Operations Center with interactive applications and an open platform for the integration of dynamic data for timely and publicly-accessible solutions. The application of the UDOP to relief efforts in Haiti optimized the gathering and management of data from government, military, non-government agency, and first responder resources, which consequently improved relief efforts simply by inviting a large user community to share data on an intuitive common platform. The experience in and lessons learned from Haiti promise great strides into the future of the geospatial technology.

Keywords: GIS, SDI, Google Earth, iSpatial, Haiti relief efforts, USSOUTHCOM, mobile applications, iPhone®, Android™.

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1. Introduction

The User-Defined Operational Picture (UDOP) was Thermopylae's answer to impediments encountered during spatial data-sharing directly following the Haiti earthquake. In order to meet the needs of organizations providing relief to Haiti, it was essential that the UDOP geographic information system (GIS) be tailored to the area and crisis, uniting a growing collection of relief workers and providing data to everyone. As users contributed content, the capability evolved and ultimately replaced many preexisting tools used for strategic and local-level data management. In conjunction with the Google Earth™ browser plug-in, the UDOP provides a 3D Web portal where users can conveniently create and share spatial information freely. As a result, a massive compilation of volunteered information was exposed and fused into a single, publicly-accessible location. To ensure this access, the UDOP Web servers and storage leveraged a combination of resources from a secure cloud on the World Wide Web and government-owned physical hardware.

Figure 1. SOUTHCOM Relief Operations (Shelley)

2. SOUTHCOM

A regional military headquarters, SOUTHCOM is also heavily staffed and affiliated with civilian US government organizations that conduct humanitarian operations. SOUTHCOM supported the military Joint Task Force (JTF) members forward deployed with policy, intelligence, and other support, but also manages issues that transcend localized missions like Operation Unified Response. Prior to this disaster, SOUTHCOM was already focused on humanitarian operations throughout the Caribbean, Central, and South America, but the scope of the damage in Haiti far exceeded anything with which they had previously dealt. The 10,000 deploy troop JTF they oversaw was ultimately charged with providing logistics in support of the U.S. Agency for International Development (USAID) and the Department of State (DoS), but effective collaboration had to include participating governmental, non-governmental, and international organizations to be optimal.

The UDOP was built on requirements of the SOUTHCOM J2 (Intelligence) Knowledge Management Office and Joint Intelligence Operations Center (JIOC) which provide solutions for SOUTHCOM's headquarters and regional operations. Driving their agenda was the fact that pertinent information would be plentiful and unclassified given the important role of a large international community. With these circumstances, complications in language, time, preparation, and the scarcity of a central controlling body would have to be addressed in any IT solution. SOUTHCOM leaders had information from its individual directorates, but a comprehensive perspective of all other activity in Haiti did not exist. Information was fragmented, diverse, and often contained in articulate forms, held separately and locally by the many individuals who compose society (Sobel and Leeson. 2007). Two fundamental objectives were 1) to fuse the efforts of the relief community by collecting data from diverse and scattered entities; and 2) to present it as a single, interactive picture to all users and to their command center the. Aggregating and displays all data in one place was a natural solution.

In evaluating their GIS requirements SOUTHCOM took into account previous investments the US DoD and DoS had made in Google Earth geospatial solutions. They measured their requirements against the U.S. Department of Homeland Security's (DHS) similar project Virtual USA, which was in its nascent phases. The open standard of the Google Earth browser application programming interface (API), associated data ingestion, and development APIs with the iSpatial™ framework allow untapped levels of integration.

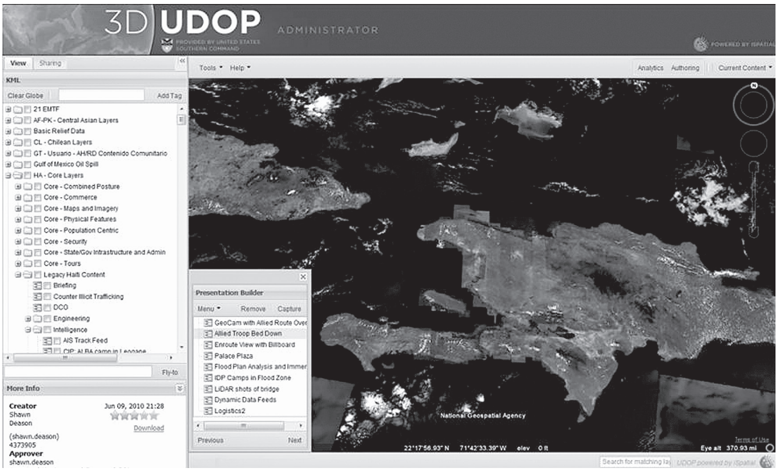

Figure 2. SOUTHCOM 3D UDOP Interface (Eckersley)

With the browser-based Google Earth plug-in and the iSpatial framework, SOUTHCOM and the relief community attained a robust, highly-accessible solution for exposing and sharing data everywhere. The Web-based toolsets provided by iSpatial provide users options as they integrate the tools they need, allowing each to customize its view of the mission while sharing the underlying data. The UDOP architecture was designed to benefit all involved parties, as a virtual world is built out with key data, contributing to the development of a spatially enabled society.

3. Overview of Problem Set

According to some accounts, the chaos in Haiti following the earthquake left 220,000 dead and the dire shortage of food, water, medical care and supplies for the approximate 300,000 injured and over 1 million displaced people. The initial crisis response by military components, federal agencies, state/local emergency response personnel, non-governmental relief organizations, and commercial industry members from across the globe rushed thousands of people and massive quantities of supplies to the already densely populated area surrounding the capital, Port-au-Prince. The international response was overwhelming, but data to enhance communication and coordinating logistics was in critical need of improvement. Breakdowns resulted in delays in the transport and delivery of much needed aid. Many of the participatory organizations possessed pertinent data and their own management practices, but the lack of a central environment and medium for collaboration hindered efficient execution of relief efforts.

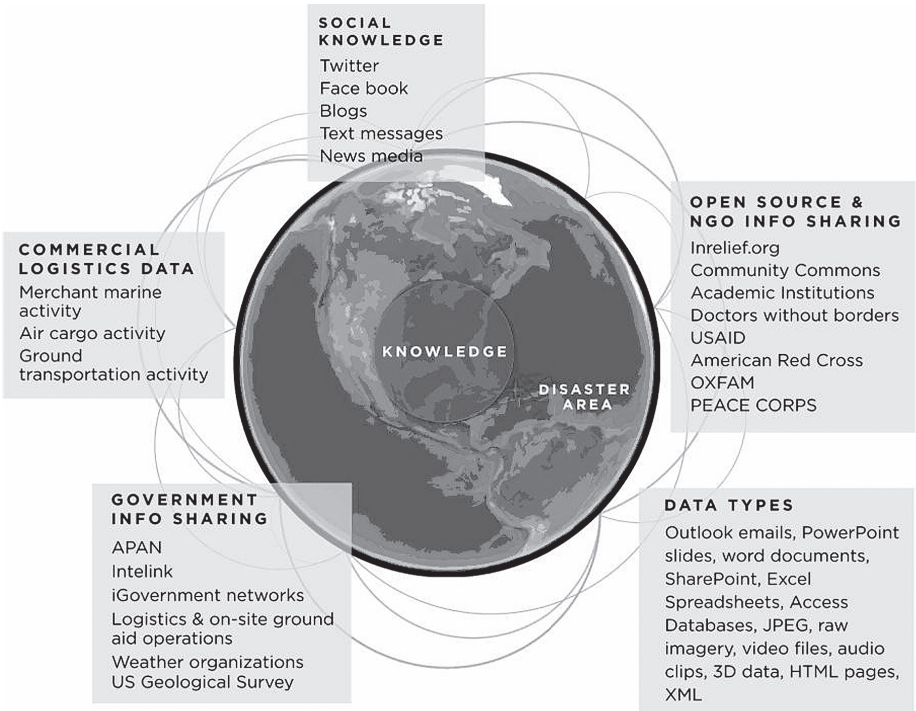

Figure 3. Wide Range of Collaboration (Eckersley)

To date, the most widely-available legacy data is from UN deployments documenting the location of various elements of infrastructure. However, this limited resource is pre-quake and comes from a single, central, thus limited place. It does not account for entities such as informal gathering areas, influence bases, and communication patterns essential to aiding the populace. Engaging the populace presented a challenge. Unlike most information available during crises, that pertinent to the Haiti disaster is unclassified, meaning the international community could and did play a much larger role. While this opened the door to more information exchange, complications of time, preparation, the scarcity of a central controlling body, and language arose. The non-standardization of nomenclature proved an issue for the collaboration of data. English, French, and Caribbean languages like Creole are all commonly used locally, so a single location could conceivably, and often did, have three separate names. As more and more ad hoc tent cities, aid stations, and distribution points were set up, multilingual nature of Haiti presented a challenge to the compilation of data that the 3D Viewer resolved by rapidly identifying duplicate entities using the universal language of geolocation.

4. Details of Technology Solutions Implemented

The limited timeframe drove the need for a robust, scalable and feature-rich solution. These core user requirements included the ability to create globes containing diverse data within a Web-based application that allowed users to upload, dynamically author, and link to content, in addition to collaborate, share and manage data. A platform with a familiar look and feel would reduce training time and accelerate user adoption; Acknowledging this, SOUTHCOM selected the Google Earth Enterprise (GEE) product for its familiarity, and for its ability to collect and streamline a vast amount of spatial formats of imagery, terrain, and vector data in a simple and highly-usable visualization system. Additionally, the Google Earth browser plug-in provided experiences in an entirely browser-based environment, greatly increasing user access to the tools.

Building these applications from the ground up would have been a time-consuming process requiring special skill sets. SOUTHCOM needed a tool that provided as much of the desired customizable, rapidly-implementable functionality as possible; for this reason, the iSpatial Enterprise Visualization Service was the natural choice for the core of the UDOP development process, providing the ability to develop Web applications rapidly on GEE and the Google Earth API plug-in. It is a rich platform comprised of both front-end libraries which augment and extend the Google Earth API and back-end services, which provide analytics and access to data, as well as support the creation of new data. These Web services assisted with quickly developing geospatial analytic capabilities, while simultaneously integrating multiple, disparate data sources. iSpatial provides the value of pre-built components and application functionality that could be quickly customized to specific requirements. The net result is a higher-quality product in a shorter time period. iSpatial is developed in coordination with the latest Google Earth API functionality, ensuring that both products are fully synchronized. Using this approach SOUTHCOM reduced their software development time by an order of magnitude, delivering the Web-based UDOP in days versus months.

Base Globe Production

While content generated by users layered the UDOP, their base was a special, customized globe on iSpatial technology, served as the foundation of the UDOP software. SOUTHCOM was able to take raw spatial products and fuse them into a self-managed Google Earth globe. They could control their own fixed geospatial data instead of having it managed by Google. As new geospatial products such as imagery, vectors layers, terrain, and Open Street Map (OSM) became available, they could be added as optional layers, but to create new versions of their own globe with updated base imagery was critical to reducing confusion.

Haiti presented a major challenge in terms of imagery acquisition. There was a pressing need for post-quake imagery, but unclassified content was extremely limited for the first few days following the disaster. A few organizations began providing imagery at no cost to those performing relief work. A major contributor to SOUTHCOM's initial globe was GeoEye, an organization that provided publicly accessible satellite imagery data. National Oceanic and Atmospheric Administration (NOAA) also provided aerial imagery. During the seven days following the earthquake, SOUTHCOM officials were put into direct contact with the Federal Emergency Management Agency (FEMA) National Response Coordination Center which notified SOUTHCOM of all known scheduled imagery collection dates from all the major providers and projected dates for release, which proved to be invaluable to the planning.

The heavy influx of imagery challenged SOUTHCOM's imagery analysts, who inspected all incoming data, removed data that contained substantial cloud cover, corrupted images, inferior resolution, or other elements rendering it unusable. Newer, more relevant data replaced older data on the globe which was then pushed onto a live production server accessible to all of the UDOP users. To make rapid updates, developers used a Google Earth Fusion Grid comprised of seven dedicated high performance servers. Additionally, over 15 terabytes of storage space was available via a storage area network (SAN) used to store raw imagery resources and the final globe product.

Adherence to the KML/KMZ format throughout the UDOP was a logical choice as it was the only robust, textual extensible markup language (XML)-based, open standard format within the geospatial realm. Ultimately, a user could open any text editor and extract the geodetic data from a KML file; the same cannot be said for various other files such as a shape file or National Imagery Transmission Format (NITF) file. A clearly-defined requirement for an inclusive environment ruled out proprietary formats. They would have been more difficult to manage, and the resulting data would have been challenging to synthesize with other spatial data files among the user base. Finally, more tools were readily available for displaying and manipulating KML/KMZ files than existing tools for other geospatial formats. The decision to standardize via using the KML/KMZ format ultimately proved to be beneficial, as information could be easily shared throughout the disaster response community.

5. Features, Solutions, and Applications Implemented

Creating and Sharing Content

The SOUTHCOM 3D UDOP was initially an extension of SOUTHCOM's preexisting and non-geospatial collaboration portal, All Partner Access Network (APAN). APAN's image, document and comment sharing were crucial to information management within SOUTHCOM's Humanitarian Assistance/Disaster Relief (HA/DR) network, which included non-military participants. Although the APAN was widely used, users made more time for the UDOP when it was accessible on the Web outside of the UNCLASSIFIED military network, and eventually became a permanent fixture in the SOUTHCOM Crisis Action Center (CAC).

The UDOP Haiti project addressed the challenge of creating one common picture of spatially-relevant data applicable to Haiti after the earthquake. The initial operating capability had three core features to support data collaboration. The first feature allowed users to import any KML/KMZ file and load it to the UDOP view. The second allowed users to link to a URL and send dynamic updates to other spatial files and render them in the UDOP. The third, which was imperative to promoting an environment of sharing, was a spatial content export tool, which allowed users to use the UDOP as a "marketplace" of spatial data, even if users didn't ultimately use the tool for fusing the information into a single picture. This ensured that the UDOP served a dual purpose as both a repository within which content could be created or viewed and as an index of available content, which was critical to its widespread use as an environment for data sharing. The ability to link spatial data layers from sources outside of the UDOP gave users the ability to define a custom view through their browser. As the volume of data increased, two additional tools, one allowing for the creation of lines, polygons, and points, and also a common labeling and icon scheme, rendered the content more easily comprehensible. Moreover, all new content automatically recorded the users name, contact info, and date of creation, in order to provide lineage and pedigree data for future viewers.

