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Spatially Enabled Society

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Spatially Enabled Society

Joint publication of FIG-Task Force on "Spatially Enabled Society"
in cooperation with GSDI Association
and with the support of Working Group 3 of the PCGIAP

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LIST OF ABBREVIATIONS

AAA	Accurate, Authoritative and Assured geospatial datasets
CORS	Continuously Operating Reference Station
FIG	Fédération Internationale des Géomètres (International Federation of Surveyors)
GGOS	Global Geodetic Observing System
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSDI	Global Spatial Data Infrastructure
ICT	Information and Communication Technology
IGS	International GNSS Service
IMU	Inertial Measurement Units
ISO	International Organisation of Standardisation
ITRF	International Terrestrial Reference Frame
LBS	Location Based Services
MEP	Member of the European Parliament
NGO	Non-Governmental Organization
NMCA	National Mapping and Cadastral Agencies
NSDI	National Spatial Data Infrastructure
OGC	Open Geospatial Consortium
PI	Positioning Infrastructure
POI	Points of Interest
RRR	Rights, Restrictions, Responsibilities
SDI	Spatial Data Infrastructure
SEG	Spatially Enabled Government
SES	Spatially Enabled Society
UN-ECE	United Nations Economic Commission for Europe
UN-GGIM	United Nations Global Geospatial Information Management

FOREWORD

This publication on "Spatially Enabled Society" is the culmination of a three-year effort by the Task Force that was established by the General Assembly of the Federation in May 2009. The Task Force included representations from the Global Spatial Data Infrastructure Association and Working Group 3 of the United Nations sponsored Permanent Committee on GIS Infrastructure for Asia and the Pacific. This is a collaborative effort led by the FIG Task Force and the publication has been compiled and edited by Dr. Daniel Steudler, Chair of the FIG Task Force on Spatially Enabled Society, and Prof. Dr. Abbas Rajabifard, President of the GSDI Association.

The rapid development and increased demand for spatial information infrastructures in many jurisdictions these past many years have made spatial information an invaluable tool in policy formulation and evidence-based decision making.

Spatial enablement, that is, the ability to add location to almost all existing information, unlocks the wealth of existing knowledge about social, economic and environmental matters, play a vital role in understanding and addressing the many challenges that we face in an increasingly complex and interconnected world. Spatial enablement requires information to be collected, updated, analysed, represented, and communicated, together with information on land ownership and custodianship, in a consistent manner to underpin good governance of land and its natural resources, whole-of-government efficiency, public safety and security towards the well being of societies, the environment and economy.

The main issue societies have to focus on is probably less about spatial data, but much more about "managing all information spatially". This is a new paradigm that still has to be explored, deliberated and understood in the context of a spatially enabled society.

This collaboration between FIG and GSDI is within the aim of the MoU signed in 2010 between these two professional bodies. Together with PCGIAP WG3, this collaboration has allowed for the participation and contribution from contributors and authors with varied expertise, from differing backgrounds and in different regions of the world.

We would like to congratulate the FIG Office, members of the Task Force, all contributors, all co-authors and the two editors for this superb effort. We extend the deep appreciation and gratitude of our Federation and Membership for their invaluable and unselfish contributions.

CheeHai Teo
President

April, 2012

EXECUTIVE SUMMARY

The needs of societies are increasingly of global scale and require spatial data and information about their land, water and other resources – on and under ground – in order to monitor, plan, and manage them in sustainable ways. Spatial data and information, land administration, land management, and land governance play crucial roles in this.

Spatial enablement is a concept that adds location to existing information, thereby unlocking the wealth of existing knowledge about land and water, its legal and economical situation, its resources, access, and potential use and hazards. Societies and their governments need to become spatially enabled in order to have the right tools and information at hand to take the right decisions. SES – including its government – is one that makes use and benefits from a wide array of spatial data, information, and services as a means to organize its land and water related activities.

This publication focuses essentially on six fundamental elements, which are required to realize the vision of a SES:

1. a **legal framework** to provide the institutional structure for data sharing, discovery, and access;
2. a sound **data integration concept** to ensure multi-sourced data integration and interoperability;
3. a **positioning infrastructure** to enable and benefit from precise positioning possibilities;
4. a **spatial data infrastructure** to facilitate data sharing, to reduce duplication and to link data producers, providers and value adders to data users based on a common goal of data sharing;
5. **land ownership information**, as the dominant issue in the interactions between government, businesses and citizens relating to land and water resources; and
6. **data and information** to respect certain basic principles and to increase the availability and interoperability of free to re-use spatial data from different actors and sectors.

Land and spatial information professionals play a primary role in translating raw data into useable spatial knowledge resources. These professions should ensure that both the social and technical systems in which spatial enablement will operate within are well understood. Spatial enablement can only be effective when it is designed with the specific needs of the jurisdiction in mind.

The concept of SES is offering new opportunities for government and the wider society, but it needs to move beyond the current tendency for the responsibility to achieve SES to lie solely with governments. SES will be more readily achieved by increasing involvement from the private sector, and in the same vein, if the surveying and spatial industries start to look toward other industries for best practices in service delivery.

Future activities need to take into account emerging trends in spatial information and the new opportunities they present for the application of spatial technologies and geographic information. These trends include among others:

- location as the fourth element of decision-making;
- differentiating between authoritative and volunteered information, yet recognizing the importance and value of both types of information towards spatial enablement and the enrichment of societies;
- growing awareness for openness of data e.g. licensing, and resultant improvements in data quality;
- move towards service provision.

1 INTRODUCTION

Daniel Steudler and Abbas Rajabifard

Our society today is being challenged by issues of global scale: economic development, social conflicts, urban growth, rural development, climate change, global warming, carbon credit management, or disaster management, are just a few issues that need careful assessment and sustainable action. In one way or another, all those issues are linked to location, as "everything happens somewhere", i.e. there is need for effective and efficient geoinformation.

Spatial is no longer special. In fact, spatial is everywhere and our ability to leverage and harness the ubiquity of spatial information will correlate to benefits in terms of wealth creation, social stability and environmental management. Spatial information intrinsically reflects the relationship between people and land by connecting activities to location.

Location is increasingly regarded as the fourth driver in decision-making, in addition to social, economic and environmental drivers. Consequently, land-related information has a key role in spatial enablement where good land governance can facilitate the delivery of a spatially enabled government to respond to the global agenda and achieve sustainable development. Societies and their governments need to become spatially enabled in order to have the right tools and information at hand to take the right decisions.

As surveyors and spatial information specialists, our professions perform a fundamental role in the flow of spatial information through society by translating raw data about land into spatial information. Assisted by new digital technologies, all levels of society are increasingly able to augment current sources of spatial information with their own personal datasets to generate new knowledge resources – the plethora of spatial mashups and crowd-sourced initiatives are testament to increasing levels of spatial utility, or spatial enablement, and contributing to the vision of a spatially enabled society.

We know that spatial enablement is not just about developing and using geographic information system (GIS) technologies. We know that the vast majority of the public are users, either knowingly or unknowingly, of spatial information. We know that a spatially enabled society will demand accurate and timely information about land. For spatial enablement to occur, it needs to be regarded as a concept that permeates all levels of society – government, industry and citizens, and its ability to flow through all levels of society will depend primarily on the spatial data infrastructure (SDI) and land administration system available in the jurisdiction (Williamson et al., 2010a; Williamson et al., 2010b).

Therefore the aim of the "FIG-Task Force on Spatially Enabled Societies" – in cooperation with other global organisations – is to focus on the term "Spatially Enabled Societies" (SES) and the issues linked with it; to come up with a definition of SES; and to support the surveying profession to become aware of those issues in order to provide the appropriate services.

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2 SPATIAL NEEDS OF SOCIETIES

Daniel Steudler and Abbas Rajabifard

When looking at media reports from the last six to 12 months, there are many examples of where sound land information and good land administration and management systems are needed.

In many large cities, the phenomenon of urban sprawl is creating huge problems, as can be seen in the example of Jakarta described by Philip (2010). The Indonesian capital with a population of 9.6 million is facing problems such as pollution, overpopulation, traffic congestions, inefficient transport systems, and urban sprawl without proper planning. In the face of these challenges, the Indonesian authorities are even considering options to move the capital to somewhere else in order to overcome them. The opposition and NGOs, however, are suggesting "to improve the existing city rather than moving into the jungle, and to create incentives to draw the middle classes back into the city centre. Just as elsewhere, high rents have driven many away – and the proliferation of lavish shopping malls has fuelled property speculation. We have to rethink the way we use land, encourage people to move back and stop building tower blocks. Land is crucial and we need the relevant information in order to manage it well". The call for better land information is a strong one, as it is the basis for the analysis and solution to the multiple problems and the well-being of huge populations.

In disaster management, there is also a strong need for sound land information. Mitchell (2010) describes three main threats to landholders in disasters. "First, there are material threats caused by displacement, including the risk of land grabbing and coercion to sell, the need for temporary shelter and resettlement, and the impact of resettlement on those with insecure tenure. A second category of threats is the material threats caused by destruction. These include damage to property, degradation, loss of official records, a reduced capacity of authorities to carry out their duties, and damage to boundary marks. The third type of threat is administrative, post-disaster. These include limited public sector capacity, planning rule changes and inadequate compensation".

A concrete example of these threats is the natural disaster management after the flooding in Brazil in January 2011 and again in March 2011. There were calls that these disasters could have been prevented by the establishment and proper use of hazardous zone definitions, of preventing building houses in those areas, and of flood prediction models. Another example was the 2004 tsunami, 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 speculators, it was effortless to manipulate land registration documents and to evict previous landowners. In Aceh, about 80% of the land documents have been destroyed, which posed huge problems for the reconstruction (Abidin et al., 2006). The post-disaster plight in Haiti after the 2010 earthquake revealed similar needs. Commentators were suggesting three building blocks for the reestablishment of a functioning society: nation building, the establishment and enforcement of law and order including land ownership, and the education of people in order to enable them to self-help (Kappeler, 2010).

An example of land grabbing has been described by Bunting (2011). In Mali, an international development company has built a 40km long water irrigation canal mandated by the government. The canal, however, displaced many local people living on the ground for generations. The development company claimed that planning of the canal has been based on maps that show the actual landownership. However, the map did not reflect the actual status on the ground as Mali has almost no private land titles and land is owned ultimately by the state. This has been interpreted with respect for customary land use, though it is not clear how the rights of those living on the land will be protected. Already, more than 150 families have been forced off the land to make way for the canal. Campaigners worry that this is only the beginning: "Even if the land does belong to the government, the people living on it still have rights, and we will do everything to fight against this injustice" (compare Figure 2.1).

Those examples from developing countries show urgent needs for efficient land administration and management systems based on sound spatial land information. In developed countries at the same time, there are important needs to have reliable spatial information as well. Due to the density of the population and the land use, existing cadastral system in such countries are to be extended to also accommodate information that reflects this use. One example is the discussion of 3D Cadastres, i.e., the extension of cadastral systems with the 3rd dimension in order to document the definition of ownership rights in condominiums.

In this same context, the paradigm of landownership rights extending up in the sky and down to the centre of the earth might no longer apply and needs discussion. In urban areas, street or railway tunnels might be built 10–20 m below existing properties and buildings. What is the legal situation when those landowners would like to drill their 100 m bore hole for geothermic heating? Such facts as well as public-law restrictions that potentially impact on the use of the land need to be documented in order to keep the land market transparent. Traditional cadastres documenting private-law rights can be extended in order to accommodate such land related issues.

There are many challenges and needs of our national societies. They are also of global scale and impact on all our lives. The spatial location and land information is in most cases crucial for responding to those needs; and while ownership information is not the sole information, it is more often than not at the core of the solution.

Mali: Whose land is it, anyway?

- Building of new irrigation canal by Government backed international contractors;
- scheme to raise agricultural yields and improve food security (of already intensively used land);
- Mali is a country where 80% of the people depend on subsistence farming for their livelihood;
- fear that this will deprive subsistence farmers of their land and food;
- farmers are promised compensation for their land, and that there will be jobs.

"The compensation they gave was not enough to build a new house," he says. "We are very deeply shocked. I have lived here all my life but I was told my smallholding was not on the map used by Malibya to build the canal. They took me to the tribunal and I was told that I had built on land where building was not allowed – and I lost my home. "This project is good for the government but it is not good for the people."

The Guardian Weekly 21.01.11 **43**

Figure 2.1: *Example of newspaper report on land grabbing.*

In the face of such complex and multi-scale challenges, spatial information and technology can be an effective tool to contribute to dealing with the challenges that society is facing. The notion of spatial enablement, and a spatially enabled society, is a reference to the use of spatial technology across all levels of society – government, industry and citizens, to improve decision-making, transparency and increase efficiency. In this regard, it is essential that land and spatial information practitioners provide the link to ensure that both the social and technical systems in which spatial enablement will operate within are understood: spatial enablement can only be effective if it is designed with the specific needs of the jurisdiction in mind.

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3 THE ROLE OF LAND ADMINISTRATION, LAND MANAGEMENT AND LAND GOVERNANCE IN SPATIALLY ENABLED SOCIETIES

Daniel Steudler and Abbas Rajabifard

Over the last 15–20 years, the topic of cadastre and land registration has been discussed extensively. The FIG-statement on the cadastre (FIG, 1995) established that the "cadastre assists in the management of land and land use, and enables sustainable development and environmental protection". In the 1990s the UN-ECE (1996) coined the term "land administration" in order to express the broader need and use of land information for managing the land as an asset. The Bathurst Declaration concluded in 1999 that sustainable development is the key driver influencing the humankind to land relationship and that it needs sound land administration (UN-FIG, 1999).

3.1 *Land Administration and Land Management in Context*

Land administration and management are serving the particular needs of societies as discussed in chapter 2. A spatially enabled society certainly needs well organized and efficient land administration and land management systems. The context of administration and management and their respective tools and methods are illustrated in Figure 3.1.

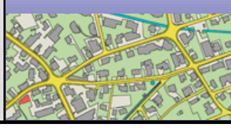
Tasks	Land related activities	Tools / Methods
Strategy • visions and objectives	**Land policy**	• political activities
Management • measures and projects for the implementation of the policy	**Land management** 	• land-use planning • land consolidation • land reallocation • melioration • landscape develop-ment • land recycling
Administration / Documentation • handling of spatial information, data analysis, data visualization • cadastral operations, data modelling, data acquisition, data maintenance, data distribution	**Land administration and cadastre** 	• monitoring • navigation • geoinformation • land registration • cartography • surveying • geodesy

Figure 3.1: *The broader context of land documentation, land administration and land management (adapted from Kaufmann, 2008).*

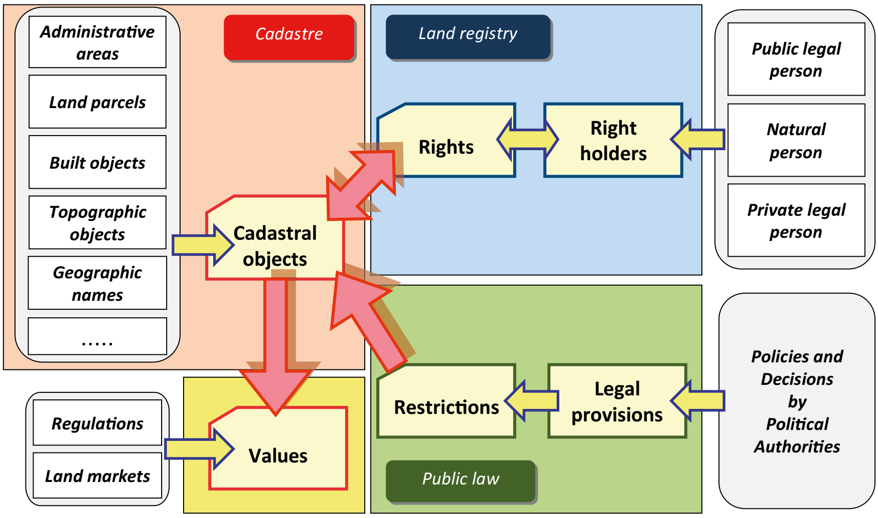


Figure 3.2: *Elements of a land administration system (from Horisberger, 2010).*

3.2 Elements of a Land Administration System

A land administration system has originally been defined by the UN-ECE as the "processes of determining, recording and disseminating information about the tenure, value and use of land when implementing land management policies". The land administration system is a basic foundation for the spatial enablement of a society and is considered to include land registration, cadastral surveying and mapping, fiscal, legal and multi-purpose cadastres and land information systems (UN-ECE, 1996).

Horisberger (2010) proposes a set of basic elements that a land administration system consists of. Those basic elements are (compare Figure 3.2):

- **cadastre** with the basic entity "cadastral object", i.e. land parcels, built objects, topographic objects, or administrative areas;
- **land registry** with the basic entities of ownership rights and rights holders;
- **land valuation** with the basic entities of land market value and regulations, based on land parcels;
- **public-law issues** with the basic entities of restrictions (with spatial extend) and legal and political provisions.

It is of course possible that a land administration system has more elements than those four basic ones. A society through its adopted land policy would have to define these other elements depending on the need. What is important is that all these elements have a link to the geographic location as they are documenting legal and administrative issues happening at a specific geographic location.

3.3 Land Administration and Spatial Data Infrastructure (SDI)

Due to sustainable development drivers and the need to manage an increasingly complex array of land rights, restrictions and responsibilities (RRRs), land administrations systems are starting to support more sophisticated land markets which include complex commodities (Williamson et al., 2005).

However, the realisation of sustainable development objectives necessarily requires the integration of cadastral data (built environment) with topographic data (natural environment) (Williamson et al., 2005). The SDI concept, which facilitates the sharing, access and utilisation of spatial data across different communities to better achieve their objectives, provides a mechanism to facilitate this integration of cadastral and topographic data to facilitate decision-making. Indeed, the importance of this relationship was underscored in the Bogor Declaration on Cadastral Reform in 1996 which stated that the spatial cadastral framework – usually a cadastral map – should be a fundamental layer within a national SDI (FIG, 1996). Land administration typically generates information about places while SDIs organize spatial information. Together, they can provide information about unique places people create and use.

3.4 Towards Land Governance

'Land administration' and 'land management' are concepts that have been widely discussed and used within FIG for many years. More recently, the term 'land governance' has been introduced, conceptualized as an elaboration of the broad notion of 'good governance' particularly with relevance to land management issues.