Another obstacle taken on was the limited access to high-speed communications, as many users interacting with the UDOP were on the ground in Haiti, where infrastructure was unreliable at best, prior to the disaster. Regarding poor infrastructure, most of the globe has played only a minor role, if any at all. If GIS is to be a truly global initiative and confer its benefits to all global citizens then a way must be found to bring these nations on board. (Holland *et al.,* 1999) On the Google Earth browser plug-in, users were able to cache and view imagery, content layers, and other data without having to coordinate communications with the server. The commonality in data production, achieved by providing a basic guideline via the Web-based content production tools, allowed different users to understand content instantly, regardless of the authorship of the layer.

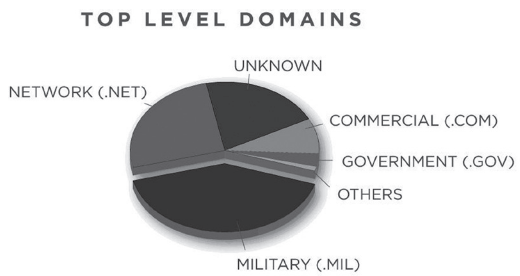

Figure 4. UDOP User Data (Eckersley)

The fact that independent users were conducting damage assessments of key facilities was invaluable to the UDOP collaborative effort, as it contributed to the creation of 3D models in Google Sketch-Up, terrain features, and LiDAR data. In turn, an inclusive environment for spatial collaboration was extremely valuable to all users, as the 3D functionality, the up-to-date imagery, and a host of functions allowed the users to define their view and create, and instantly update it. The collection of these functions and abilities within a single place not only drove users to the UDOP, but also increased the time users spent interacting with the site. Once the content creation tools were integrated and the overall volume of information in the UDOP increased, Thermopylae noticed major spikes in the time each user spent in their session; within one week of the earthquake, the average time a user spent interacting with the data was between two and three hours per session. This was up from little to no time spent interacting in a spatial collaborative environment.

Mobile Apps were some of the most effective methods for building knowledge within the system and collected data directly from those individuals in the field during the crisis. To this end, SOUTHCOM officials were able to take advantage of smart phone (i.e. iPhone® or Android™) technology and integrate customized software on various mobile platforms that complemented UDOP. Allowing relief workers to share and post data about their immediate surroundings in real-time. Integration of mobile applications leveraged the comprehensive 2-D version of Google Maps™ for mobile phones. This included uploading geo-located text and descriptions, as well as photographs taken using the mobile application through in-house developed Disaster Relief and also using GeoCam developed by NASA and Google. The UDOP also leveraged existing crowd source tools include Ushahidi based services that generated layers from geolocated SMS messages sponsored by local telecoms immediately after the earthquake.

Figure 5. GEOCAM App in UDOP (Eckersley)

SOUTHCOM developers deployed Android GI mobile phones in Haiti, loaded with a custom mobile application that allowed users to be "collectors." The phones were able to embed 3.2 megapixel photographs with a pinpoint-specific location and the camera's heading at the time of the picture. With this capability combined with Web connectivity and server space, military personnel in Haiti had the ability to provide all UDOP users with sharp, geospecific imagery that updated to a dynamic UDOP layer in near-real time. On the UDOP, the image appears as an upright window with a zoom capability. Thus, phone carriers could effectively build a room where the walls make up a 360-degree view.

These applications provided quick and easy access to critical knowledge on an as-needed basis, such as locating the nearest medical facility or relief camp. An important additional feature of the application was an offline mode that allowed users to store data on their mobile device locally before finding a data point, such as a Wi-Fi® hotspot or a working cell phone tower. Once data was able to be sent and received, the mobile application prompted the user to submit the locally-stored data. The "Disaster Relief" application was created initially using the iPhone software development kit (SDK). The application was made freely available within Apple®'s "App Store" and allowed ad hoc distribution. The application was also ported to Android and other popular mobile platforms.

By combining these resources, SOUTHCOM leaders were able to build a full-featured solution, supporting the sharing of information among relief supporters and coordinators, as well as enabling direct interaction with those on the ground in Haiti. If information is power, it must be placed in the hands of all participants so they can work together in myriad ways to solve the problems of crisis and improve lives (Onsrud, 2003).

Figure 6. iPhone UDOP App (Eckersley)

The Presentation Builder is the UDOP's answer to PowerPoint, but is a briefing tool with notable advantages. Presentations are sequences of content and view captures that can be easily rearranged, updated, or interacted with on the fly. They can be built rapidly manipulating the entire catalog of content contributed by the user community instead of from creating content scratch. Furthermore, Presentations update automatically as the UDOP's content is updated by data custodians and users click through different personalized views. The daily standup briefs at SOUTHCOM are now conducted with the Presentation Builder, putting audiences immediately in touch with their community's content.

iHarvest immerses each user in the UDOP's content and user community by profiling the layers and areas searched. As that profile is built over time, the user will be prompted with new and existing content similar to previous searches and users with similar profiles will be informed of each other's presence. No longer do UDOP users operate in a vacuum. iHarvest also allows users to exchange or update profiles which facilitates familiarization of a new area or mission. Turnovers can begin long before a relief worker ever enters a disaster area as situational awareness spreads.

Collaboration was further improved by promoting interaction and the exchange of opinions regarding geospatial data. The Sharing function allows users to share their screen with others, even those without logons, so the user community can show each other content which is a step up from ordinary discussion. With each layer shown is Scoring, shown in stars, that is aggregated from the entire user community's feedback.

6. Content Management

According to Manual Castells, "The most critical distinction in organizational logic is not stability, but inclusion and exclusion" (Castells, 1999). In relation to the UDOP, this meant that aggregating data from varied sources was central to accommodating as much of the relief community as possible, but it also presented challenges. Even early on data was bountiful, but managing it proved to be a significant test.

Organization

The initial organizational strategy was based on the first users who populated and verified much of the initial content at SOUTHCOM. Spatial layers were organized under ten headers, such as "Operations" and "Logistics", which reflected U.S. Military Joint organization. As content and the user community grew a more intuitive strategy became necessary. Centrally managing layers became unwieldy and nonscalable as administrators were reluctant to dispose of other's data when misplaced or disorganized. Another disadvantage was that central management implicitly made SOUTHCOM responsible for the accuracy and timeliness of each layer. Watch standers and content managers at SOUTHCOM were not onsite in Haiti, so once they took control of specific layers, they soon became unsure of whether or not information was still relevant, or moreover if it was even accurate in the first place.

Short of calling each aid station, there is no way to confirm the relevance or accuracy, so the onus must remain with the custodians of each layer who may reveal information.

To make the UDOP as open and inclusive as possible to the international community, its sponsors sought input from the global geospatial community referencing Spatial Data Infrastructure (SDI) Cookbook documentation and subject matter expertise from the Geospatial Data Infrastructure Association (GSDI). A team of GIS and SDI experts structured data around a disaster relief ontology. The resulting organization structure was well received by the user community and has built in flexibility for future relief efforts.

Moving towards dynamic layers was more scalable portraying content as controlled by its custodians. It is better to trust the original source of the information rather than a regurgitation. Data custodians are empowered with the ability to expose or conceal all parts of their data discovery. Centrally managing content was easier to standardize, but problems from KML file names, to icon colors, to the format of embedded data and was update schedules weighed on administrators. The solution was to clarify which icons and standards were approved by embedding a transparent legend, instructions in the user manual, and icons themselves which were both useable in the UDOP and exportable to Google Earth where some content was built.

Content Fidelity and Validation

A recurring issue focused on the validity of data. The SOUTHCOM J2/J3Deputy Director for Knowledge Management assessed that while individuals could update data to a collaborative site, for the data to be orderly when publicly viewed, it needed to be vetted and approved by a content management group. Occasions where the UDOP was filled with "bad data," illustrated the need for checks. Centrally managing content was performed by Miami-based

SOUTHCOM personnel, but this practice proved to be grossly inefficient, due the number of people and hours need to be dedicated to uploading static data layers that was already managed elsewhere.

In version 1.0 of the SOUTHCOM UDOP, there were only two types of users: general and administrator. Any user could add content to the site; administrators also had the ability to approve the content for public view. Content managers soon found themselves with too much data to manage. Early program administrators were able to delegate administrator rights to others, which led to large numbers of questionable layers being approved, and others being unnecessarily deleted. Once a layer was uploaded, there was no mechanism to check its accuracy and it was difficult to tell when certain layers of data were collected, and whether or not they were outdated—or even accurate—without embedded information.

This issue was addressed by creating approvers with narrow purviews. Distribution of responsibilities created order by preventing users from altering content outside their folder, but it was important not to suffocate users by limiting their access to information. Content management benefited from more defined user privileges as loose structures were tightened to make the volume and quality of inputs more manageable by administrators.

User Defined

As users created content, they could use icons from either Military Standard 2525 or internationally-recognized basic relief symbols. The foundation for the international symbols used for the UDOP was based on a collaborative effort by the American Institute for Graphic Arts (AIGA) and the U.S. Department of Transportation.

To further define the structure, a series of voting mechanisms, both manual and automatic to develop baseline metrics, were instituted. The combination of international "crowd input" through voting and SDI expertise is combined on a quarterly basis to update the content management strategy for the UDOP. The voting mechanisms provide capability way for knowledge managers to understand which layers have more or less value and relevance.

Figure 7. Fusion of Layers (Eckersley)

Duplication of Info

Data was bountiful, but managing it proved to be a significant challenge with the duplication of information. This occurred when content was completely identical, and also when they represent the same thing, but differ in format, name, language or appearance. If two organizations' territory overlapped and kept records on the same aid station, there would be two icons representing the same thing. The icons may have different names, manage separate information, or make updates at different intervals, but such is likely with the patchwork nature of urgent relief efforts. The SOUTHCOM UDOP is building features to resolve and account for the duplication of information by automating communication forums for the custodians with or collocated data. Matching layer custodians and encouraging their collaboration by prompting them with a comment window or other functions will promote merging or removal as means to address icon redundancy and duplication.

The UDOP effort stressed the integration of different file formats and this compilation becomes uniquely valuable when formatting data originally unintended to be viewable geospatially. The UDOP can place the fruits of many collectors' labors in one interface, in a context that everyone can understand: geographic space.

7. Best Practices and Noteable Experiences

Training

According to proponents of the open-access of geographic information, distance learning has increased accessibility and contribution in education, paralleling collaboration in the information age (van Loenen and Unsed, 2004); this philosophy was adopted for the development of the UDOP.

Training was provided in a variety of formats to include as many learning styles and operating resources as possible as it was anticipated that time and/or bandwidth would be limited. A user manual familiarized users with the UDOP capabilities and explained how the program fit into SOUTHCOM's mission. This succinct document informed users, well before they received an account or downloaded the Google Earth plug-in. Training video podcasts were also created to provide step-by-step lessons for all functions. Demonstrations of the range of content promoted the creation of more content, while also highlighting the contributions of others. The cumulative diversity and density of data that could be layered was testament to the need for agility and innovation in content management. Although the technical team was only exposed to approximately 10-15 percent of the user base on the Web site, they were able to capture the prioritized needs from that group, and then expand upon the capabilities the entire user community needed. Furthermore, when brief training videos were viewable directly from the UDOP splash page, requests for support dropped by 70 percent. Using a common tool such as the Google Earth browser plug-in with the iSpatial framework, relief workers could use the UDOP with little-to-no training. Users could build video fly-through presentations with data that was live, up-to-date and interactive, so when it was presented a user could stop and drill down into a greater level of detail for facilities, mobile units, and landmarks as well as basic reporting and imagery. This supported an extremely adaptive environment for the intelligence personnel supporting the relief effort.

Figure 8. Training CNIGS on UDOP (Holliday)

Hands-on training was provided to those most in need as well. Thermopylae's program liaison travelled to Haiti to train their geospatial agency Centre National de l'Information Géo Spatiale (CNIGS), a small group of intensely committed professionals, in the UDOP and how it could be useful for use by their domestic services. Infrastructural problems were an obvious limitation, but senior officials in the Civil Protection Agency saw the value in a tool that could be used by most people with minimal training and handled the inputs of a large user community. In rebuilding their country, they had the foresight to want to rebuild their institutions so that they could a common place to view information and a way of reaching the population.

While conducting training at SOUTHCOM and beyond, all training materials produced were available to the entire user population, with the prospect of delegating content management to best-suited the individuals. Intuitive and easily-used training products garnered enough interest in the UDOP so custodians of each data set were willing to share their closely-managed data with SOUTHCOM.

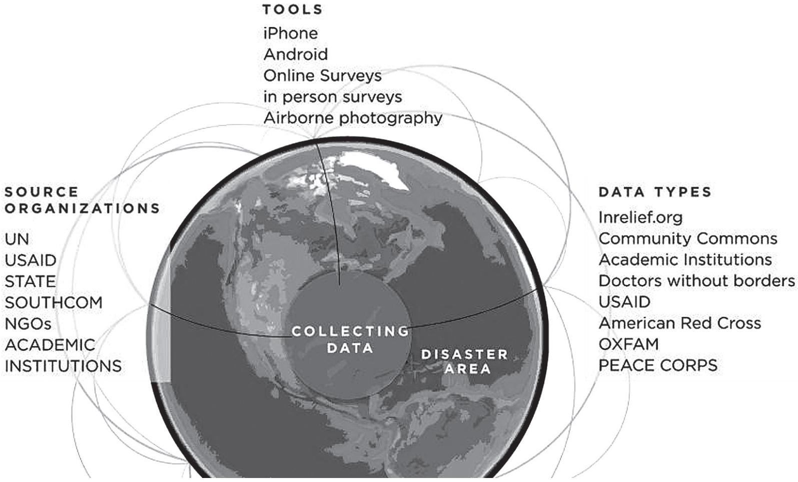

Figure 9. Supported Data, Tools, and Sources (Eckersley)

8. Conclusion

How the UDOP filled the need for collaborative geospatial data coordination in disaster relief is undeniably one of the most notable features. Thousands of users from partner nations, non-government organizations, and local and state first responders had one central location to access and share relevant intelligence. From geo-tagged snapshots of gang areas and flood plains on smart phones, to the creation of adaptive spot-reporting layers, the UDOP flexed to meet a variety of needs for relief workers in Haiti and was referenced in Chile, Guatemala, and the Gulf of Mexico oil spill this year as well. The future promises to bring new challenges as the limits of how much information can be fused into one Google Earth browser plug-in. The door is open to a variety of potential capabilities, and it will be exciting to see further experiments with matching the right functionality to a spatial data representation.

In the UDOP project with SOUTHCOM officials, much of the innovation was driven to make the tools immediately needed by the relief coordinators. Due to the urgent need for a timely response, SOUTHCOM officials broke from the norm and embraced an inclusive, collaborative environment. The UDOP for Haiti demonstrated that if users are intellectually involved in improving the technical capability, they have a greater interest in the application. Also, having a responsive design team that can integrate capabilities in a matter of days, versus weeks, was imperative to retain user buy-in. The humanitarian community benefits from this rapid spiraling method of development as tools are tailored to their biggest challenges. As the technical capabilities for sharing data increase over time, new ideas will be formed from users as they reset their understanding of what the high-water mark is for inclusive sharing of spatial data.