The term 'land governance' has become a widely accepted concept globally, and generally refers to the "the policies, processes and institutions by which land, property and natural resources are managed" (Enemark, 2009, p. 4). This includes access to land, land rights, land use and land development: essentially, land governance is about determining and implementing sustainable land policies and inherent to this, is the legal and institutional framework for the land sector (FIG, 2010).

Therefore, land administration systems provide the basis for conceptualising rights, restrictions and responsibilities; land administration functions form the operational component of land management; land governance enables the determination of land policies that direct land administration systems and land management practices so that these can be effectively implemented to ensure sustainability.

By bringing together the various strands – land administration, land management and land governance, we can create a strong framework by which land and natural resources can be effectively managed to fulfil political, economic and social objectives, that is, to help realize sustainable development objectives.

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4 KEY ELEMENTS FOR A SPATIALLY ENABLED SOCIETY

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SES and its role in government and society

Spatial enablement is a concept that adds location to existing information and thereby unlocks the wealth of existing knowledge about the land, its legal and economical status, its resources, potential use and hazards. 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 (compare Figure 4.1). Information on landownership is thereby a basic and crucial component to allow for correct decision-making. Such data and information must be available in a free, efficient, and comprehensive way in order to support the sustainable development of society. It therefore needs to be organized in such a way that it can easily be shared, integrated, and analysed to provide the basis for value-added services.

However, SES, and inherent to this, the concept of Spatially Enabled Government (SEG), has gained momentum internationally as jurisdictions begin to recognize the benefits it delivers. This can be seen in the number of conferences, symposiums, and numerous activities that have been organized around the theme of spatial enablement. SEG is now part of the objectives of governments in many countries, highlighting the importance of spatial information and strategies in policy development and decision-making in the public sector. SEG increasingly operates in a virtual world, but SEG initiatives need to be coupled with real world institutional and structural reforms in the use of spatial information and spatial data infrastructures as an enabling platform.

Therefore, a society can be regarded as spatially enabled when location and spatial information are commonly available to citizens and businesses to encourage creativity

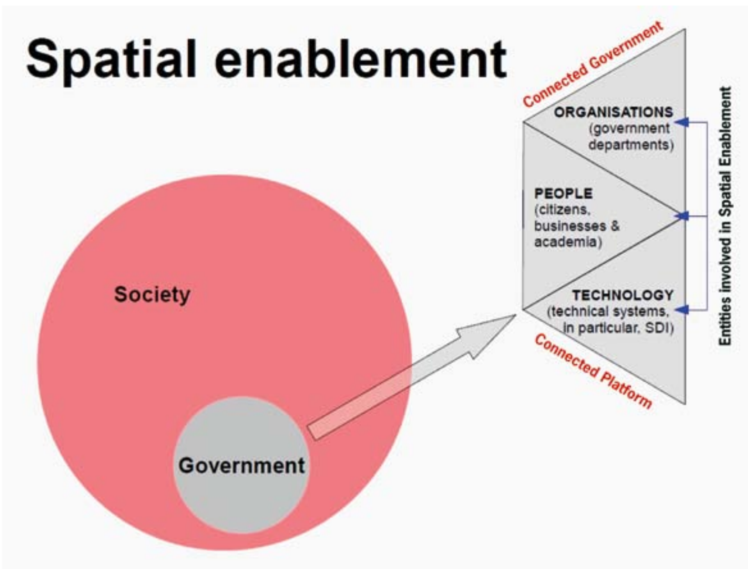

Figure 4.1: *Concept of spatial enablement and how it relates to social and technical systems within a society (adapted from Holland et al., 2009).*

and product development (Wallace et al., 2006), and it is also defined as an innovator and enabler across society and a promoter of e-Democracy.

Spatial enablement, and therefore SES, should be regarded as an evolving definition. Similar to other emerging concepts, there are different views on spatial enablement but essentially it 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.

Definition

The Task Force agreed on the following definition for the term "Spatially Enabled Society", which not only focuses on land, but also includes water:

> A spatially enabled society – including its government – is one that makes use and benefits from a wide array of spatial data, information, and services as a means to organize its land and water related activities. Spatial enablement is a concept that adds location to existing information and thereby unlocks the wealth of existing knowledge about land and water, its legal and economical status, its resources, potential use and hazards. Information on the ownership of land and water is thereby a basic and crucial component to allow for correct decision-making. Such data and information must be available in a free, efficient, and comprehensive way in order to support the sustainable development of society. It therefore needs to be organized in such a way that it can easily be shared, integrated, and analysed to provide the basis for value-added services.

Six key elements

In order to support this concept, the Task Force identified six elements, which are critical to its implementation. Without those six elements, the spatial enablement of a society or government would seriously be held back in its progress. They are:

- **Legal framework:** to provide a stable basis for the acquisition, management, and distribution of spatial data and information;
- **Common data integration concept:** to facilitate that existing spatial data – from government as well as other sources – respect the common standards in order to ensure interoperability for the benefit of all;
- **Positioning infrastructure:** to provide a common geodetic reference framework in order to enable the integration of spatial data and information;
- **Spatial data infrastructure:** to provide the physical and technical infrastructure for spatial data and information to be shared and distributed;
- **Landownership information:** to provide the updated and correct documentation on the ownership and tenure of the land, fisheries, and forests, without which spatial planning, monitoring, and sound land development and management cannot take place;

– **Data and information concepts:** to respect and accommodate the different developments in the acquisition and use of spatial data and information.

In terms of keeping a society spatially enabled, there are probably further issues that need to be considered, namely the educational framework, the technical and institutional development of spatial data management, the development of awareness on all levels of society – such as citizens, institutions, and decision-makers – and the development and applicability of land management tools in order to make best use of spatial data. These elements, however, are not further discussed in this report.

The following sections now look at the six key elements listed above and highlight their relevance and their roles in a spatially enabled society. Six renowned authors from around the world have been invited to share their views.

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4.1 Legal Framework

Abbas Rajabifard, Serene Ho and Jude Wallace

Introduction

This chapter focuses on the legal framework pertaining to land and spatial information and the role it plays in supporting the vision of Spatially Enabled Societies (SES). This is in line with the relationship between people and land, which is often governed and protected by law in the form of land title and land rights, restrictions and responsibilities (RRRs). Moreover, in some cultures, this relationship may alternatively be recognized within informal – yet no less legitimate – customary norms and practices.

The concept of SES depends on the effective use and delivery of spatial data and services. This effectiveness is a consequence of legislation that mandates its use, and implicitly deals with issues of data quality and liability (Onsrud, 2010). A jurisdiction's legal framework sets up the rules and regulations that mandate how information can, or should be, shared. This is often the crucial precursor to technical interoperability. Additionally, the social aspects of land and spatial information operations are important, as is a move towards applying standards of good governance to land administration and its various functions.

Jurisdictional framework

The legal framework is a key element in achieving SES as it constitutes an integral component of a jurisdiction's institutional structures. The framework depends on the set of laws and regulations that govern behaviour and create institutional arrangements within a jurisdiction. These usually appear in an hierarchical structure flowing from the national constitution to local laws. These highly formal laws and regulations are augmented by many subordinate, sometimes highly sophisticated, protocols, standards, conventions, and rules that operate in professional, business and technical areas. These structures are what facilitate the use, sharing, access and management of spatial information and technologies within and between different levels of society. Consequently, these also underpin the mechanisms of a jurisdiction's spatial data infrastructure (SDI) as an enabling platform.

As SES is dependent on the effective use and delivery of spatial data and services, the types of legislation that need to be considered are primarily those addressing the availability of spatial data (either by facilitation or limitation). Inherent to this is legislation that authorizes the government (or its contractors) to collect information about land, in all its social and economic complexity, as this underpins the reliability, legal effect and authenticity of information. Once data has been collected, secondary legislation will affect its availability: access, re-use and sharing. Finally, there will likely be broader legislation within the jurisdictional framework that deals with issues such as privacy, liability and intellectual property: these will provide a constraining factor in the use (and re-use) of spatial data (Janssen and Dumortier, 2007). Therefore, the combination, coherence and currency of such categories of legislation that exists within a jurisdiction will undoubtedly shape the strategic challenges in realising SES.

In addition to its particular local content, the framework needs to deal with issues that will inevitably arise. These include use of information in formal situations (especially in courts as evidence); proofs and verifications of information, commercial-in-confidence limitations, privacy and personal protection, protection of people in special circumstances (such as politicians or people under threat of violence), licence arrangements, embellishment for innovative or secondary purposes, reuse (especially on a commercial basis), social access, intellectual property, storage and archiving, liability for error, responsibility for maintenance, forms in which the information is kept, and more. One further constraint is overarching: the nature of a legal framework ensures that it will always run behind the technological frontier.

Legal interoperability and challenges

As part of the jurisdictional framework, legal interoperability is a very important aspect. The ability to enable spatial data sharing and interoperability by reconciling often competing legislative policies has always posed a significant challenge to governments (Onsrud et al., 2004). However, recent technological developments and adoption of open access information policies have contributed to increased online availability of spatial data and tools to facilitate easy creation and distribution of new customized spatial resources (using existing spatial datasets). This has given rise to the issue of legal interoperability. The datasets used to create new resources could potentially have conflicting licensing, or legal use, requirements and in this context, legal interoperability has been defined as (Onsrud, 2010):

… "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."