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Chapter 15

Integrating Spatial Planning and Disaster Risk Reduction at the Local Level in the Context of Spatially Enabled Government

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Abstract

Spatial planning is increasingly regarded as one of the important instrument in disaster risk reduction. It facilitates decision on the future use of space in any administrative unit, which in some cases may be confronted by natural hazards. This would be an important component of any society and government if they want to become spatially enabled. This chapter discusses theoretical approach in integrating disaster risk reduction into spatial planning at the local government level. Attention is focused on the local government level because at this level mainly the operational aspect of spatial planning is executed. Prerequisites for proper integration are elaborated. A method for the integration based on integrated risk map and vulnerability map is proposed. It also shows example of how the local government in Indonesia tried to incorporate disaster risk reduction in the spatial planning. Four aspects of policy and regulation, organizational aspect, data consideration and platform for integration were assessed.

Keywords: spatial planning, disaster risk reduction, local government, spatially enabled government

1. Introduction

Recent figures from a number of international agencies indicate that there is escalation of casualties and economic losses from natural disasters. These conditions are closely related to the increase exposure of people and infrastructures to natural hazards, as a result from population growth, limited available space and global climate change (Sanderson, 2000; Resurreccion *et al.,* 2008). The high number of casualties and economic losses will weaken the ability of a community or country to achieve sustainable development objectives. A large amount of financial resources has to be allocated for emergency responses and reconstruction program afterward, and leaving another important sector receive less funding. Natural disaster will affect people, physical environment, and socio economic activities. Pre-disaster condition

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of these four aspects rarely can be brought back after the reconstruction phase ended. As disaster hit a particular geographical location, disaster risk reduction effort should also look at the utilization on the place in relation to natural hazards, at present time and foreseeable future.

Spatial planning is increasingly regarded as one important instrument for disaster risk reduction. Its attractiveness lies in its function for regulating long term use of space. Through appropriate land use allocation, exposures to natural hazards at the current and future situation can be minimized or even prevented. Multi hazards approach is required since a location may receive threat from numerous type of natural hazards. A coordinated policy, which contains laws and regulations, is needed to provide organizational and technical guidelines for the incorporation of disaster risk reduction strategy in spatial planning.

Within this context, this chapter explores the conceptual method of integrating spatial planning and disaster risk reduction at the local government level. Attention is focused on the local government level since at this level the detail spatial plan is formulated and the responses to disaster risks is sought at first. Focus on the local government is also strongly endorsed by some international organizations and meeting, most recently by Incheon Declaration in 2009.

The structure of this chapter is as follows. This chapter begins with discussion on the relation between spatial planning and spatially enabled government, followed by description on the importance of disaster risk reduction in ensuring sustainable development. The next section describes the significant role of spatial planning in disaster risk reduction. It then addresses the method to integrate disaster risk reduction and analyses how the concept was being implemented in the Indonesian local government context. The final section provides summary and conclusions.

2. Spatial Planing and Spatially Enabled Government

2.1 Elements of Spatial Planning

Spatial planning involves the process of allocation, forming, sizing, and harmonizing space (land) for multifunction uses (Albrechts, 2006). This task is conducted by city, district or municipal planning agency with close collaboration with other government agencies. The main objective of spatial planning is to decide the future use of space (Greiving *et al.,* 2006b). Three challenges are now faced by planners: growing population, scarcity of suitable space and risks from natural disasters, as shown in Figure 1. With limited available space and population growth, there is an escalation of competition in the use of space. The problem in finding suitable location and appropriate allocation is coupled with the increasing number of disasters. The impact of natural disaster is predicted to becoming more severe, especially when coupled with global climate change (Resurreccion *et al.,* 2008).

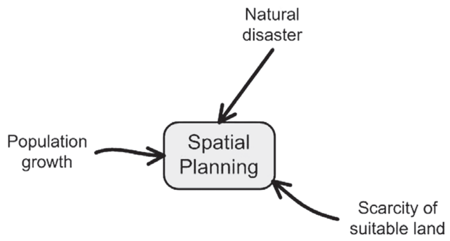

Figure 1. External pressures on spatial planning

Spatial planning is usually classified into national, provincial (state), local (district or municipality), depending on the system of governance implemented in a particular country. National and provincial level spatial plans are concerned on strategic direction of the utilization of land at large coverage, harmonizing multi regions spatial plans and have little operational guidelines. Based on the spatial scales and information content, spatial plans can be classified into two categories: general and detail spatial plans.

- General spatial plans. It addresses the issues of pattern and structure spatial usage on residential, transportation and utility. The definition of developable and undevelopable zones is covered here. The general spatial plans are represented on maps on a scale from 1: 25,000 to 1: 100,000.
- Detail spatial plans. It contains information on zoning, density, ratios of building and open space and acceptable storey. It has a legally binding status on what type of development that can or cannot be built in any particular location. It is usually represented on maps on a scale of 1:5,000 to 1: 10,000.

2.2 Spatial Planning in the Context of Spatially Enabled Government

Spatial planning extensively uses spatial information, together with non-spatial information. Spatial information is essential in different stages of spatial planning, from preparation, development to the presentation to the public. Spatial planning requires that any information therein should be made available and accessible to public. This fits with the main idea of Spatially Enabled Government (SEG) where government delivers spatial information in digital form on the web and makes it accessible to citizens and business (Wallace *et al.,* 2006), to increase transparency and accountability of government activities and encourage further development of value added product. A spatially enabled government is applying spatially based information to facilitate productive and effective decision making and developing policy (Rajabifard, 2007).

Some countries have implemented SEG concept in spatial planning, such as the United Kingdom, the Netherlands, Australia and partly in Indonesia. UK has developed a web portal <http://www.planningportal.gov.uk/> which contain all information regarding planning matters in the UK. Every local government is required to develop its own portal to address local requirements. Information on these portals includes planning and building regulations, planning permit application, appeals on the decision and access to development information for a particular location (Planning Portal, 2010). The website of the Netherlands' Ministry of

Housing, Spatial Planning and Environment <http://www.ruimtelijkeplannen.nl/web-roo/> aimed to transparently provide spatial plans to citizens, private institutions and government agencies. It has a collection of data from all level of government – state, province and municipality. The new law of spatial planning of the Netherlands requires that all municipalities make their spatial plans digitally available online by 1st January 2010 (Georgiadou and Stoter, 2010).

In Australia, every state has their unique approach in incorporating spatial planning in the SEG context. Some of the early implementation was developed before the terminology of SEG being coined. The implementing agency is usually the Department of Land in each state. In the State of Victoria, information on spatial plans is available at <http://services.land.vic.gov.au/landchannel/jsp/map/PlanningMapsIntro.jsp>. This portal provides information on planning scheme maps (including historical archives dating back to 1954), planning zones and overlays, and aerial imagery (Land Victoria, 2010).

In Indonesia, the website of the Directorate of Spatial Planning, Department of Public Work <http://www.penataanruang.pu.go.id> has wealth of information regarding spatial planning at the national, provincial and district level. It also contains information on laws and regulations. Its WebGIS has information at the national and provincial level as well as on the island and strategic area been developed. Small number of local governments have developed webGIS portal which include simple spatial planning map.

3. Disaster Risk Reduction and Sustainable Development

Three aspects are closely related to natural disasters, namely hazard, risk and vulnerability. Natural hazard is a potentiality dangerous natural phenomenon which can cause injury or loss of life, property and infrastructure damage, and disruption of social and economic activities (UNISDR, 2009). If added to the vulnerability, it becomes risk. Vulnerability is a condition related to exposure and susceptibility to losses. Disaster is the realization of risk. Natural disaster is a result natural hazard when it struck vulnerable people or property. It will remain a usual natural phenomenon if it hit remote area which is un-inhabited by people and no infrastructure lie in the area. The impact of disasters will depend on the type of natural disaster, geographic coverage, population density and condition of infrastructures.

In the last four decades, natural disasters have created a lot of suffering and great economic losses. The increase on disaster losses and reconstruction cost can hinder spending on other sectors such as education and health, thus reducing capacity of government in sustainable development. Reducing disaster risk, therefore, should be aimed at the development of resilience community to natural hazards and ensuring that development will not increase further vulnerability of community and infrastructures (UNISDR, 2001).

Disaster risk reduction is a systematic effort to reduce risks of disaster through the reduction of exposure of elements at risk to hazards, lessened vulnerability of people and property, better land management practices and improvement in preparedness (UNISDR, 2009). Mainstreaming disaster risk reduction and integrating it into development program and spatial planning at all levels of government is essential. At the national context, mainstreaming can be realized when all related government agencies at all levels become concerned and involved in the development of framework at the same time (Mitchell, 2003).

Disaster risk reduction focuses on three main component of disaster risk, hazards, vulnerability and exposure (DFID, 2006). Most of hazards are coming from the force of nature beyond human capability to reduce their destructive potentiality. However, some of them can be influenced or modified by human activities. Reducing vulnerability requires understanding of the underlying factors that create hazards and how they interact with elements at risk. Elements at risk are people, building, infrastructures, economic and social activities which are possibly in danger of hazards.

Impacts of disaster can last for several years or even tens of years which can hamper sustainable development. Brundland Commission (1987) defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Disasters can destroy development accomplishment, and reducing capacity to maintain and improving it in the long run. The long term impacts of disaster are on the people, infrastructures, environment and socio-economic activities. These elements at risk should be safeguarded against disaster risks to ensure sustainable development objective will not be compromised.

4. Role of Spatial Planning Response in Disaster Risk Reduction

Spatial planning is responsible for the decision on long term utilization of land. Although not directly responsible for disaster risk reduction, spatial planning has fundamental role in disaster risk reduction. Four possible roles of spatial planning in disaster risk reduction, as identified by Fleischhauer *et al.* (2005) are:

1. Prohibiting future development in certain areas. In highly prone area, especially with history of disaster occurrences, development should be prohibited. Areas required for emergency response and retention need to be keep free.
2. Classify different land use setting for disaster prone areas. Every disaster has their own acceptable risk on different land use classes. Steep slope which is highly susceptible to landslide should not be us for residential or commercial area, but may still be suitable for plantation.
3. Regulating land use or zoning plans with legally binding status. In an area vulnerable to earthquake, regulation on building density is essential to reduce impact of building collapse.
4. Hazard modification. Spatial planning can play role in promoting soft engineering method to reduce risk of flooding. Retarding basin required to contain flood water should be keep free of development to maintain its function.

Implementation of the functions of spatial planning in disaster risk reduction should be effectively conducted at the local government level. Incheon Declaration (2009) endorsed the importance of local government role in disaster risk reduction. The local government is the one who has to responds to the disaster at the very beginning of catastrophe. During the prevention stage, the local government is responsible to prepare a comprehensive policy on disaster mitigation. Figure 2 shows the relation between local disaster, planning and action.

When a local disaster struck, the local government is the one who should first response the situation. Local planning in reducing disaster risk includes long term prevention strategy which can be manifested in spatial plan. Moreover, local planning will help in developing better local responses because of their knowledge on local condition.

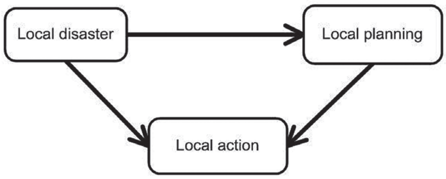

Figure 2. The importance of local planning in disaster risk reduction

Disasters are mostly unpredictable and time-dependent. Current knowledge and technology cannot precisely predict where, what magnitude and extent a particular disaster will occur. The term time-dependent disaster means that the magnitude, extend and frequency of hazards may increase or decrease in the future. It is likely that disaster occurrence will increase along with the increase exposure of people and infrastructures to hazards.

Prediction on how disasters will occur in the future is very important element in developing spatial plans. Prediction is more likely to succeed for long term hazards with slow progression, such as land subsidence and sea level rise. These two hazards produced a noticeable signs of their progression in the long run, although in the short term may not be clearly visible. On other types of hazards, prediction could only rely on historical data of their occurrences, magnitude and frequency. In all cases of natural disasters, planners and scientists are confronted with uncertainty. However, any uncertainty should not hampering incorporation of risk reduction strategy in spatial planning.

5. Integrating Disaster Risk Reduction in Spatial Planning

5.1 Pre-Requisites for Integration

The integration of disaster risk reduction into spatial planning involves several aspects, i.e. policy, organizational, data and platform (Figure 3). Currently, organizations with tasks on disaster risk reduction and spatial planning working separately. It appears that there was no direct relation between national or local disaster management agencies with their counterpart on spatial planning. Nonetheless, Observation on spatial plan maps in from various countries such as Australia, United States, Japan, Netherland and Indonesia reveals that into some extents spatial planning have considered disaster risks.

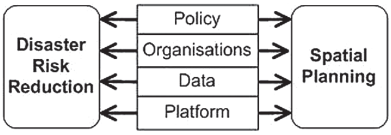

Figure 3. Elements in the integration of disaster risk reduction into spatial planning

Policy provides guidelines and directive on the implementation of integration of disaster risk reduction in spatial planning. It is formally materialized in laws and regulations. Laws and regulations will clearly defined responsibilities of all participating agencies, institutional arrangement and how the operational procedures be executed. The structure and hierarchy will depend on the system of government adopted by each country. Generally, a central (or federal) government laws and regulations are required to provide umbrella and directives for local government actions.

Data for disaster risk reduction are coming from different agencies in different format. Standardized data format is preferred to enable seamless data exchange and sharing, especially on spatial data. Spatial data come from different agency usually submitted in different format, projection system, visualization, semantic, and scale. One of the fundamental requirements is on the interoperability of spatial data, since inappropriate merging of data can result in misleading decisions. Similarity or interoperability on data format and projection system is another requirement. Different visualization coding may be used by different organization to depict similar features. Classification on categorical data, e.g. slope steepness, among participating organization should be made alike. There is also problem on the use of scale. Natural hazards, such as landslide and flooding, usually represented in small scale map. On the other hand, detail spatial planning requires large scale representation for zoning purpose.

Records on past event of disaster may well be maintained in develop countries, but are scarce in many developing countries. Availability and limitation of historical data can affect the prediction of the future probability events. In terms of thematic maps, the following are required for integration with spatial planning:

1. Past events of disaster;
2. Hazard risks map;
3. Element at risks map.

Incorporation of disaster risk reduction strategy in spatial planning involves active participation from various government agencies as well as public engagement. A platform for facilitating this task is required, to enable seamless data sharing and exchange. Spatial Data Infrastructures (SDI) needs to be set up for this purpose.

5.2 Existing Risk Assessment Model

Some models for assessing disaster risks have been proposed by different organizations, for example by Munich Reinsurance Company (Munich Re, 2003), Hazards Research Lab, Department of Geography at the University of South Carolina, and the Institute of Spatial Planning, University of Dortmund (IRPUD). Munich Re model (Munich Re, 2003) was aimed to find out overall risk index of 50 megacities all over the world. It consists of three major indices namely hazards exposure, vulnerability and exposed value. The hazards exposure component consists of two elements of 'average annual losses' (AAL) and 'probability of maximum losses (PML). On the vulnerability components, it consists of six elements: standard of preparedness, standard of safeguards, residential construction vulnerability, commercial/industrial vulnerability, building density and quality of construction. Exposed values components focuses on economic values of the area. The three main components receive same weight of 33.3%. The model seems to end with overall risk index of the existing environment but without prediction on the future situation. However, this can be understood since the model was developed from the viewpoint of an insurance company.

The second model called Total Place Vulnerability Index. The description of this model follows 'State of South Carolina Hazards Assessment 2005' (SCEMD, 2005) and Greiving *et al.* (2006a). It is an index which ranks counties by level of their vulnerability to hazards. To come up with total place vulnerability, the model received inputs from total hazards probability of occurrences scores and total social vulnerability scores. These two inputs have same weight of 50%. The total hazards probability of occurrences scores were based on historical data of hazards affected all counties in the region, without consideration on their extent and magnitude. The total social vulnerability scores were obtained from variables of age, gender, population, race, income, and number of mobile homes per county. All sub-elements in the two inputs have similar weight regardless of their degree of importance. Although mathematically simple, some extreme values in one sub-element can distort the final place vulnerability index.

The third model, Integrated Risk Assessment of Multi Hazards, was developed by at the Institute of Spatial Planning, University of Dortmund (IRPUD) Greiving *et al.* (2006a). The objective of the model was to develop an integrated risk map based on integrated hazards map and vulnerability map. Inputs for integrated hazards map were all relevant hazards in a particular geographical location. Weight for each hazard classes, e.g. typhoon, landslide, flood were derived using Delphi process, based on the opinion of scientist and stakeholders in the region. Therefore, there will be different weights on each hazards class. The vulnerability map consists of the following components, hazard exposure and coping capacity. Hazard exposure is the product of GDP per capita and human damage potential based on population density. GDP per capita is an aggregation of infrastructures, residential buildings, production capacity, etc. The coping capacity is actually representing financial capacity of the nation or region to cope with the disaster.

5.3 Model for Integrating Disaster Risk Reduction into Spatial Planning

The previously mentioned models provide a foundation on how to assess multi hazards risks in any urban or rural area. However, those models stop after risk indexes or maps have been produced. They did not move forward into the integration with spatial planning. In this section, a model which takes risk maps into spatial planning is presented (Figure 4). The integrated risk component of this model was adapted from IRPUD model (Greiving *et al.,* 2006a), but was modified to suit the requirement in different geographical setting and was simplified in generating vulnerability map. The main component of this model is on the integration of integrated risk maps with spatial plan to produce disaster resilient spatial plan.

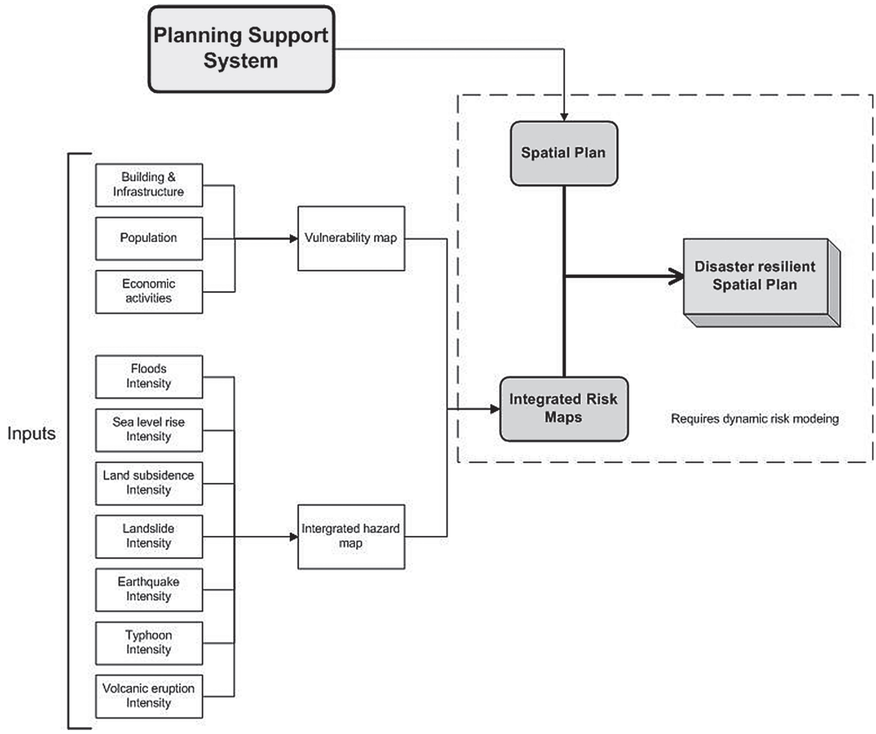

Figure 4. A model for integration of disaster risk reduction into spatial planning

Integrated hazard map is the product of individual hazard, which is location-dependent. In this model, the natural hazards were typical of coastal urban cities located in deltaic area or alluvial plain. Individual hazard map is developed using historical data and prediction of probability of future events. The latter is essential in the context of dynamic disaster. The vulnerability map is created using three inputs, building and infrastructures, population and economic activities. Building is an aggregation of the residential, commercial, industrial and public buildings. Infrastructures consist of road and rail network, utility, energy and telecommunication facilities. To be able to map this entire element at risk, a large scale map with detail information is required. Integrated hazard map and vulnerability map are then combined to produce an integrated risk map.

The integrated risk map is to be used to assess the fitness of spatial plan with regard to disaster risk. Spatial plan is the product of planning support system, although not necessarily using it. Conventional method of developing spatial plan is still valid. Land use allocation need to be tested against the integrated risk maps to ascertain that they can accept disaster risks, if any. A measure on acceptable risk indicators should be developed to accommodate any land use assignment which can allow a certain degree of risk. For example, agriculture field can be located in floodplain since it does not possess any danger to human life. All accepted land use designation will result in disaster resilient spatial plan. Otherwise, the spatial planning should be repeated until it satisfies this requirement. The testing procedure is essential in relation to the possibility of future disaster, as shown in Figure 5.

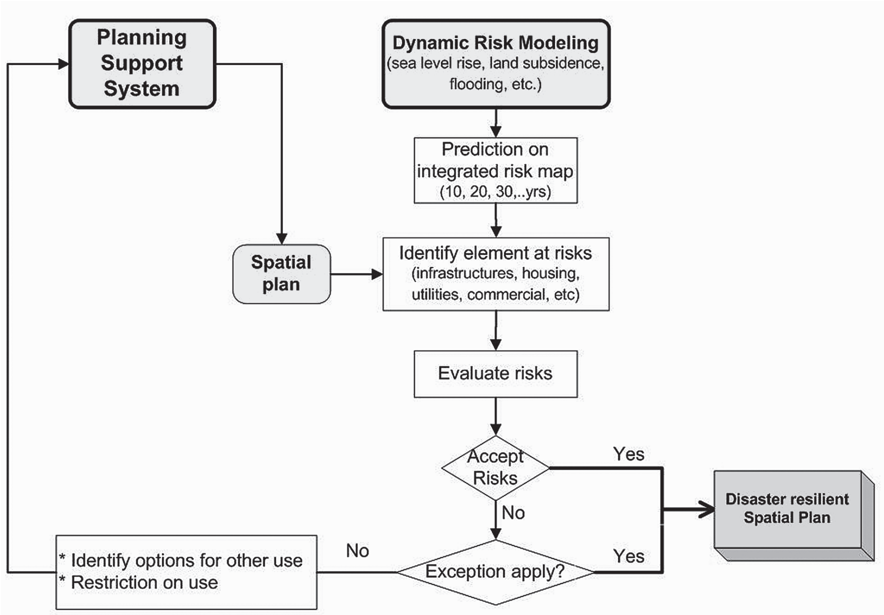

Figure 5. Dynamic risk modeling in spatial planning

The process starts with dynamic risk modeling of some natural hazards, e.g. sea level rise, land subsidence, flooding, etc. The sea level rise, coupled with land subsidence in a coastal city, can increase the frequency, magnitude and extend of flooding. Location currently not subject to flooding may be inundated in 10 or 20 years from now. Therefore, anticipation strategy should be developed at earliest possible time because some development activities are irreversible. Relocating highly utilized industrial complex is costly and will create financial losses.

The spatial plan will then be evaluated, based on the predicted future risks. Element at risk will be developed, based on the overlay between spatial plan and integrated risks map. The next step is evaluating the degree of risk of the designated land use plan. If there is no risk found or the risk is acceptable, then it goes to final spatial plan. In case the risk is not acceptable, the second test whether a condition of exception is applicable will be conducted. An example whereby an exception is applicable is the location of seaport in flooding prone area. There is little possibility to move seaport to other location, but the flood hazard should be overcome by hard engineering measures. If disaster risk cannot be accepted and no exception applies, then the next step is to identify options for other uses or restriction on uses. It will go back to spatial plan formulation. Although planning support system will speed up the process with technically un-biased result, it may not be found everywhere.

6. Case Study from Indonesia

The economic losses of natural disasters in Indonesia since 1907 were paramount, exceeding US$ 23.5 billion (EM-DAT, 2010). To gauge how the Local Planning Agencies respond to disaster risk reduction issues and link it to spatial planning, a survey was conducted in June and July 2009. The questionnaire was distributed to 70 Local Planning Agencies in Indonesia, with 34 responses were received from respondents from diverse geographic location of Sumatra Island, Java Island, Kalimantan Island, Sulawesi Island and Nusa Tenggara region. The respondents were Local Planning Agencies at the district or city level. The questionnaire covers aspect of organization, inter-agency cooperation, spatial data infrastructures and the incorporation of disaster risk reduction in spatial planning. The finding reveals that the local governments in Indonesia have started to integrate disaster risk reduction into spatial planning. Some impediments were found, but in general, the finding indicates that there are some considerable progresses in the move toward spatially enabled government in the disaster risk reduction and spatial planning sector.

6.1 Policy and Regulation

A number of policies have been issued by the central government to reduce disaster risks and casualties. The culmination of this effort was the enactment of the law regarding to disaster mitigation. Law number 24 on Disaster Mitigation which was enacted in April 2007 comprehensively regulates all aspects of disaster management. The idea of disaster preparedness and risk reduction is central in this law. Implementation and enforcement of spatial plans is essential in disaster risk reduction during pre-disaster event. Two other laws were enacted at the same year, Law 26 / 2007 on Spatial Planning and Law 27 / 2007 on Coastal Zone Management and Small Islands. The new Law on Spatial Planning has many improvements in the aspect of disaster risk reduction compare to the previous one which was enacted in 1992. It dictates that spatial plans should be based, among other things, on the consideration to includes disaster mitigation measures. Law on Coastal Zone Management and Small Islands has also a strong attachment to disaster mitigation. Disaster risk reduction strategy has to be included in the spatial plans of coastal zones and small islands. If there is a disaster as a result of negligence in developing disaster mitigation strategy, the responsible parties can be fined for up to US$ 1.05 million or jailed for up to 10 years.

These three laws have been complemented with government regulations providing technical guidelines. In terms of policy dissemination, 72% respondents knew and understand the regulation. In some local governments, there were some local regulations on spatial planning and disaster mitigation already in place. What is still missing is a regulation on spatial data sharing and exchange between different government agencies. This situation leads to the reluctance of different government agencies to share their spatial data, especially because each agency has their own mandates and regulations which sometimes do not fit each other. Parcel level spatial planning information still difficult to achieve. Law on Geospatial Information, which is currently being discussed in the parliament, is thought will overcome the problem.

6.2 Organizational Aspect

National organization for coordinating efforts in disaster mitigation and responses was set up in 1967 through a Presidential Decree. The agency was named the National Coordinating Board for Disaster Management and Internally Displaced People. This agency was transformed into the National Board for Disaster Mitigation (BNPB) in 2008. The Disaster Mitigation Boards were established at the National, Provincial and District/Local Level. The personnel usually come from the previous organization so that they already have the field experience in tackling disaster event.

The Disaster Mitigation Board has no role in spatial planning. Spatial plans formulation is the responsibility of Local Planning Agency, though usually contracted out to private consultant with close consultation with, and supervision from, a committee from Local Planning Agency. The committee consists of officials from various government agencies, such as the National Land Agency, Public Work, Forestry, Agriculture, and the Geological Agency. In this process data on natural hazards risk are shared between the parties. However, the utilization of this information depends on some factors, among them available expertise and infrastructure. Only 29% of the respondents have staffs with education background in geosciences. Cooperation among local government agencies was mostly based on 'gentlemen's agreement', only a few have a formal agreement for cooperation.

6.3 Data Consideration

Obviously all local planning agencies require data from other government agencies, public, private sector, university and Non Governmental Organizations. Main source for data on natural hazards was other government agencies. Agency who supplies most of the hazard maps is the Centre for Volcanology and Geologic Hazard Mitigation. Spatial data of hazards risk of, e.g. mass movement, usually available at small scale of 1:100,000 or 1:250,000. The small scale map was difficult to be overlaid on the detail spatial planning map of scale 1:5,000 or 1:10,000. Only recently there were initiatives from local government to execute hazards and element at risks mapping. These include flooding and landslide, and were executed by local government agencies. Local knowledge was considered in the process, as stated by 84% respondents.

The hazard maps were then being used in spatial planning. However, into what extent the information on hazards location affect the final product of spatial planning is unknown. Little has been done to predict future impact of disaster on the spatial plan. And if addressed in the planning document, the influence on the spatial planning is small. Planners faced a very complex situation with limited options and no adequate tools and accurate spatial data for simulation.

6.4 Platform for Integration

Indonesia has almost 500 districts or cities spread well over 5,000 km east-west and 1600 km north-south direction in more than 13,000 islands. Their ICT capability is varied significantly, depending on the location, funding and local policy. The move toward fully digital spatial planning method is still on the way. Policy on spatial data infrastructures has been issued by the central government in 2007. It was aimed to develop spatial data clearinghouse in every department and local government. It is anticipated that the development of local SDI will facilitate better environment for collaboration in spatial planning and disaster risk reduction. As for the current practice, data sharing and exchange was conducted offline.