The users and their purposes of using or accessing spatial data will be governed by a variety of information and legal policies (Janssen and Dumortier, 2007; Onsrud et al., 2004). The use of data that is not legally interoperable may expose the user to legal liabilities including copyright, or other intellectual property law, infringements. This issue is of particular significance for spatially enabled datasets as they often have multiple uses that were not anticipated in the original licensing conditions or in its creation, which could increase the risk of litigation should injury result from the inappropriate use of the data (Pomfret and Ramage, 2010).

Sharing data is therefore a complex issue, of which intellectual property is but one facet. Onsrud and Rushton (1995, in Onsrud, 2010: 7) defined the complexities in GIS sharing as needing to deal with "both the technical and institutional aspects of collecting, structuring, analysing, presenting, disseminating, integrating and maintaining spatial data". More recent trends in spatial data use have further compounded the already complex privacy and intellectual property challenges. These trends include ubiquitous location-based devices and services and the collection and use of personal information; the call for more open access to data and the variety of licensing regimes; and the crowdsourcing movement borne of Web 2.0 (Pomfret and Ramage, 2010). While SDIs provide a platform that facilitates the resolution of some of these issues, they nonetheless still pose significant challenges.

Governance and SES

One of the ways in which an SDI, as an enabling platform, can support the legal framework is to provide an avenue for governance. According to Rajabifard and Box (2009), the notion of governance is an old one, derived from ancient Greek and meaning to steer or pilot a ship. Today, it is a key concept in a number of disciplines, but has different, and often contested, definitions. This has contributed to the lack of a common approach in addressing governance challenges, which means that each jurisdiction must independently solve governance challenges. This duplication of effort leads to incompatible approaches to governance which ultimately diminishes both the prospects for reuse of data as well as the ability to foster dependencies between SDIs. Ultimately, these constraints will have a negative impact on the realisation of SES objectives.

In considering the role of governance as applied to SDIs, Rajabifard and Box (2009) highlighted the importance of considering the nature of SDIs to arrive at a more appropriate conceptualisation of governance. They noted that governance is traditionally considered a 'steering' function because it provides leadership and an enabling framework for collective decision-making; however, as applied to SDI, governance has become shorthand for the institutional arrangements that enable an SDI, and therefore includes functions such as co-ordination and management. These 'rowing' functions extend the scope of governance to include decision implementation.

Governance plays a central role in SDI, and therefore SES, by enabling the creation of agreements that bind together the people and geospatial resources (data and technology) involved. A range of other functions are however necessary to channel collective efforts towards common goals. A broader view of SDI governance is that of a framework enabling stakeholders to make and implement decisions and evaluate commu-

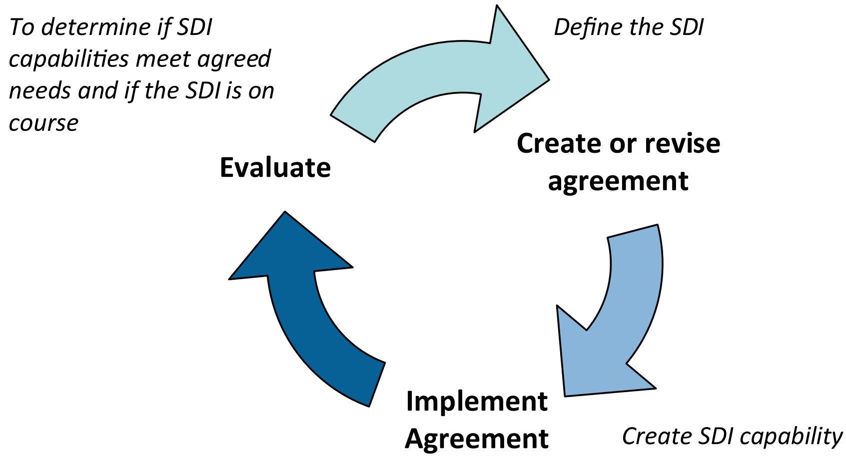

Figure 4.2: *SDI governance as a cyclical process (Box and Rajabifard, 2009).*

nity efforts towards the realisation of agreed common goals, thus keeping the initiative on track. This view of SDI governance as a cyclical process is shown in Figure 4.2 above.

The creation of agreements and their periodic review, ensuring that they continue to achieve desired outcomes, is the first step in the process. The governance of technical agreements, such as standards, specifications and application schema, is one of the major challenges of SDI and therefore will be a challenge in SES governance. Technical agreements are used to define how SDI capabilities (primarily data delivered via technology-supported services) are configured. Capabilities are developed, owned and operated by individual organisations, in accordance with agreements, to meet agreed community needs.

SDI governance can be likened to steering a flotilla of ships representing institutionally independent but functionally interdependent capabilities. To keep both individual vessels and the entire flotilla on course it is necessary to provide an unambiguous definition of the collective and individual responsibilities for decision-making, implementation and evaluation, together with the mechanisms that enable these.

Conclusions

Spatial data has traditionally been used by public organisations, businesses and academia. However, in line with spatial enablement objectives, spatial data is also increasingly being used by ordinary citizens. The users and their purposes of using or accessing spatial data will be governed by a variety of information and legal policies. The ability to enable land and spatial data sharing and interoperability by reconciling often competing legislative policies has always posed a significant challenge to governments. However, with the rapid development of practices such as crowd-sourcing and open access to information, there are acknowledged gaps in the current legal framework that are not yet able to provide effective regulation or even basic guidance.

These challenges were acknowledged at the first United Nations Global Geospatial Information Management (UNGGIM) High Level Forum held in Seoul, South Korea, in October 2011. Consequently, one of the declarations that emerged highlights the importance for governments around the world to share their experiences in ″policy-making, supporting legislation, and funding strategies to encourage and develop best practices in the management (i.e. collection, storage, maintenance and dissemination) with respect to global geospatial information management, and to facilitate and to promote the sharing of knowledge and expertise, especially with developing countries“.

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4.2 Common Data Integration Concept

Jürg Kaufmann and Daniel Steudler

Context

In every society – spatially enabled or not – data in digital format is collected by different authorities, offices, private and public sector bodies and persons. They all need the data to either run a business or to enforce laws and regulations; and they all began to automate their work processes and to transform their data into digital format. The content of the data sets responds to the needs of the respective data owners. Due to the fact that businesses as well as laws and regulations concern affairs taking place somewhere in the living space, the majority of the data is related to a position, i.e. has a spatial relation. In order to establish this spatial relation, all data owners use the technique best known to him, be it a verbal description, a street address, or a coordinate.

Ultimately, a spatially enabled society (SES) needs to establish a digital data model of the reality. The better and more complete this model is, the better the decisions can be prepared and implemented and the impacts forecasted in that model.

In a SES all the data representing the model finally shall be made available to other parties and institutions not being owners of the individual data sets. This process is called "Data Integration" and was defined by Lenzerini (2002) as: ***Data integration*** *involves combining data residing in different sources and providing users with a unified view of these data*.

A common data integration concept therefore is to be considered as a key element of a SES. Indeed a SES can only be operational when a common data integration concept is agreed upon.

Role of the common data integration concept

SES means that all stakeholders within a society can depend on reliable information about their living space to investigate the state of affairs, to elaborate projects for the development of the society and its environment, to evaluate the projects in view of sustainability and to implement them when the decision process is completed.

Reliable information can only be produced when objective and correct data is available and when the society can understand the content and the meaning of the data available. The data integration concept must ensure that no misinterpretation falsifies investigation, project preparation and evaluation, and implementation.

Information must be as complete as possible. This means that data gaps must be avoided, because information compiled with incomplete data sets will not be correct.

The data integration concept must also serve to avoid loss of data. Data acquisition is in most cases expensive. This means that already captured data represents a significant value. This value should be protected from loss. This can best be achieved by a sound data integration concept.

Three pre-conditions for a common data integration concept

The three pre-conditions for successful data integration are: i) an integration-friendly data structure; ii) a standardized data modelling concept; and iii) a common geodetic reference framework. FIG has already discussed these issues (Kaufmann and Steudler, 1998).

Integration-friendly data structure

Successful data integration is made possible by an integration-friendly data structure based on the existing legal framework. The legislation normally defines the given and lived realities of the different societies regulating the behaviour expected from the citizens and the political and economic institutions and fixes the responsibilities of the authorities charged with the enforcement of the laws. The legal prescriptions concerning the living space define what shall happen where and fix the impacted areas. These legal frameworks are similar in structure and content because existing laws of other countries are often used to draft proposed legislation. However, certain differences exist in the handling of the different issues as well as in the enforcement. The legislation provides a stable framework for the arrangement of the spatial data and for the creation of consistent data models.

A first condition to design an integration-friendly structure is fulfilled when the **geo-data representing spatial objects subject to the same law and underlying a unique adjudication procedure are arranged in separate data layers**.

This type of arranging the data layers is called the principle of "legal/institutional independence". This principle allows the design of a model corresponding to the allocation of the responsibilities as defined by the legal framework.

The legal framework assigns the responsibility for the data layers to a particular authority. Those authorities are the data owners and are responsible for the collection, updating and management of certain spatial data layers. Data ownership is not altered by the introduction of a model with legal/institutional independence. They are therefore not divested of their initial responsibilities and keep the full control of the data layers for which they are declared to be responsible (compare Figure 4.3).

With this arrangement the allocation of the responsibilities corresponds to the laws and regulations. In addition each data owner has access to the data layers of the other stakeholders. All the users of this model can use the information for their work and decision-making. There is no need to deliver information to other stakeholders or to receive copies of data of other data owners.