Information on disaster risk and spatial planning was mostly disseminated through printed documents on public meeting and newspaper. The use of internet for spatial data dissemination, which include spatial plan, was still limited. Information dissemination on the internet will facilitate greater participation on spatial planning, including disaster risk reduction effort. Some biggest challenges to provide interoperable across hundreds of local governments are preparing human resources and deploying equipment. Government initiatives on spatial data infrastructures and PALAPA Ring will accelerate the process toward spatially enabled government at the local level. SDI policy will create better environment and organizational arrangement. PALAPA Ring will connect all local government using fiber optic network, and add 320 Gbps internet connection (Iskandar, 2007) for the whole country.

7. Conclusion

In the past, disaster management was stressed at emergency response and reconstruction phase. However, it is currently endorsed a shifting paradigm toward prevention strategy before the disaster strike. Disaster risk reduction strategy can minimize economic losses, human casualties and ensuring sustainability of development. It composed of developing vulnerability and integrated hazard maps. The combination of these two is integrated risk maps which is essential in the inclusion of disaster risk reduction strategy into spatial planning.

Integration of disaster risk reduction strategy into spatial planning means that there is a necessity to simulate future impacts of disaster. Spatial plans should be evaluated against integrated risk maps in order to have understanding the possible consequences of disaster on land use allocation. If the designated land use cannot withstand the risk, options on another land use should be sought. There are some degrees of acceptable risk or exception that may applicable, depending on the land use types. The focus of attention should be put on the local government level, as it will be the first to deal with disaster consequences and has the authority in spatial planning at their jurisdiction. Assessment on the Indonesian local government indicates that they are ready to incorporate disaster risk reduction strategy in their spatial planning. Policy, organizational aspect, spatial data, and enabling platform are currently being developed. Nevertheless, there are some differences among local government capacity in delivering this function.

Spatial planning is an important element in the spatial enablement of government. it should be publicly available at the most convenience way. Incorporation of disaster risk reduction strategy in spatial planning will enhance and enrich SEG functionalities. This process, however, should be designed carefully, because there are large disparities among countries and among local government in one country.

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Chapter 16

Making Sense of Local Spatial Data Infrastructure in Volcanic Disaster Risk Management: A Case Study at Sleman Regency, Indonesia

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Abstract

The Sleman local government conducts a risk management program for the Merapi Volcano to minimize damages and casualties in case of an eruption. This program uses spatial data technologies to enhance decision making and enable coordination of the risk management activities. The current situation is that spatial data are sporadically available, and data integration, sharing and effective use by decision makers within Sleman government agencies is not optimal. This research aimed to design and test an application to support a Local Spatial Data Infrastructure (SDI) for risk management efforts, with a particular emphasis on evacuation planning in case of a Merapi Volcano disaster. One of the essential applications of this local SDI was the design of a geoportal. The design of this portal followed a number of steps. The first step involved a review on the activities needed in managing risks of the Merapi Volcano, and the associated spatial data needed. The next step was to examine the processes, problems, and information flows in evacuation planning. These prerequisites were used as foundation for the development of the application. The initial version of the proposed Geocollaboration Portal was customized in order to facilitate decision makers to coordinate and share updates and information on top of the portal's map when dealing with the evacuation process. This customization consisted of equipping the portal with usable map presentations and interaction tools to support the collaborative decisions in volcanic disaster management. The final step consisted of a user group assessment to evaluate the usability of the application. The evaluation of this assessment showed that the collaborative portal on top of a local SDI could improve the agencies' coordination and decision-making processes in the context of disaster preparedness and mitigation. The result shows the potential use of geocollaboration portals in support of the development of spatially enabled societies.

Keywords: Merapi Volcano, local SDI, risk management, evacuation planning, geoportal.

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1. Introduction

Merapi Volcano, located at subduction zone between the Eurasian and Indo-Australian plates, is a constant threat to its surroundings. The International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) in 1994 has declared Merapi as one of The Decade Volcano due to the fact it has erupted more than 80 times and killed thousands of people. Merapi flanks are also home of dense population in Central Java Province and Special Region of Yogyakarta. Therefore disaster risk management of Merapi Volcano is indispensable to protect the endangered population. Sleman Regency as the nearest region that will affected by Merapi's threat, needs to optimize all data and information available to develop the disaster risk management.

The potential utilization of spatial data technologies for disaster management activities has been addressed both from academic and professional perspectives (see e.g., van Westen and Georgiadou, 2001; Mansor *et al.,* 2004). Currently, local and national agencies in Indonesia already link some spatial data with statistical and social data, to construct hazard identification, preparation and mitigation plans, response actions and also reconstruction programs. However, to conduct a proper Merapi volcanic risk management, the local government of Sleman Regency requires instant spatial data access from various national agencies simultaneously, including the Vulcanological Survey of Indonesia (VSI) and National Coordinating Agency for Survey and Mapping (Bakosurtanal)) in developing a disaster risk map of Merapi Volcano. This access to basic spatial data should typically be accompanied with thematic data, collected by local agencies (such as Housing, Infrastructure and Transportation Agency, Health Agency or Local Planning Agency). The combination of such data helps for example in the determination of the evacuation routes or refuges relocation plan. Accessing data from different stakeholders (including Non-governmental Organizations (NGOs)) at different levels of authority requires, however, coordination.

Unfortunately, in the Indonesian disaster management context the coordination of both stakeholders and data is problematic. Many of the available data are seldomly used, even if they were available, while many of the required data do not exist. One explanation for this situation is that the data are not yet standardized, which by definition makes coordination problematic (Kompas, 2005). If each agency collects the required data with their own specifications and codifications, data sharing and integration of different spatial data produced by agencies cannot be realized. Consequently, the spatial data potential for disaster management is underused.

One advocated solution strategy to improve stakeholder coordination is fostering the establishment of a Spatial Data Infrastructure (SDI), as proposed by Mansourian *et al.* (2006) and Aditya (2008). Such an SDI would facilitate access and distribution of spatial data among local agencies and could potentially improve utilization of spatial data for developing spatially enabled societies at a local level including in the context of disaster management. A crucial part of such an SDI involves the interface to spatial data and spatial data exchange for all stakeholders before, during and after the disaster. This study encapsulates a full design study. This starts by an exploration of how the design would fit in an overall local SDI strategy. After this general technical specification, follows a context specification based on requirements from a disaster management perspective. Based on the evaluated user requirements we then present the specifications for the actual portal, and the resulting design. We conclude by an evaluation of the design with stakeholders, and a number of general observations how the design could be improved.

2. Theoretical Grounding in SDI Concepts

SDI as a concept to support coordination is rooted in relatively recent conceptualizations of SDIs. An SDI constitutes of a set of political, technological, and institutional frameworks to facilitate spatial data availability, access, and utilization (Nebert, 2004), or the 'metadata, spatial data sets and spatial data services; network services and technologies; agreements on sharing, access and use; and coordination and monitoring mechanisms, processes and procedures (European Parliament, 2007).

SDIs provide a basis for spatial data discovery, evaluation, and application for all different organization levels (e.g. regional, national, or local level). SDI developments range from local to state/provincial, national, and international regional levels, to a global level (Groot and McLaughin, 2000; Masser, 2005). Most SDI coordination activities were initiated by national mapping agencies (Crompvoets *et al.,* 2004). Originally, the emphasis was on linking large volumes of data at national scales. However, bottom-up SDI coordination activities involved also accommodating the richness of local GIS applications (Yan, 2005; Nedovic-Budic *et al.,* 2004; Muller and von St. Vith, 2009).

2.1 Portals AS Technical Component of SDI

One of the key elements of SDI coordination is the presence of a geoportal, also known as geospatial portal. It provides access to spatial content together with the metadata. A portal enables users to easily find spatial data which they need. The content of such a portal includes offline data and OGC web services such as Web Map Services (WMS), Web Feature Services (WFS), and Web Coverage Services (WCS). One of the key features of geoportal is the ability to support data exchange and sharing between institutions via the internet (Maguire and Longley, 2005). Therefore redundant data acquisition can be prevented and coordination of efforts in collecting data can be enhanced.

In addition to improving the accessibility of a large variety of geospatial resources, geoportal also facilitate geocollaboration since it can be used in a group of user. Geocollaboration portal enables a single user to interact with other users and exchange spatial information within a group work activities. The data and information provided in such portal are more focused to support discussion and sharing to respond to a particular activity of decision making process, including capability for creating annotations of geospatial features in the maps (Aditya and Kraak, 2009).

In the context of disaster management, previous studies found that SDI strategies can be utilized to reduce time wasted in data collection and to make data integration for the purpose of decision making in flood management more efficient (O'Donnell and Birnbaum, 2005), earthquake response (Mansourian *et al.,* 2006), hazard characterizations and vulnerability assessment (Asante *et al.,* 2006). Utilization of a geoportal for disaster management has been identified for enhancing community preparedness and distributed collaboration among local government agencies (Aditya, 2008) as well as tools for discovery, visualization and access to data related to disaster risk contained by different national organizations (Molina *et al.,* 2008).

2.2 Translating the Merapi Volcanic Risk Management Activities into SDI Portal Requirements

The fact that the Sleman Regency is one of the closest regions to the Merapi Volcano has made the local government painfully aware of the need to develop a risk management strategy urgently. Furthermore, such a strategy should make the most use of the technical possibilities of data management. The activities of Merapi volcanic risk management at Sleman Regency can be classified based on disaster management taxonomy, which classifies disaster management into risk assessment, mitigation, and preparedness.

In terms of risk assessment, the activity of mapping the hazards of the Merapi Volcano has been conducted by VSI as the authorities on monitoring and analyzing Merapi Volcano movement. This national agency had started to compose the map since 1978 based on extensive research and assessment of Merapi's hazards. The most recent hazards map was published in 2002 at scale 1:50,000. The hazards map was based on geomorphology, geology, eruption history, distribution of previous eruption products and additional field studies. The map detailed the types of volcanic hazards in Central Java and the Yogyakarta Special Province. The local government of the Sleman Regency has made use of the hazard map to identify villages and sub-villages prone to volcanic disaster and to employ this as a basis to compile the risk map. Information on hazard area has been used to determine the location of evacuation barracks, or to select which village would be appropriate for capacity improvement programs such as evacuation drill or Search and Rescue (SAR) team training.

The mitigation efforts consist of structural and non-structural mitigation. Structural mitigation refers to any physical construction to reduce or avoid possible impacts of Merapi volcanic hazards. It includes construction of bunkers, evacuation barracks, evacuation roads and development of Early Warning System (EWS). Non-structural mitigation related to other non-physical measures with the aim of modifying the impacts of Merapi volcanic hazards on individuals and the community. Efforts of the non-structural mitigation are formulation of the regulation for Merapi Volcano disaster management, formation of standard operating procedure for emergency response, and establishment of the contingency plan.

One of the key mitigation efforts is the evacuation planning. This refers to the activity of arranging the villagers living in the danger zone in order to locate them to a safer location. In terms of the possible Merapi Volcano disasters, the Sleman Government includes the arrangement of evacuation in the contingency plan. Evacuation planning is organized for villages and sub-villages at Pakem, Cangkringan, and Turi sub-district which have been determined as highest risk area according to the risk map of Merapi Volcano. The planning aims to minimize casualties and to prepare facilities and infrastructures needed in the evacuation process.

Even though the local act of Sleman Regency No. 83/Kep.KDH/A/2006 had described a detailed operation procedure for the evacuation process, in reality, experience from the 2006 eruptions had revealed some common hindrances. The allocation of medical services in evacuation barracks was still inadequate, as many of the evacuees did not receive gas mask to prevent inhaling volcanic ashes. Consequently, some of the inhabitants were confronted with respiratory infections (Kedaulatan Rakyat, 2006). Another issue which emerged was related with the condition of the evacuation roads (Tupai, 2006). Immediate identification of damaged and impassable roads was essential as an input for the local authorities to perform appropriate reparation or maintenance. Moreover, there was a problem regarding livestock of the villagers. Many of the villagers returned to their villages during evacuation phase, because they were worried that their livestock and crops would be vulnerable to theft (Anonymous, 2006). The local government was required to determine places and strategies to relocate these cattle in retrospect.

Preparedness efforts related to raising public awareness regarding the risk of Merapi Volcano were undertaken. The local government conducted workshop or discussion group as one of the methods to make the community understand the Merapi volcanic hazards, and to inform how they should anticipate and prepare for the disaster. Another method was through performing evacuation drills, which involved the community, local government agencies, NGOs and volunteers. This aimed at making people lived through the emergency situation so they would be ready to anticipate the danger. One last essential effort regarding the preparedness is formulation of the Community Emergency Response (CER). This intends to activate community participation in order to develop proper response during emergency situation.

3. Methodology

This research investigates problems in accessing, sharing and integrating spatial data at local government. Moreover, it looks at the possibility of a local SDI to facilitate data provision and sharing to be used in Merapi volcanic risk management activities, particularly the evacuation planning. For this purpose, interview, questionnaire surveys and field survey were conducted. First primary data collection was done by interviewing officials at local government agencies to gather information about existence of a local SDI at Sleman Regency. In addition, a questionnaire survey to 15 selected institutions was established to identify user requirements. Those two activities are supported by secondary data collection through collecting reports, products and documentations from the local government institutions. Subsequently, a prototype of a geoportal to support the evacuation planning was developed as well as user group assessment to evaluate the prototype.

3.1 User Requirements

The questionnaire responses revealed the requirements of the users, needed to design an application for evacuation planning of Merapi Volcano disaster. These requirements referred to the spatial data for evacuation planning and the geospatial web services required in the application. According to the respondents there were at least six data types needed by the local agencies in the process of making evacuation plan. Table 1 lists these data types.

Spatial data theme	Attributes	Data provider
Evacuation roads	name, location, length	Dinas P3BA (Local agency for disaster management)
Evacuation barracks	name, location, size, capacity, facility, condition	Dinas P3BA (Local agency for disaster management)
Health facilities	type, name, location	Dinas Kesehatan (Health Agency)
Village administrative map	name, extent, boundary	Bappeda (Planning Agency)
Volcanic hazard map of Merapi Volcano	hazard area, hazard types	BPPTK (Agency for Volcano Research & Technological Development)
Population in the hazard zones	number of population, households, man, women, children, disabled people, pregnant women, elderly	Bappeda (Planning Agency)

Table 1. Requirement of spatial data for evacuation planning

From hereon Dinas P3BA, Dinas Kesehatan, and Bappeda will be used to refer to Local agency for disaster management, Health Agency, and Planning Agency in the Sleman Regency. On the topic of geospatial web services, most of the respondents expressed that the prototype should provide a facility where users could discover information. They also indicated to have map visualization possibilities in the prototype. They furthermore believed that using satellite images was easier to understand than vector-based maps. In addition, about 90% expected to have a service which offers the possibility to interact with the map. All of the participants agreed that the spatial data in the prototype should be available via internet and/or intranet.

In addition to the prerequisites resulting from questionnaire surveys, there were additional requirements in terms of information sources and needs during evacuation process. Examining the standard operation procedure of emergency response and analyzing relevant documents (such as the contingency plan and mitigation reports) helped to determine information sharing requirements. The focus was on four local agencies only; those considered the most significant in the evacuation planning. The resulting information needs can be distinguished by three phases i.e. pre, during and post evacuation as described in Table 2.

In the pre-evacuation phase, it is clear that the four agencies require information concerning the alert level from VSI. Information provided by one agency can be used in this case as a basis to perform subsequent actions by another agency. For example, the Dinas P3BA has data about the number of evacuees in evacuation barracks, which they can deploy to the Dinas Kesehatan, who can then determine how much medical equipment and personnel should be delivered.

Institution	Pre-Evacuation	During Evacuation	Post-Evacuation
Dinas P3BA	• hazard zones • notification of alert level from VSI • susceptible population • village map • evacuation roads condition • available resources in the village • available facilities in evacuation barracks	• number of people evacuated in barracks • number of injured people	• damaged area/ villages • number of missing people
Dinas Kimpraswilhub	• notification of alert level from VSI • evacuation roads condition • alternative routes • susceptible population number • available transportation means • location of evacuation barracks	• traffic flow of the vehicles • supply of the water	• damaged roads affected by the eruptions and cost estimation • available transportation means to return the evacuees
Dinas Kesehatan	• notification of alert level from VSI • susceptible population number • location of evacuation barracks • condition of health facilities and infrastructure • available medical team (doctors, nurses, midwife)	• number of people evacuated in barracks • number of injured people • supply of medicines	• number of injured people who need more treatment
Dinas Nakersos & KB	• notification of alert level from VSI • susceptible population number • location of evacuation barracks • potential location of public kitchen	• number of people evacuated in barracks • logistics supply (food, blanket, mattress, etc)	• logistics remains in the warehouse

Table 2. Information needs in evacuation process

3.2 Design of The Prototype

The requirements were represented in a visual model using Unified Modeling Language (UML). UML helps to achieve an effective communication between system developers and the users. There are two types of UML diagrams used in designing an application for evacuation planning i.e. use case diagram and sequence diagram.

A use case diagram enables the system designer to discover the requirements of the target system from the user's perspective (Tsang *et al.,* 2005). Therefore the data collected during the fieldwork supported the creation of a use case diagram. This diagram describes which actors are involved and which actors have which roles in evacuation planning. The use case diagram in Figure 1 identifies seven institutions with significant functions. This model was used as the basis to determine the users who will operate the prototype.

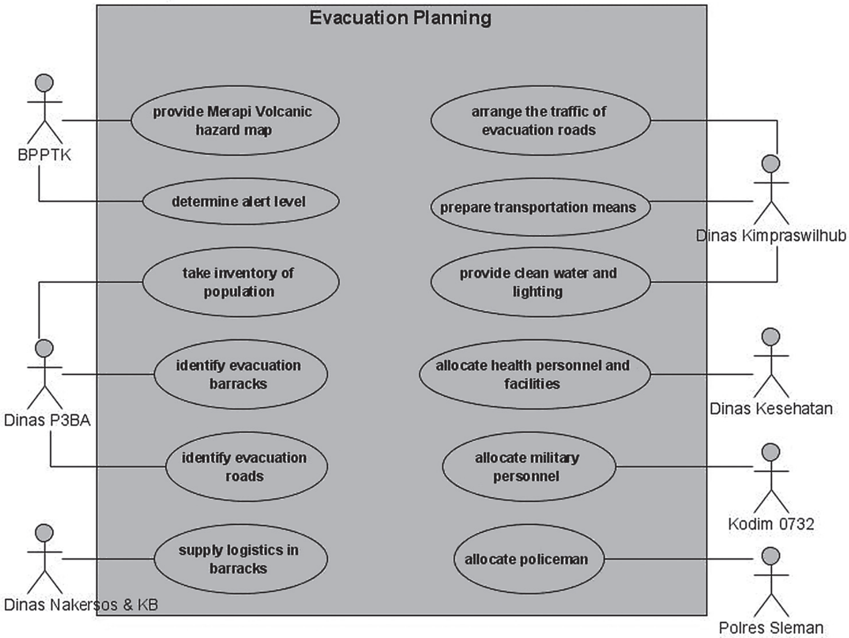

Figure 1. Use case diagram of the evacuation planning system

Secondly, a UML sequence diagram is created to show the interaction of messages between objects in the prototype. This diagram has two dimensions: the vertical dimension and the horizontal dimension, respectively representing the passage of time and the objects involved in the interaction. The sequence diagram represents six main objects, namely: Login Panel, Google Maps Panel, WMS Layer Panel, Metadata, MapServer and Database. In the beginning, a user has to login before to start utilizing the system and to access the map presentations. The purpose of login is to manage the access rights on the maps, in such a way that only recognized users may obtain access. Consequently, unauthorized users will not be able to add invalid information on the maps. After a user has successfully entered the system, the Google Maps Panel displays a satellite image of the Sleman Regency. Then, the user can select any available thematic map – in this case: any map which may be required for evacuation planning (supported by its metadata information). The prototype facilitates a user to add any information to the selected map. This include appending new points, lines, and polygons within the *Google Maps*, and attaching relevant and significant additional attribute information on those objects. The information inserted by the user is saved in the database, thus enabling other users to view it.

An example of a detailed sequence diagram for evacuation planning is presented in Figure 2. Based on the use case diagram, the Dinas Kesehatan has responsibility in the allocation of health personnel and facilities. This task can be achieved by making use of the prototype. First, Dinas Kesehatan had to know recent situation at evacuation barracks in order to determine appropriate health services. The information can be found in the WMS Layer Panel provided in the prototype. Subsequently, after recognizing this information, allocation of the health personnel and facilities can be deployed by using add annotation facilities in the maps presentation.

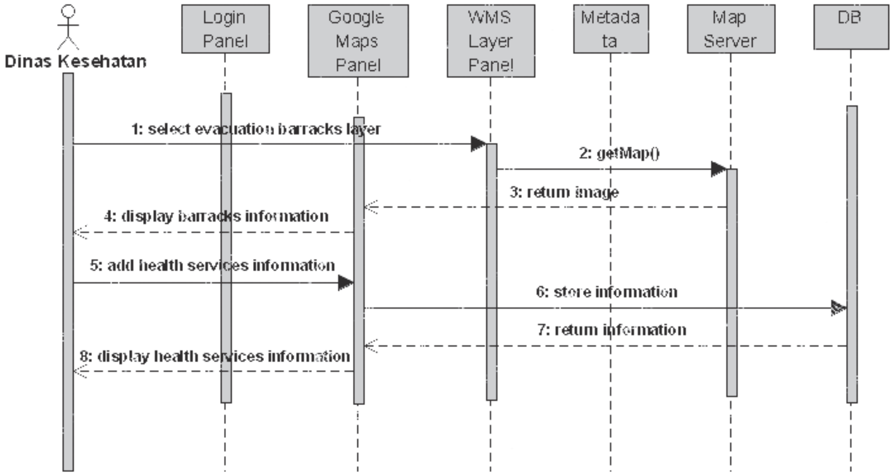

Figure 2. Sequence diagram of the allocation of health services

3.3 Geospatial Web Services Development

One of the user requirements is to provide a portrayal service in the prototype. The collection of data required for evaluation planning preceded the creation of the services in the prototype. The prototype only used data from the Kecamatan Pakem, Turi and Cangkringan, since the evacuation planning prioritized these sub-districts. OGC WMS and OGC KML (formerly Keyhole Markup Language) were used to accommodate this prerequisite.

MapServer was the software tool used to implement the WMS instances. WMS was created for the sub-districts boundary theme. The initial preparation of the spatial data used ArcGIS. Then followed the creation of a Mapfile (which is a text file required by the MapServer). The Mapfile described the relationships between the objects. Additionally, it points the MapServer to where data are located, and it defines how things are to be drawn.

The purpose of implementing OGC KML is to display the spatial data in the Google Maps Panel thus it can be cascaded synchronously. The KML were created for five themes: Merapi volcanic hazard zones, village administrative, evacuation barracks, evacuation roads, and health facilities. Population theme was attached to the village administrative map so each village would have attributes regarding distribution of the inhabitants. In order to generate KML files for these data, the author utilized Export to KML Extension version 2.5, which is an extension developed for ArcMap 9.x. The extension allows ArcMap users to export any point, polyline, or polygon dataset in KML format. The KML data format was selected since it offers flexibility to be exchanged and displayed instantly on top of web map interface.

3.4 Customization of the Geocollaboration Portal

The GeoCollaboration Portal is an application of a local SDI developed that aims to support decision makers investigate, analyze and provide alternative solutions when dealing with disaster management at Yogyakarta Province (Aditya, 2008). It facilitates data sharing through availability of enhanced map interface where various WMS layers can be cascaded synchronously. It provides synchronous annotation which can be used to share information among local agencies. GeoCollaboration Portal was built using PHP programming and improved with MySQL database in the server side while the map presentation was developed using Google Maps API. Synchronous communication via a portal is seen in this project as a possible innovation to improve the quality of coordination and communication among the agencies.

In this research several customizations to the Portal were made. With the aim to make the Portal prototype for a local SDI implementation, it supports the evacuation planning conducted by Sleman Regency government. The foremost adjustment regarded the data layer. All the created geospatial web services were integrated in the prototype. A total six spatial resources are available: the Sub-district boundary, the Merapi volcanic hazard zones, the village administrative boundaries, the evacuation barracks, the evacuation roads, and the Centre for Community Health (Puskesmas).

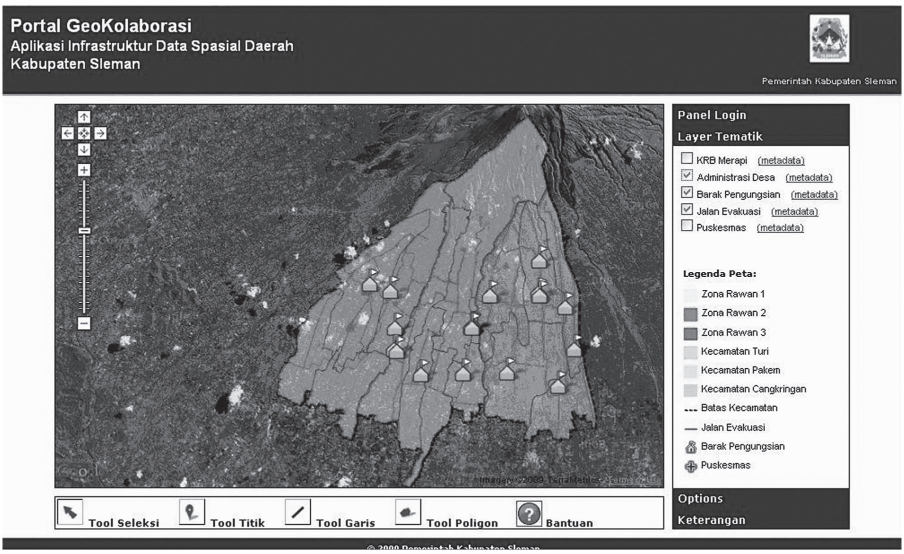

Figure 3: Interface of the customized prototype

In addition to the data layer adjustment, a new map legend for all data layers was a first enhancement to the prototype. The legend can help users to understand which features are available in the layer. A second enhancement was the generation of metadata for each data layer. The metadata consist of information regarding the spatial data and created based on the FGDC's metadata standard. With these metadata, users were able to view for example, description of the spatial data and also its contact information. Another enhancement was creation of a help file in the prototype. This help file provides the user with a guideline in how to utilize specific elements of the prototype. An adjustment was also made in the user list of the prototype. From the use case diagram in the design phase, one can determine which user can operate the prototype. There are four local agencies considered as the users i.e. Dinas P3BA, Dinas Kimpraswilhub, Dinas Kesehatan and Dinas Nakersos (agency for human resources and social). Interface of the prototype is presented in Figure 3.

3.5 Evaluation of the Prototype

The purpose of conducting an assessment test for the prototype of a local SDI application is to determine effectiveness, satisfaction and accessibility of the application. In addition, the assessment also aims to determine usefulness of the prototype in supporting evacuation planning activities for Merapi Volcano disaster. The testing also included a group discussion in order to elaborate user expectation and opinions concerning issues of local SDI related with the application. Usability data was collected using observation and questionnaire method while the group discussion was conducted in a structured way with predefined questions. Participants of the evaluation are 3 (three) persons that are representatives from local agencies involved in evacuation planning of Merapi Volcano Disaster, specifically Dinas P3BA and Dinas Kesehatan. Bappeda which has significant role in the implementation of local SDI was also present.

The evaluation consisted of utilization of the application based on specific scenario regarding evacuation planning. The scenario used for test assessment was based on disaster event of pyroclastic flows which is predicted to flow down to the south slope towards Gendol, Kuning, Boyong and Bedog River. This pyroclastic flow affects seven villages i.e. Wonokerto and Girikerto in Turi sub-district; Hargobinangun and Purwobinangun in Pakem sub-district; Glagaharjo, Kepuharjo, and Umbulharjo in Cangkringan sub-district (Dinas P3BA, 2009).

From this scenario several tasks were generated for Dinas P3BA and Dinas Kesehatan in accordance to their roles in evacuation planning. Dinas P3BA has tasks to specify evacuation barracks that will be used and to provide information about numbers of the evacuee. In this regard, Dinas P3BA has to share their findings through the portal synchronously. Meanwhile, Dinas Kesehatan has roles to identify location of the health facilities and to supply information regarding health services which will be designated to the evacuation barracks. Dinas Kesehatan should also update their findings through the portal. Tasks for Bappeda were established based on its role as leading institution in the implementation of local SDI at Sleman Regency.

That scenario was then implemented as a collaboration session involving participants from representative agencies. The participants execute the tasks according to their specified roles. During the execution of the tasks, video and audio recorders were utilized to observe participants activities when interacting with the prototype. After the test session, the questionnaire response was measured using likert scales which represent participant's levels of agreement to a statement regarding usability issues (i.e. effectiveness, satisfaction and usefulness). Some useful comments were put forward by the participants as they carried out the tasks that were given to them during the session. These comments were noticed as one of significant input – beside the remarks collected from the group discussion, for further development of the prototype.

4. Results and Discussions

4.1 Existing Local SDI at Sleman Regency

At national level, SDI coordination has been arranged through the Presidential Act No. 85/2007. The importance of local SDI implementation has been recognized by the Sleman Government. However, the effectiveness of the local SDI at the Sleman Regency is still rather limited, and only a few initiatives have been conducted to change this. Interviews with officials from Bappeda revealed that SDI development initiatives started in 2008 by information awareness activities onthe advantages of a having a local SDI. In the following year, this program was enhanced by formulating a local regulation draft, which would act as a foundation to implement a local SDI strategy for the Sleman Government. Currently, this draft regulation is however still under discussion, although the expectation is that it will be a formal declaration in the course of 2010. Apart from this formalization strategy, the local government also began to prepare single-base maps of entire Sleman Regency, and planned to establish a project for creating metadata of all spatial data.