Common geodetic reference framework

The second condition to achieve integration friendliness **is the localisation of all spatial objects in the same geographic reference framework.**

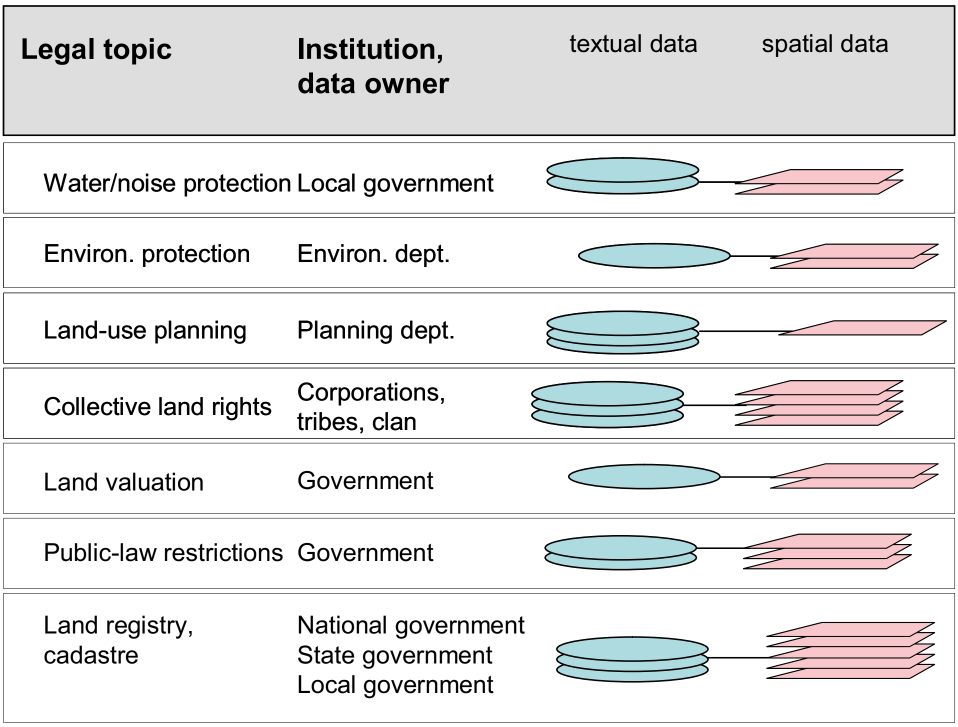

***Figure 4.3:** Legal/institutional independence, where the different stakeholders can manage their data sets independently from outside interference.*

With the location of the spatial objects in a common reference framework, the model of reality becomes coherent and sufficiently correct. This arrangement makes it possible to derive the relation between objects through their location in space with the help of algorithms at any moment when needed. This means that there is no need to take explicit care of the logic relation between objects by storing and maintaining it. The use of localisation algorithms – drilling through the spatial data layers – instead of logic relations makes the model absolutely flexible and efficient.

A system where the logic relations between spatial objects are to be stored and maintained will contain (n*(n–1))/2 links. This is 1 link for 2 objects, 45 links for 10, 4,950 for 100, and 499,500 links for 1,000 objects. All these links must be verified and adapted to a new state of affairs, whenever there is a change to one of the objects. This means that there is more work and a higher risk of inconsistency in the data sets.

In the data model based on a common reference framework, the data layers will change as the dynamic state makes it necessary. The relation between objects is established only when required. There is no unnecessary work to be done.

When new spatial data layers are to be introduced, they are simply added without any need to re-arrange or adapt already existing data and layers. If data layers are no longer needed, for example because a law becomes obsolete, the respective data layer can be removed, without any effect to other data and links in the system. Such a concept allows full flexibility and interoperability in the set-up of spatial data infrastructure.

Standardized data modelling concept

The aspect of data modelling is crucial for the concept of a SES. For a long time, the map was the traditional model of spatial reality. If the data was represented according to the drafting rules for map production a model represented on paper emerged. The map was at the same time data storage and representation medium in one. In a data-centred solution, maps or drawings will serve simply to represent information derived from data stored in data bases. The storage media is no longer the map, but the data bases.

This means that the two functions of the paper map are now divided into two parts. The data base must be modelled according to the logic of data processing. The representation of the data by means of drawings makes it easier to understand the content of the data bases and to interpret an existing or planned situation. The representation is modelled with a representation model according to the needs of the viewers.

Data and representation description are to be IT-friendly. Data and their structure are described with something akin to a programming language. The best solution is an interpretable data description language readable by a computer. Thus data bases can be designed by intelligent software and data can be checked automatically. Representation models shall be IT-friendly as well. They serve to compile machine-aided representations.

Unless a society is able to change from a map to a model paradigm, it cannot be considered to be spatially enabled.

With the help of standardized data description languages such as, for example, INTERLIS or future ISO Standards, it is possible to integrate data sets and make them available for interested partners with a high level of reliability, correctness, and completeness.

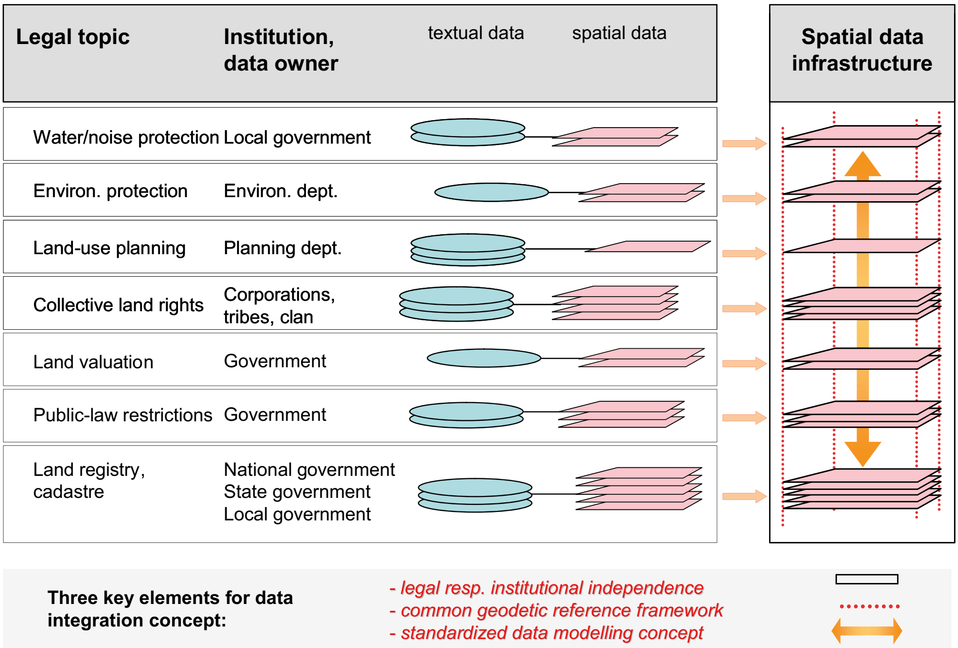

Figure 4.4: *Three key elements for the data integration concept: legal/institutional independence, common geodetic reference system, and standardized data modelling concept.*

Summary

The common data integration concept is based on three pillars: legal/institutional independence, common geodetic reference system, and standardized data modelling concept as shown in Figure 4.4.

Difficulty in implementing a common data integration concept

The way to implement a common data integration concept is, according to experience, a stony and steep path and a great number of obstacles are to be overcome. Several reasons can be identified, which make the implementation of a data integration concept difficult.

Low acceptance for standards and rules

The fact that the existing data collections emerged from an individual need makes the owners feel threatened and suspicious if another stakeholder wishes to use the data and to impose a certain regulation. A proposal to apply another technique to define the data or to change the way of the description of the location generally provokes dismissive reactions. This effect is somehow understandable because such attempts are understood as an outside interference similar to a trespass on a property.

Fear to lose the lead and to suffer from disadvantages

The owners of data collections have acted according to their individual skills and needs. They had to find and introduce appropriate solutions for their purposes without reference to other users. Any attempt to introduce standards creates fear of losing control over the established solutions and the proven advantages.

Many stakeholders

SES means that many stakeholders with different tasks and interests and acting on different political and administrative levels are involved. It is difficult to win the confidence and to persuade the many stakeholders that cooperation and standardisation is needed to achieve the goal of a spatially enabled society. It proves to be necessary to carefully call for the stakeholders and to open the way into a new integrated environment in an individual way. The legal/institutional independence can help to overcome the fears because the stakeholders retain the responsibility for their data.

Possible approaches for successful implementation

Common data integration concepts do not emerge automatically. There is a need to promote their implementation. A basic need is an effective and open communication between the stakeholders.

The application of the principle of legal/institutional independence leaves the responsibility for the data layers to the institution declared as data owner by law. Taking away that responsibility engenders fear that a task cannot be fulfilled any more.

Also important is the awareness that the agreement on a concept always needs a certain period of time and that the implementation on a voluntary base will be slow. The time consumption can be influenced by additional imposed measures such as the obligation to use certain standards. Unfortunately, development of a concept is also an agreement process.

The best method is to fix the requirements for data structure, data modelling and data definition in a law. This makes many discussions superfluous and forces the stakeholders to reach agreement.

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4.3 Positioning Infrastructure

Matt Higgins

What is positioning infrastructure?

In recent years, the concept of a Positioning Infrastructure (PI) has developed based on the widespread availability of receivers of Global Navigation Satellite Systems for geodesy, surveying and for geo-spatial data capture. The concept of a PI as used in this section is shown in Figure 4.5 and has two main components:

1. The first and most essential components of a PI are the satellite navigation systems themselves;
2. The second component further augments the satellite systems through additional ground infrastructure in the form of Continuously Operating Reference Stations (CORS) to improve accuracy and/or reliability for users.

Looking at the first component, most current users of satellite positioning employ the USA's Global Positioning System (GPS) but the future will be dominated by the overarching concept of Global Navigation Satellite Systems (GNSS) as a system-of-systems, which includes GPS but extends to other global systems such as Russia's recently completed GLONASS and systems currently under development such as Europe's Galileo and China's Beidou. India and Japan are also developing their own regional systems. For a recent description of GNSS developments and their impact on PI see Rizos et al. (2010)Each of these individual GNSS systems has a number of sub-components including the space segment, which are the satellites themselves, and the ground segment. The ground segment typically includes a sparse network of tracking stations across the globe, which enables tracking the position and condition of each satellite to be broadcast to the user's receiver.

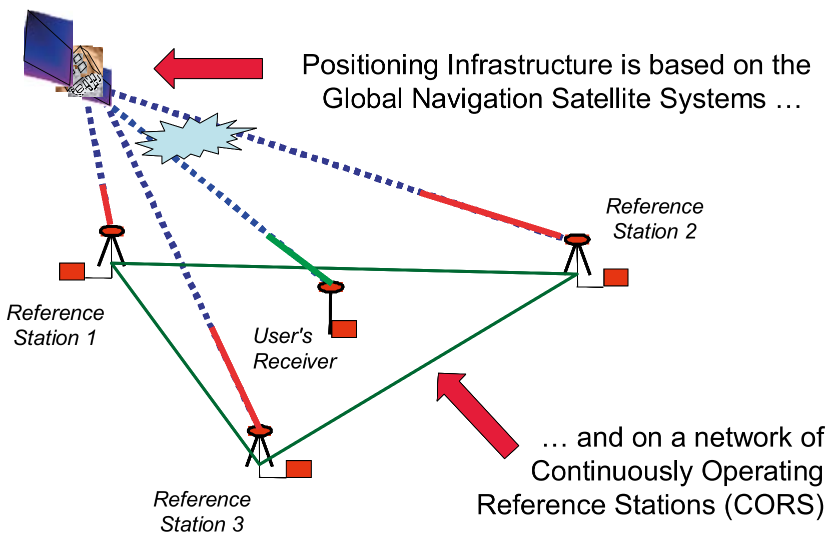

Figure 4.5: *Components of a Positioning Infrastructure.*

Most currently available mass-marketed receivers use only GPS and allow a typical accuracy of a few metres to tens of metres when used in single point position mode. Many users require improved accuracy and/or improved reliability and therefore need to position themselves relative to nearby reference stations. A reference station uses a high quality GNSS receiver at a known location to calculate corrections for factors such as the satellite orbits, the ionosphere and troposphere. Those corrections can then be applied to the user's receiver which can then be more accurately positioned relative to the reference station.

Why is positioning infrastructure important?

While PI based on CORS has its root in surveying and the activities traditionally associated with a geodetic datum, the concept now extends to much broader roles on the global stage. Therefore, the roles of a modern PI can be grouped into three main categories:

1. Geodesy – Continuation of the traditional role of a geodetic datum as the fundamental layer of a Spatial Data Infrastructure by underpinning surveying and mapping activities;
2. Monitoring – Providing a stable geodetic reference frame for precise measurement and modelling of global processes such as sea level rise and plate tectonics; and
3. Services – Extension to the concept of a true infrastructure that underpins the explosion in industrial and mass market use of positioning technology.

Geodesy – Continuation of the Traditional Role of a Geodetic Datum

The Geodetic Datum is widely recognized as the most fundamental layer of any Spatial Data Infrastructure (SDI). Traditionally, the geodetic datum has been realized through the placement of permanent survey marks and carrying out surveys to generate accurate latitudes, longitudes and heights for those marks. A global trend during the last decade has been a trend away from reliance on survey marks and episodic measurement campaigns to the establishment of Continuously Operating Reference Stations (CORS) with GNSS receivers. CORS networks enable a highly accurate and continuously monitored realization of the reference frame and are therefore complementing and/or replacing permanent survey marks as a means of realizing and delivering the geodetic datum (Figure 4.6).

The GNSS data from CORS networks in any country can now be processed with data from the global CORS network run by the International GNSS Service (IGS, see Dow et

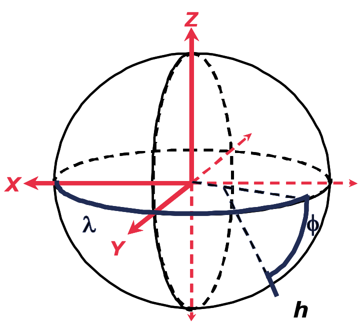

Figure 4.6: *Mathematical model for a geodetic datum.*

al., 2008). The connection to IGS enables the local geodetic datum to achieve excellent internal and external accuracy, as well as global compatibility through links to the International Terrestrial Reference Frame (ITRF). Therefore, the concepts behind PI and geodetic datum are becoming increasingly intertwined.

Monitoring – Measurement and modelling of global processes and changes over time

Enemark (2008) summarizes the key challenges of the new millennium as climate change, food shortage, energy scarcity, urban growth, environmental degradation, and natural disasters. Against that background, the second role of PI considered here is the enhancement of our ability to measure and model global processes and to monitor any changes over time.

A simple example of this second role for the PI is that it is difficult to be confident of millimetre quality measurements of sea level rise using a tide gauge, when the wharf on which the tide gauge is mounted could be subsiding. Therefore, the state of the art approach to monitoring sea level rise is to mount a CORS on the tide gauge to monitor its height relative to a reference frame that is highly stable over time through connection to the national and global CORS network, as portrayed in Figure 4.7.

Thinking more broadly, the role of understanding global processes is typified by the concept of the Global Geodetic Observing System (GGOS, see Rummel et al., 2005). GGOS is being developed under the auspices of the International Association of Geodesy (a sister organization of FIG) and is enabling greatly improved measurement capabilities and monitoring of global processes, such as:

- changes in sea level due to global warming;
- changes in various layers of the atmosphere over the short and long term;
- changes in the planet's overall water storage, either as liquid, vapour or ice;

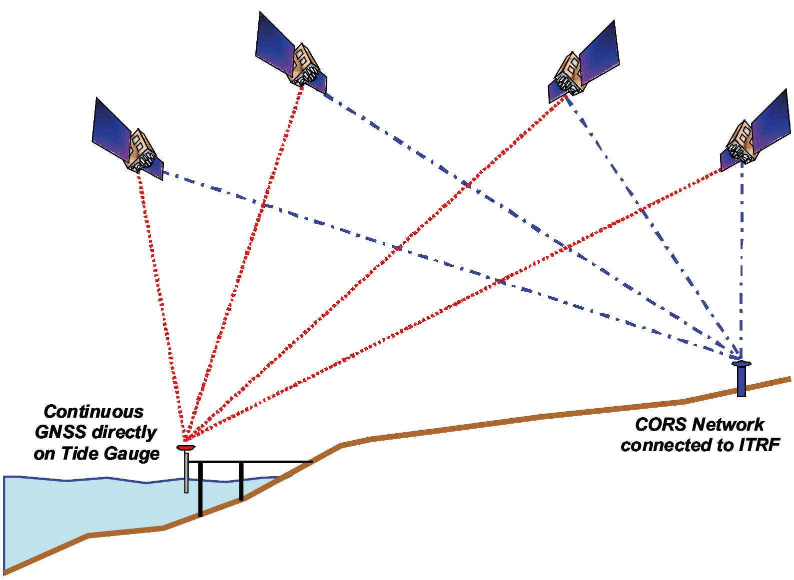

Figure 4.7: *GNSS and CORS for monitoring sea level rise.*

- changes in ground cover through desertification or deforestation;
- changes in the earth's crust as motion, uplift or deformation and including plate tectonics;
- applying some or all of the above change detection capabilities to disaster monitoring and management, including earthquakes, tsunamis, floods, cyclones and hurricanes.

In a world influenced by global change, surveyors will be involved in many land policy decisions that will need to be based on high quality measurements at a given instant and on the ability to regularly repeat such measurements over long time scales into the future. Therefore, those measurements will need to be based on a highly accurate and stable geodetic reference frame, which is best realized through a PI that is strongly connected to the International Terrestrial Reference Frame.

Extension to the concept of a true infrastructure that underpins industrial and mass market positioning

The third and most recent role comes from the growing trend to think of positioning capability in a more systematic way and in terms of a true infrastructure. In coming years PI will come to be seen as the fifth infrastructure after water, transport, energy, and telecommunications. Similar to those others, the PI will be seen as a critical infrastructure for society's triple bottom line.

The first two roles of a PI can often be satisfied by post-processing of a user's GNSS data relative to the CORS network but the other important characteristic of this third role is that it extends to the ability to deliver services in real-time. The state of the art is the real-time network approach, where a central computer uses the CORS to model errors across the network coverage area due to the satellite orbits, the ionosphere and the troposphere. The current state of the art requires CORS spaced at intervals of no more than 70km to deliver centimetre accuracy in real-time. It is likely that less dense networks may be required in the future as more satellite signals and new processing algorithms become available.