The currently available spatial data in the Sleman Regency come from different local agencies. Table 3 provides an overview of these data. It shows that most of the spatial data are provided by Bappeda and derived from the topographic maps (1:25,000). This might be insufficient for programs that need more detail information such as urban planning or land system in sub-districts level. The Local Land Agency (BPPD) has started to utilize larger scale information from Ikonos image in 2005 and has produced administrative boundary and land parcel maps with scale of 1:5,000.

Table 3 also shows that there are several redundant data sets. For example, the road network data is provided by Bappeda and also by the Dinas Kimpraswilhub. Although both of the data contain in the same scale and content, the format and feature catalogue is different. Bappeda distinguishes road into five classes (national, collector, local, other, and footstep road) whilst Dinas Kimpraswilhub uses three classes (national, provincial and regency road).

Meanwhile, from survey activities it can be concluded that all the institutions involved in Merapi volcanic risk management have spatial data whether in digital or hardcopy format. However, only 27% of the spatial data contain metadata. This indicates that not all institutions are aware about the importance or have the capacity to maintain metadata. The spatial data are generally used in problem analysis, as visualization instruments in meetings, and as (geo-)reference tools for field surveys. In terms of spatial data access and sharing, most of the respondents (68%) experienced that accessing spatial data from other institutions is not difficult. There are two main methods to know which spatial data are available at institutions, firstly by searching in the catalog and secondly by asking directly to official. Giving the digital maps in CD/DVD is the most common method of data sharing compared to providing the print out maps and online maps. However there are some problems experienced when they integrating the data such as different scale/resolution, different format and inconsistent features of the spatial data.

Theme	Contents	Provider	Scale	Format	Latest update
Administrative boundary	village, sub-district	Bappeda	1:25,000	ArcGIS *shp*	2006
	village, sub-district	BPPD	1:5,000	ArcGIS *shp*	2006
Environment	slope, geological, soil, forest resource, mine and mineral resource, geomorphologic, soil water reserve	Bappeda	1:25,000	ArcGIS *shp*	2005
Land	landuse	Bappeda	1:25,000	ArcGIS *shp*	2007
	parcels	BPPD	1:5,000	ArcGIS *shp*	2005
	land amplification	Dinas P3BA	1:50,000	ArcGIS *shp*	2008
Transportation	road network, transportation system	Bappeda	1:25,000	ArcGIS *shp*	2006
	road network	Dinas Kimpraswilhub	1:25,000	AutoCAD	2005
Hydrology	river, irrigation system	Bappeda	1:25,000	ArcGIS *shp*	2007
Utilities	electricity network, telecommunication	Bappeda	1:25,000	ArcGIS *shp*	2005
Facilities	health facility	Dinas Kesehatan	--	ArcGIS *shp*	2005
	education facility, worship places, commerce facility	Bappeda	1:25,000	ArcGIS *shp*	2007
Population	density	Bappeda	1:25,000	ArcGIS *shp*	2005
Economics	gross regional domestic product, fishery production, rice production, industry, rice field distribution, crops plant	Bappeda	1:25,000	ArcGIS *shp*	2005
Natural Hazards	Merapi volcanic risk, landslide, drought, cyclone	Dinas P3BA	1:50,000	ArcGIS *shp*	2004

Table 3. Spatial data available at Sleman Government Agencies

4.2. Evaluation Results

From the observation data it was recorded that all of three participants completed their tasks successfully and they were able to access the prototype using different internet browser. On the subject of usefulness, participants voice their agreement on the usefulness of the prototype to be implemented in the Regency. All users agreed that the spatial data available in the prototype were required to support the activities of evacuation planning. They were satisfied with the information embedded in the thematic maps, as they could easily find a number of population data, through clicking on a village in the village administration layer. They were also pleased with the prototype's capability to create synchronous annotation on maps since they utilized this facility in order to finish the tasks. It was proven that by using this function, a user could generate and share recent information in term of evacuation process, such as number of evacuees or location of damaged roads. From the evaluation session, it can be concluded that coordination and communication among the participants in response to the evacuation scenario can be facilitated well using the geocollaboration portal. Thus it can be concluded that the geocollaboration portal facilitate the group to effectively complete the evacuation scenario. This finding shows an example how to deliver SDI advantages for a specific need urgently required by a local government.

The users found the prototype was effective in exploring and in interacting with the map layers. Moreover, in terms of prototype's feature in spatial data provision required for evacuation planning, all participants were able to find those data which provided by different local agencies. Response from the questionnaire illustrated their satisfaction with the user interface and content of the prototype. Most users were pleased with the available metadata, since it enabled them to locate the information, which they themselves considered valuable. One limitation was however that the metadata elements were only available in English, and not in Bahasa Indonesia. This was considered a significant requirement for the improvement of the prototype.

Generally, the participants understood the advantage for the existence of a functioning local SDI to support the evacuation planning. By testing the portal prototype, they were able to see the advantage of having the technical facility of coordinated data sharing among stakeholders. In order to enhance the implementation of the local SDI, they insisted improving several aspects, such as increasing the availability and quality of the spatial data, establishing local regulations on data availability and standards for interoperability, the development and maintenance of metadata, and the further reinforcement of skills.

5. Conclusion

Risk management is indispensable for the protection and reduction negative impacts of any Merapi Volcano disasters. The Sleman Government has been executing hazards identification, risk assessment, mitigation measures and preparedness actions. It is found that in performing these activities spatial data are crucial for the local government. There are a couple of important findings related to the risk management activities. First, the risk management required cooperation and coordination among different local agencies. Even though the Bupati Act clearly stated roles of each agency, in its implementation some overlapping functions were occurred. Second, although the local government has produced a standard operating procedure for evacuation process, some general obstacles were identified in the field. It includes insufficient medical services, identification of damaged evacuation roads and livestock dilemma of the villagers. A local SDI could be introduced to overcome such problems.

The study found that in order to support the risk management, local SDI has to be able to provide related spatial resources, access to the data, metadata information, and web services which enables interactions with spatial resources. These functionalities are basis for development of the prototype. It is found that geoportal can be exploited to provide spatial data resources, metadata layer and interactive map presentation. Meanwhile, geospatial web services represented by WMS and KML files were generated to supply the spatial data to the geoportal. From this research it is found that users of the prototype have in the same agreement concerning the advantage of a local SDI to support the evacuation planning. Further from the evaluation session done, it can be concluded that coordination and communication between agencies involved in evacuation planning can be facilitated well by the geocollaboration portal developed. From this work, it becomes very clear that a customized geocollaboration portal for a local SDI can support the development of spatially enabled societies at a local level.

However, some suggestions were also recorded for the next prototype development particularly on spatial data quality, standard of feature cataloguing and metadata development. Regarding development of the prototype, an interesting next step will be to enable spatial analysis on top of the map presentation in order to more effectively support evacuation planning and other disaster management related efforts. It will require implementation of other geospatial web services such as OGC WFS, WCS, WPS and integration with the geodatabase of the dataset. Those suggestions bring more focused requirements to improve the design and implementation of a geocollaboration portal of local SDI in order to support tailor-made and customized local needs.

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Chapter 17

Intelligent Speed Assist: Spatially Enabling Societies

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Abstract

The key objectives of Intelligent Speed Assist (ISA) are to achieve road safety and environmental benefits. In order to achieve these objectives it is necessary to bring speed-aware road network information into road vehicles. A speed-aware road network assists citizens to choose an appropriate speed and assists governments to maintain citizens' safety and promote a sustainable environment.

Current and accurate speed zone data is an important requirement to support ISA initiatives. The collection, maintenance and timely distribution of a speed-aware road network is vital for the success of ISA. Key to achieving this is the establishment of necessary business processes which ensure the governance of speed limit change life cycle and distribution. This includes the governance of speed limit changes and the resultant speed sign installation and/or removal actions; new speed sign location and attribute validation; and management and control of corresponding speed zone changes. Once these business process requirements are established by an authoritative data custodian, then the accuracy and timeliness of speed zone data can be maintained.

An authoritative information source plays a key role in assuring the quality of published speed zone data prepared and issued by ISA industry data suppliers (data aggregators). Additionally, data licensing and regular audit of the ISA industry data suppliers will help ensure the use of the data meets license requirements and expectations.

This chapter discusses the business process to establish the minimum requirements for building and maintaining speed-aware road network data to support ISA objectives. Timeliness, completeness and accuracy are discussed to set out the quality requirements for ISA data.

The chapter presents ISA as one of the initiatives which contribute to a spatially enabled society, in which location and spatial information are regarded as common goods made available to citizens and businesses to assist sustainable development.

VicRoads, the statutory road authority in the State of Victoria, Australia, has commenced the acquisition and development of a speed-aware road network as part of its ISA initiative under the "arrive alive 2008 – 2017" Victorian government strategy for safer vehicles.

Keywords: Intelligent Speed Assist, Spatially enabling society, Speed-aware road network database, Speed zone data

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1. Introduction

Spatial Data Infrastructure (SDI) aims to assist the spatial enablement of societies. One of the key characteristics of spatially enabled societies is the availability of spatial information to governments, citizens and businesses as a means of organising their activities and information (Williamson *et al.,* 2010).

Transport and road data have always been a highly utilized commodity for citizens and governments. Citizens use a variety of road related data to plan their trips, freight goods, and site facilities. It has been an invaluable decision making tool for governments for planning, evaluation and maintenance of the transport system as a critical infrastructure.

Speed aware road network data adds value to transport network information that will enable governments to make better decisions to improve road safety, manage vulnerable road infrastructure eg bridges, and sustain the environment through enforcing lower speeds and reducing fuel consumption. It also helps citizens to achieve safer road usage by being aware of appropriate (legal) driving speeds.

Key to achieving this is the establishment of necessary business processes to collect speed zone data and to manage the life cycle of speed zone changes for publishing to ISA industry data suppliers (data aggregators). The process of speed zone data collection includes the collection and mapping of speed limit sign location and attributes according to accuracy standards. Maintenance of speed zone data is critically important. This includes the governance of speed limit changes through the registry of approval of changes, installation and/or removal of speed limit signs and also validation of location and attributes of new speed signs. Once the changes are made on speed zone data, then the data can be distributed to the users through data aggregators. Timely management of changes which are enforced by an authoritative data custodian can ensure the data represents the latest speed limit condition. The authoritative custodian of speed zone data which has overarching governance over the collection, maintenance, change management and distribution of speed limit information should maintain this chain of processes.

VicRoads, the statutory road authority in the State of Victoria, Australia, has commenced the acquisition and development of a speed-aware road network as part of the ISA initiative under the "arrive alive 2008 – 2017" Victorian governments road safety strategy (arrive alive, 2010). '"arrive alive" addresses the necessity of implementing business processes to allow ISA technology to function across Victoria.

VicRoads is the legislated authority responsible for approving speed limit signage on all Victorian roads.

VicRoads' speed zone mapping processes encompass a number of core components including the Speed Sign Database, Speed Zone Mapping Database, Speed Zone Data Dissemination, and ISA Policy.

This chapter articulates the speed zone mapping initiative as a step towards a spatially enabled society and presents the minimum requirements for a speed-aware road network database to disseminate speed zone information to the vendors for ISA devices.

2. Intelligent Speed Assist (ISA) to Assist Spatially Enabled Societies

In spatially enabled societies, information is easily accessible by citizens. SDIs assist this requirement by facilitating the integration, sharing and distribution of spatially-relevant information.

An emerging information dataset that is highly utilized by governments and citizens is road information. Governments use road information to manage and maintain road networks and assets. Commerce and industry use road information to freight goods and locate facilities. Citizens use road information to plan trips and use the road network appropriately.

Inappropriate speed increases both the risk of a crash and the severity of injuries resulting from a crash. Therefore managing speed is critical to maintain safety on roads to reduce death and injury. The use of in-vehicle technology can assist drivers with choosing an appropriate speed (Figure 1) and discourages exceeding legal speed limits. This is known as Intelligent Speed Assist (Paine *et al.,* 2007).

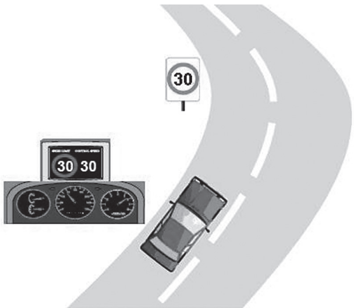

Figure 1. ISA to assist choosing appropriate speed

Other potential benefits of ISA are:

- Environmental – by reducing fuel consumption and reduced emissions;
- Road asset management – by prioritizing asset use and assisting route navigation;
- Occupational Health and Safety – by contributing to a safer work environment for company and fleet vehicles.

2.1 Safety Benefits of ISA

ISA technology has the potential to deliver safety benefits. Research in the United Kingdom has shown that ISA can achieve an 18% to 37% reduction in fatal accidents (Carsten and Tate, 2001). In other European Union countries research suggests traffic deaths could be avoided in up to 50% of speed-related crashes if all cars were equipped with supportive ISA (Carsten, 2005).

Table 1 sets out speed-related crash statistics from several countries (Paine *et al.,* 2007).

Region/Country	Percentage of crashes where speeding was a factor
New South Wales, Australia (2005)	38% of fatal 17% of all crashes
United Kingdom (THINK)	29% of fatal 12% of all crashes
USA (NHTSA)	33% of fatal
New Zealand (ACC)	42% of fatal
Europe (ECMT)	33% of fatal in some countries

Table 1. speed-related crashes

In this regard, ISA-assisted drivers are more likely to abide by the static and variable speed limits as posted by the roadside speed limit signs. Drivers receive the same information that they see on traffic signs through an onboard communication system. It is preferred that ISA is also be able to indicate the speed within the legal limit adapted to traffic conditions, road features and weather conditions as well as some periodic restrictions such as roadworks (Goodwin *et al.,* 2006).

2.2 Environmental Benefits of ISA

Speed management has emissions benefits. According to ISA studies CO2 emissions could fall by 8% for the cars that are equipped with an ISA device (Carsten, 2005). Nowadays the efforts for improving the climate impact of the road sector have focused on the fuel efficiency of new vehicles.

The ISA initiative by city of Stockholm also emphasises the improvement in fuel efficiency (Larbo, 2009). This study also suggests the combination of fuel-saving and economical driving components to the existing ISA-system. The study also highlights the key role of combining support before driving (education, incentives), during driving (from the vehicle computer) and after driving (statistics, feedback) to achieve economical driving.

Lower speed limits were introduced in an attempt to improve fuel efficiency after the oil crisis of the 1970s. Current concerns over climate change and CO2 emissions have once again demanded lowering speed limits and improving their enforcement (IEA, 2001; IEA, 2005; TAC, 2008).

2.3 Road Asset Management

Road safety and environmental concerns are not the only rationale for speed limit management. Managing speed can also contribute to the management of road assets (eg bridges) (TCA, 2006). ISA has the potential to influence and control the routes and behaviours of vehicles that may have a detrimental affect on road assets.

Restricted and controlled speed of heavy vehicles using the road network and crossing vulnerable assets such as bridges and large culverts, in combination with other spatial and temporal access conditions, increases the efficiency and durability of road network and assets.

2.4 Occupational Health and Safety

Under OHS law, when utilised for work related travel, the vehicle is considered the workplace and employers have a responsibility to provide a safe environment (WorkSafe, 2008). The installation of ISA could be considered a proactive safety measure from companies on behalf of their employees, but could also contribute to ensuring that company vehicles are driven in a responsible manner. For example, all vehicles that are used more than six month for the Swedish Roads Administration should have an ISA device installed (Passmore, 2008).

3. Authoritative Source of Data

Governments play a significant role in ISA through:

- developing standards for devices;
- developing and maintenance of master speed zone databases;
- promoting uptake of innovative technology.

As the management of speed limits is the responsibility of State Road Authorities (SRAs) in Australia, Governments (through the SRAs) are in the best position to develop and supply master speed zone data to ISA industry data suppliers for use with ISA devices. This role may also include the setting of protocols under which this information could be provided to the manufacturers of ISA devices.

In terms of Victoria, only VicRoads has the authority to govern the approval process for speed limit signs in Victoria. This gives Victoria the unique opportunity to act as the centralized point of approval which enables an authoritative dataset to be maintained effectively for information about the installation and/or removal of speed limit signs and validation of changes to speed zones. Other States in Australia have similar approval mandates.

In order to govern the ISA initiative to provide reliable data to ISA devices, some core components should be developed. VicRoads speed zone mapping processes encompass a number of main components including:

1. Speed Sign Database: This is the source data used to delineate and update the speed-aware road network;
2. Speed Zone Mapping Database: Continuously maintained, current speed-aware road network database;
3. ISA Policy: Key to this process is the certification of published speed zone data, and the licensing and audit of ISA industry data suppliers to ensure the use of the data meets license requirements (VicRoads, 2008);
4. Speed Zone Data Dissemination: Procedures and processes for distributing ISA-compatible speed data to ISA industry data suppliers; etc.

In the speed zone data chain, generating a speed zone mapping database is the first step and includes capturing speed sign location and speed limit information and converting it to speed zone data.

Then the data needs compilation and rectification for use by ISA data users. Final step is to compile the speed data and to provide advanced functions in the in-vehicle devices. ISA industry data suppliers govern this final step.

4. ISA Data Suppliers (Data Aggregators)

ISA industry data suppliers (referred to as data aggregators) will play a key role in the dissemination of speed zone data to in-vehicle devices.
Data aggregators have a number of significant tasks to fulfill this role, being:

1. Development of a high quality, comprehensive base road network data set;
2. Data compilation to comply and integrate with in-vehicle devices technology and standards;
3. Advanced services and functions to communicate speed zones and associated information to the users;
4. Provision of quality and usability feedback to master speed zone data suppliers.

Data aggregators may choose to utilize existing infrastructures such as in-vehicle navigation systems or proprietary systems to communicate speed data with drivers.
Data aggregators may also choose to use road network data as supplied by data providers or combine master speed zone data with their preferred road network data.
These Data Aggregators service a national (and perhaps international) market, and so consistency and interoperability between the SRAs is important.

5. Speed-Aware Road Network Data

Speed zones are created as a result of observed speed limit sign locations, or for those roads where no speed limit signs exist, on the basis of default[5] speed limits resulting from a determination of built-up area as defined in the jurisdictions' Road Rules.

5.1 Speed Signs Data

Victoria is the second most populous state in Australia, with approximately 5.2 million people, but is the second smallest in land area. Victoria's road network covers about 150,000 kilometres of roads that are open for general traffic, not including approximately 50,000 km's in additional minor roads and tracks in parks and forests. VicRoads is responsible for the management and development of the major arterials of Victoria's road network, known as the declared road network. These roads, which comprise around 22,300 km's and 874 roads, are classified as Freeways and Arterials. Table 2 below summarizes the composition of the Victorian road network.

[5] The Road Rules – Victoria specify that where a speed limit sign does not apply to a length of road then default speed limits are either 50kph in built-up areas, or 100kph elsewhere.

Road Type	Total Length	Responsibility
Freeways	Approx. 907 km's	VicRoads
Arterial roads	Approx. 21,500 km's	VicRoads
Municipal roads	Approx. 128,000 km's	79 local governments
Park and forest roads	Approx. 50,000 km's	Department of Sustainability and Environment

Table 2. Compostion of the Victorian Road Network

The total number of registered vehicles in Victoria is approximately 4.7 million, and the total estimated Vehicle Kilometres Travelled (VKT) is over 56 billion.

The following types of speed limit signs can appear on Victorian roads:

- "Fixed" Speed Limit Signs: Permanent speed signs;
- "Planned Variable" Speed Limit Signs: Displayed speed limit will change according to a prescribed calendar (time of day, day of week);
- "Dynamic Variable" Speed Limit Signs: Displayed speed limit may vary as a result of changing traffic conditions due to seasonal, weather or other traffic conditions.

Minimum requirements of speed sign data capture include both positional and attribution information. According to the specifications developed by VicRoads (VicRoads, 2009), speed limit signs are to be located by coordinates to within ±10 metres of their actual location along the road in urban areas, and ±20 metres of their actual location along the road in non-urban (rural) areas. Points representing locations of speed signs must maintain the same relationship to the road network vectors as existed in the real world.

Speed limit signs associated with long term roadworks may often appear as a standard fixed speed limit sign and not be directly accompanied with other roadworks warning signs. These speed signs must be located and mapped.

Real-time data broadcasts resulting from speed limit display changes of dynamic variable signs are not in the scope of the VicRoads' ISA project, but will likely be considered in the future.

5.2 Speed Zones Data

Speed zones need to be created for each travel direction. One way roads, divided roads and freeway ramps need a speed limit value of 0 to be set against the contra-travel direction.

On undivided roads, there can be road segments that have no signage in one travel direction, but are signed in reverse direction. Although they fall within default speed limit zones, the speed limit of reverse travel direction is considered to be applicable to the unsigned road segments. In order to meet the road rule requirements, these road segments are attributed with the speed value equal to the signed travel direction's speed, but will be identified as unsigned.

Speed zones will be created to represent sections of roads where variable speed limits may apply due to school zones, strip shopping zones, changing traffic conditions or other speed limit variations, or for those sections of roads affected by long-term roadworks.

The speed limits on many rural roads are unsigned. Default speed limits apply based on legislation which basically applies 50 kph to roads in built-up areas and 100 kph elsewhere.

The issues in determining and maintaining speed zones for roads that do not have speed limit signs are considerable, both in terms of what methods may be used and in terms of effort required, not to mention the implication underpinning the determination that may flow back to the SRA depending upon the level of ISA use that the speed zone data distribution is intended to support.

5.3 Publishing Speed Zone Data

Speed zone data published to the ISA data industry can be made available periodically as full replacement or as incremental content since the last supply period. Historic data should also be available.

6. Quality Statements

The ideal is to have a full coverage of a speed zone dataset for all roads, with 100% accuracy and 24 hours currency. However, in reality it is very difficult to achieve this level of quality due to a number of factors:

- continuous changes throughout the road network with road upgrades, new roads being opened or roads being closed;
- speed limit changes continue to be made to control local road safety demands and evolving traffic management standards;
- the interpretation and maintenance of default speed limits as built-up areas expand into previously rural or undeveloped landuse.

Realistically some jurisdictions will have their data available before others and to different levels of completeness, currency and accuracy. It is desirable that each jurisdiction's published data be accompanied by a quality statement indicating the degree of completeness, currency and accuracy. Desirably jurisdictions will adopt the same format for their quality statements to allow vendors and users to better understand the data they are using.

It is desirable that jurisdictions establish an audit program to provide a degree of assurance that their speed zone data does continue to meet the claimed quality standards.

6.1 Completeness

While the ideal target may be to create the speed zones database for all signed public roads, it may not be practicable. Initially jurisdictions may wish to release speed zone data for some of their roads eg:

- All roads managed by SRAs within designated municipalities;
- All sealed public roads within designated municipalities;
- All public roads within a region of the State;
- All arterial roads within a region; etc.

In order to capture speed limit information on signed roads, VicRoads proposes to map public roads in the greater metropolitan Melbourne and other areas according to following criteria:
In the greater metropolitan Melbourne:

- All arterial roads including each carriageway of freeways and tollways and divided roads including all freeway ramps, highways and arterial roads;
- All service roads of arterial roads;
- All local (municipal) roads classified as Secondary Roads, Major Roads, and Connector Roads;
- All local roads which are within 300m of schools, or are within 300m of traffic signals, and which are not included in any previous category; and,
- Any road where a speed limit sign is observed while surveying another road, in which case the road on which the speed limit sign is observed must be surveyed until the end of the road (T-intersection or dead end), or until an end of speed limit or a speed derestriction sign is observed.

In other areas of the State:

- All arterial roads including each carriageway of freeways and tollways and divided roads including all freeway ramps, highways and arterial roads;
- All service roads of arterial roads;
- All rest areas adjacent to arterial roads;
- All sealed local roads;
- All unsealed local roads within and exiting regional cities/towns/hamlets/etc.;
- All unsealed local roads which are within 300m of schools, or are within 300m of traffic signals, and which are not included in any previous category.

For those roads where no speed limit signs exist, on the basis of default speed limits resulting from a determination of built-up area as defined in the jurisdiction's Road Rules.

6.2 Currency

Speed zone data is constantly changing through introduction of new speed limits, thus the quality of the data depends highly on the currency and timeliness of the data. The majority of changes of speed zone database are caused by changes in speed limit signage.

Reflecting these changes into speed zones within a minimum time ensures the provision of current data to ISA users. VicRoads intention is to publish data to ISA vendors according to following cycle.

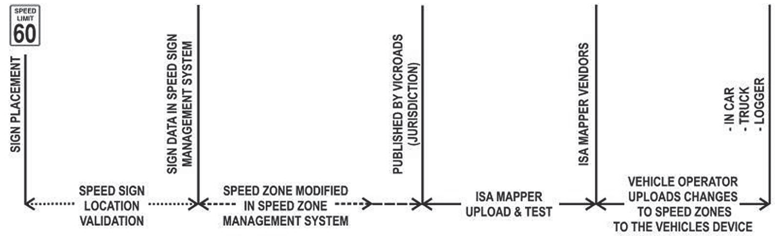

Figure 2. speed zone update cycle

To maintain the quality of the speed zone database in terms of currency, there should be a regime to convey updates and changes of speed limit signage to the speed zone database. There should also be a time limit between sign placement and sign location validation to enter the updates to the speed zone database.

VicRoads proposes that the speed zone database obtains daily updates of validated speed limit signage which keeps the speed zone data as current as possible. Then the changes can be published on a regular basis (weekly, monthly or quarterly) to the data aggregators and other users.

The time since the sign has been placed until it is entered into the speed zone database should not be more than two weeks. It includes the sign validation[6].

It is critical to enter only VALIDATED speed sign locations into the system. It should be a mandatory part of the sign placement workflow to ensure the resultant quality of the speed zone database.

6.3 Accuracy

The dataset of speed zones shall be maintained to ensure that:

- The signed speed zone values are correct ie the value of 60 kph where the speed zone is 60 kph on the sign, within the currency statement above;
- The signed changes of speed zones represented by this dataset are correctly located to within 30 metres of their position on the ground;
- For all roads ISA speed zones will only ever be representative. Speed limit signs and legislation will be the final arbiter of the applicable speed limit irrespective of ISA;
- These speed zones are for permanently signed zones and do not include temporary worksite speed limits.

For those zones which have the speed limit determined as the result of speed limit signs, the degree of accuracy certainty is higher than those areas where default speed limits apply. This should be considered in data publishing to clearly distinguish the default speed limits from signed speed limits so that ISA vendors have the option of informing users as to the confidence of the speed limit displayed by the device.

7. Publication of ISA Data

Speed zone data published to the ISA industry can be made available periodically as full replacement or as incremental content since last period. Historic data should also be available. Options that SRAs need to consider in supporting ISA by supplying speed zone data include:

- Commitment to distribute speed zone vectors for all public roads, whether based on signed speed limits or on any other interpretation of (default) speed limits;

[6] Sign validation is the process to confirm speed limit sign change details (including location, sign type, sign speed, direction sign faces, etc.) in the field to ensure the sign change request workflow correctly reflects actual works completed.

- Commitment to distribute speed zones for public roads where speed limit signs are placed, and offer to provide a supplemental distribution of speed limit information on roads that are otherwise unsigned and to which the default speed limits (should) apply:
    - Provide default speed zones as vectors; or
    - Provide default speed limit information as representative (approximate) polygon areas (built-up areas and rural areas) and supported with "exceptions" to default speed zones being supplied as vectors;
- Commitment to distribute speed zone vectors only for roads where speed limit signs are placed.

The speed zone database should be maintained to a certain quality level to meet the ISA users' requirements as discussed in section 6. A metadata certificate to outline the completeness, currency and accuracy of the speed zone database should be maintained by all SRAs. VicRoads proposed to adopt the Australia New Zealand Land Information Council (ANZLIC) Metadata Profile for the speed zone metadata.

Licensing is also essential to ensure that SRAs are protected against misuse, misrepresentation, legal liability, etc. Licensing also ensures the licensee is clear on what they can and cannot do with the data.

8. Conclusion

In spatially enabled societies location and spatial information are regarded as common goods made available to citizens and businesses to assist decision making consistent with sustainable development.

The road network is a critical infrastructure for societies. Appropriate and safe use of the road network is therefore of high importance for governments and citizens. ISA addresses the need for a speed-aware road network and assists road users to make informed decisions.

A speed-aware road network assists governments to manage and maintain road network and assets effectively and allows citizens to choose appropriate travel speed. These outcomes provide a safer, better and more sustainable road network.

The development of a speed-aware road network should address required information for a variety of situations and conditions. A speed-aware road network should meet the spatial accuracy requirements and also should contain necessary information to represent the speed limits accurately. The necessary business processes including speed limit change governance process, approval and validation processes should be developed to sustain and ensure the quality and currency of data.

Publication of ISA data by SRAs should comply with data sharing standards and should meet agreed quality standards. The distribution of ISA data by data aggregators also requires some quality standards. Completeness, accuracy and timeliness should be maintained to a degree that meets the road user requirements including drivers, vehicle operators and governments.

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