While real-time precise positioning has its roots in surveying, the most important recent influence has been the rapidly growing market outside surveying with the current emphasis being on precise guidance of heavy machinery. In an Australian example, the Allen Consulting Group (2008), has found that in agriculture, construction and mining alone, productivity gains from machine guidance have the potential to generate a cumulative benefit to the Australian economy of between $73 billion and $134 billion over the next 20 years (Australian Dollars or AUD). The study also found that a coordinated roll-out of a national network of CORS across Australia (as opposed to depending solely on market forces) would increase the total uptake and the rate of uptake, providing additional cumulative benefits of between $32 billion and $58 billion (AUD) gross to 2030.

Significant environmental benefits are also enabled by a PI because many of the efficiency gains from machine guidance arise from fuel efficiency. For example, in controlled track farming of wheat, fuel efficiencies have been estimated to reduce the carbon footprint by 89 kg of CO_2 equivalent gases per hectare. Other significant contributions to carbon footprint come from the manufacture of fertilizers and pesticides. Therefore, reducing their usage along with less soil disturbance and then adding to the fuel savings means that controlled track farming could reduce overall emissions of CO_2 equivalent by as much as 300 kg/ha (Tullberg, 2008). As well as the carbon footprint, there are also significant additional environmental benefits through minimization of fertilizer and pesticide use.

Positioning infrastructure's role in SES

As described earlier, the first key components of a PI are the GNSS satellites themselves. It is interesting to note that unlike other infrastructures such as water, transport, energy or telecommunications, the same basic level of GNSS service is available globally to users in every country, rich or poor. As such, GNSS could be considered as perhaps the most truly global infrastructure available today.

That global ubiquity along with the availability of low cost receivers has made GNSS one of the key technological developments underpinning the broad spatial enabling of society. The widespread availability of GPS in mobile phones and cars means that hundreds of millions of people are now able to locate themselves with an accuracy that would have been envied by trained navigators and surveyors just 30 years ago. However, the ubiquity of that spatial enablement is also addictive and GNSS is no different from other technologies in that users soon find applications that require constantly improving performance. With GNSS, such improved performance is often required in terms of accuracy or reliability and often in terms of both.

The hunger for ever improving performance is being addressed in part by new GNSS systems providing more satellite signals to increase the availability of positioning in areas where GPS alone might not work effectively; areas such as urban canyons or forests. It is of interest that this need to increase availability is felt even in mass market spatial enablement, as can be seen in the latest Apple iPhone (the 4S at the time of writing) being able to track both the USA's GPS and Russia's GLONASS satellites.

However, there are limits to the advantages that come from simply adding more and more satellite signals so there is still a need for the second component of a PI in the form of ground based CORS to deliver significant improvements to both accuracy and reliability.

As mentioned earlier, the overall PI, for example, is enabling new applications for precise positioning through machine guidance. That is taking spatial enablement to new levels in industrial applications, which are further enhanced by the data communications moving spatial enablement into the real-time domain and taking advantage of data exchange in both directions. Such data exchange can now be tailored not only to the user's application, but also to their location. In heavy construction machinery, for example, if a bulldozer's performance begins to drop when it is operating on steeply sloping land, it might signal a looming maintenance problem. In such a case, it is possible to trigger an alert for an off-site mechanic to undertake diagnostic checks in real-time and make decisions about whether or not the machine should come in for maintenance.

In the next decade, we can expect to see spatial enablement based on precise positioning further evolve from industrial applications and into the mass market. A key application area to watch in this regard will be the so-called Cooperative Intelligent Transport Systems (C-ITS). That development will see vehicle navigation systems go beyond their current function of basic navigation and leverage real-time communications to develop warning functions, such as informing a driver about an accident on the road ahead. That evolution will continue to an even higher level where it may eventually be possible for the vehicle's guidance system to take control of the vehicle to help avoid an impending collision.

All of the above increased requirements of the PI will also put parallel high demands on the spatial data infrastructure (SDI). Continuing with the road safety example, high-end collision avoidance systems are likely to require mapping of all major roads in a given area at a level of accuracy that enables a vehicle to not only avoid colliding with another vehicle, but also to include the location of road side obstacles, such as guard rails or trees. So for fully automatic vehicle safety systems to work on all roads and between all vehicles, the ultimate accuracy requirement of both the PI and SDI is likely to be better than 10 cm and at very high confidence levels. For example, the 95% confidence levels typically used to express positional uncertainty in spatial data sets leaves open the possibility of a 5% failure rate which may not be acceptable in a vehicle safety system.

Overall, it can be seen that we are only at the beginning of an era of accelerating and broadening spatial enablement based on PI. However, while the possibilities are exciting, it is not all good news. As the PI serves more and more high performance applications, with high economic and environmental value (such as in mining operations) or with high societal value (such as in road safety), it will be necessary to ensure that such high levels of performance can be guaranteed and that users are warned of any threats. An example of a threat to PI that has already occurred is interference to the GNSS signals, either through accidental interference by other radio sources or by intentional jamming. This adds another dimension to the need to think of PI as a true infrastructure and to ensure that the technical and institutional arrangements are in line with those expected of a robust and resilient critical infrastructure.

How can positioning infrastructure best be implemented?

In many countries, PI implementation is often hierarchical, which Rizos (2008) has characterized into several Tiers. How those Tiers can serve the three roles for a PI outlined above is depicted in Table 4.1.

In designing a PI it can also be useful to consider the accompanying policy considerations. Higgins (2008) suggested some key principles that might underpin PI policy-making, which were further developed in Rizos et al. (2010) and can be stated in generic terms as follows:

- *Public Good:* Meeting public good needs such as strengthening rather than fragmenting the geospatial reference frame and supporting improved management of natural disasters and climate change;
- *Open Standards:* Conforming to well defined and open standards in relation to issues such as interoperability for equipment and data transmissions and for connection to the geospatial reference frame;
- *Multi-purpose:* Enabling multiple applications where possible, including science;
- *Beneficial:* Allowing full realization (by users and operators) of the economic, environmental and societal benefits;
- *Optimal:* Avoiding unnecessary duplication of stations and associated infrastructure to minimize the costs of establishment and maintenance to the economy as a whole;
- *Collaborative:* Encouraging the appropriate level of participation across the public, private and research sectors;

CORS Tier	Description	Role 1 – Geodesy	Role 2 – Monitoring	Role 3 – Services
1	IGS-class CORS for the Nation	International link to ITRF.	Essential reference frame + can also act like Tier 2.	Essential reference frame + can be real-time enabled to act like Tier 3.
2	IGS Quality but Higher Density	Fleshes out national reference frame.	Essential for detailed models of natural processes and long term change analysis.	Additional Framework + can be real-time enabled to act like Tier 3.
3	Real-Time Network	Delivers reference frame directly to users in real-time.	Value for monitoring depends on physical stability of the Tier 3 CORS.	Essential for real-time centimetre services.

Table 4.1: *Tiers versus roles for Positioning Infrastructure.*

- *Sustainable:* Allowing for revenue streams for station owners to recover operating and replacement costs either directly or through partnerships with commercial service providers;
- *Extensible:* Recognizing that availability of resources to build the PI may vary in time, location and across sectors. Therefore, extensibility is desirable to take advantage of funding injections when available.

A particularly pragmatic aspect to be considered when designing a PI is that as with many other types of infrastructure, the quality and coverage that can be justified is often based on population densities. Fully developed PIs delivering real-time centimetre level positioning services – e.g. based on CORS at a maximum spacing of 70km – are most viable where there are a large number of users in a relatively small area. Such areas also tend to be where the necessary mobile communications infrastructure is also readily available. In such cases, it may be possible to justify the establishment of a PI based on the benefits for the surveying and spatial sector alone.

However, justifications based solely on the surveying and spatial sector can often be more challenging when there is a desire to extend the PI coverage into rural and remote areas of a given country or region. In such cases, it may be necessary to broaden the business case, beyond surveying and spatial data, to include machine guidance for agriculture, construction and mining and to use their economic, environmental and safety benefits to help bolster the business case.

As well as those broader benefits, any organization contemplating the establishment of PI should also consider whether or not they are best placed to undertake all aspects of the PI. Looking at currently established PIs in various countries, we see a mix of government and private sector involvement, such as a government deploying the reference stations and the private sector delivering value added services to users. Higgins (2008) outlines a generic model as shown in Figure 4.8 that can be used for understanding and agreeing the roles of various organizations; from specifying and operating the PI through to delivering the services to users.

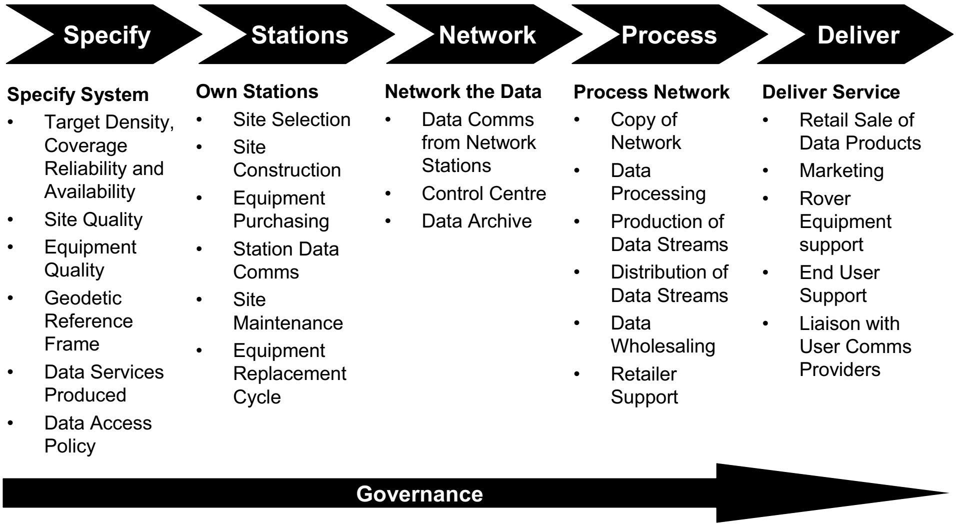

Figure 4.8: *A model for organisational roles within a Positioning Infrastructure.*

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4.4 Spatial Data Infrastructure

Abbas Rajabifard

Introduction

The notion of a spatially enabled society has generally been used to refer to the concept where location, place and other spatial information and services are ubiquitously available to governments, citizens and businesses as a means of organising their activities and information transparently. This concept has become widely embraced as people have increasingly realized that ready and timely access to spatial information – knowing where people and assets are – is essential and a critical tool for making any informed decisions on key economic, environmental and social issues (Rajabifard, 2009).

The effective management, networking and sharing of spatial information and services across agency, state and even national boundaries will result in information being used more efficiently and effectively, and lead to the creation of new services. In facilitating this and to improve access, sharing and integration of spatial data and services, spatial data infrastructures (SDIs) have emerged as a key network infrastructure, and more recently, has evolved to become conceptualized as an enabling platform.

This section will discuss the components of an SDI and outline the various elements that need to be considered – both technical and non-technical – for successful implementation so as to support the dynamic, hierarchic, multi-levelled and multi-disciplinary use of SDI as an enabling platform in a spatially enabled society.

SDI as an enabling platform

SDIs were initially developed as a mechanism to facilitate access and sharing of spatial data for use within a GIS environment, using spatial information to provide a unifying medium linking solutions to location (see Figure 4.9).

The conceptualisation of SDIs have evolved over time, resulting in three different approaches. The hierarchical approach conceptualized SDIs as a link across different levels (local to global) (Rajabifard et al., 2000). The network approach, which is perhaps the concept most relevant to this chapter, is less concerned with linking through the levels,

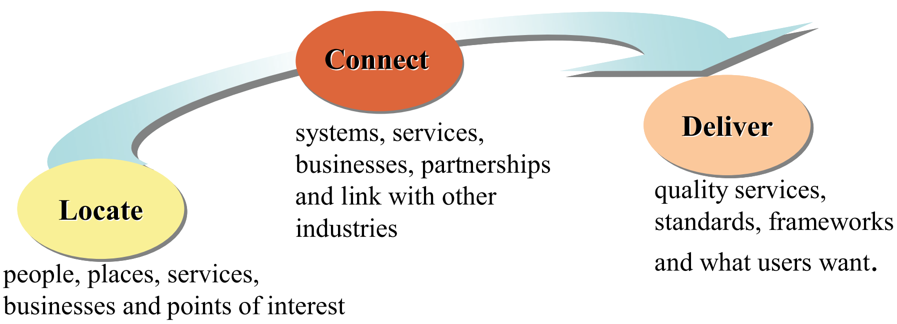

Figure 4.9: *A network to locate, connect and deliver spatial information and services.*

and more concerned with linking across different organisations (see Vandenbroucke et al., 2009; Crompvoets et al., 2010). More recently, with the increasing role of private industry in providing spatial information, the SDI has taken on the dimension of a market place, facilitating transactions in spatial information in all sectors of industry and society (for example, see ANZLIC, 2011).

However, the role that SDI initiatives are playing within society is now changing. Users now require the ability to gain access to precise spatial information and services in real time about real world objects, in order to support more effective cross-jurisdictional and inter-agency decision, making it a priority in areas such as emergency management, disaster relief, natural resource management and water rights. The ability to gain access to information and services has moved well beyond the domain of single organisations, and SDIs now require an enabling platform to support the networking of services across participating organisations.

This has led to an evolution of the concept of an SDI, where it is now increasingly viewed as an enabling platform linking data producers, providers and value adders to data users based on a common goal of data sharing (see Figure 4.10) (Rajabifard et al., 2006). Therefore, SDIs as a platform have come to be regarded as an integrated, multi-level hierarchy of interconnected SDIs based on partnerships at corporate, local, state/provincial, national, multi-national (regional) and global levels. This enables users to save resources, time and effort when seeking to acquire new datasets by avoiding duplication of expenses associated with the generation and maintenance of data and their integration with other datasets, and can lead to the creation of new services.

The development of an SDI as an enabling platform for a country or a jurisdiction will assist in the realisation of a spatially enabled society by enhancing the capability of government, the private sector and the general community to engage in systems-based, integrated and holistic decision-making about the future of that jurisdiction. Such a platform would lower barriers to access and use of spatial data and services, to both government and the wider community within any jurisdiction, and particularly to the spatial information industry. This in turn would enable organisations to pursue their core business objectives with greater efficiency and effectiveness. In particular, industry would be able to reduce their costs, which would encourage investment in capacity for generating and delivering a wider range of spatial information products and services to a wider market, thereby helping to realize a spatially enabled society.

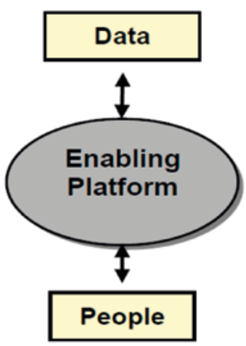

Figure 4.10: *SDI as an enabling platform connecting people to data.*

In order to develop a successful and functioning platform, a set of concepts and principles are required to ensure the design of such a platform facilitates interoperability and inter-working of functional entities within a heterogeneous environment. The following section outlines the key elements of an SDI.

Elements of an SDI

The aim of an SDI is to facilitate the ability of stakeholders to share, access and discover spatial information, and therefore, needs to evolve with its users. As an enabling platform, it also needs to constantly evolve in line with the development of available network technologies. With this in mind, at the heart of the SDI lies five core, but dynamic, components – people, access network, policy, standards and data (see Figure 4.11).

Social and technical components

SDIs are fundamentally about facilitation and coordination of the exchange and sharing of spatial data. However, much of the potential for the use of data and services lies in the ways by which knowledge may be shared. This depends heavily upon the culture of a society. All communities and societies have a culture – a system of shared meaning (Langdon and Marshall, 1998). Similarly, any initiative or function, including the sharing of information, also has a specific culture which needs to be promoted to prepare the environment for developing/pursuing the specific activity. Whether that culture is weak or strong is important to both a coordinating agency and individual parties. Therefore, sharing knowledge and information requires a specific culture – a culture for sharing. The people component can therefore be viewed as the social aspect of an SDI, which includes an organisation's policies and remits, its financial and human resources as well as the culture of sharing.

The technical component can be viewed as the networking and delivery mechanisms such as access network, policies and standards, as well as spatial data itself. In developing SDI as an enabling platform, practitioners will typically find that much of the necessary technological foundation already exists; however, the successful development of an SDI is as much dependent on the institutional and cultural willingness to share outside of one's immediate work group, as on its technical components. This creates the need for jurisdictional governance and inter-agency collaborative arrangements to bring together both information and users to promote interoperability and to facilitate the realisation of an SDI as an enabling platform.

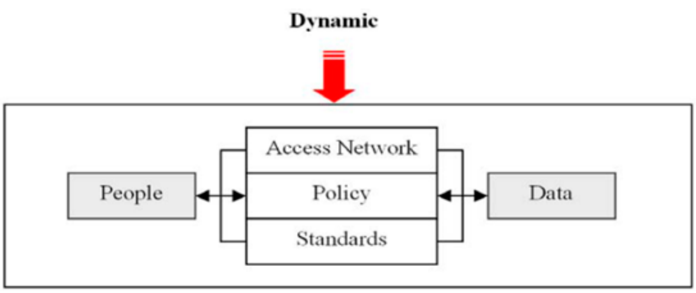

Figure 4.11: *Components of an SDI (Rajabifard, 2008).*

Interoperability

The social and technical components are necessary to ensure that those working at the appropriate (global, regional, national, local) scale are not impeded in meeting their objectives. This in turn supports decision-making at different scales for multiple purposes, and enables users to save both time and money in accessing and acquiring new datasets by avoiding duplication of expenses and effort associated with the generation and maintenance of spatial data. However, this is reliant on an SDI being interoperable with other systems and information. Interoperability can be described as the ability to transfer and use data and information in a uniform and efficient manner across multiple organizations and information systems.

The SDI shares reliance on interoperability with other information platforms. In this context, and in the context of data integration as part of an SDI platform, reflecting its social and technical components, there are various technical and non-technical issues such as legal, policy, institutional, and social factors that affect interoperability (see Figure 4.12). For example, technical interoperability is maintained by continued involvement in the development of standard communications, construction of data exchanges, modelling, and storage as well as access portals, as well as creating interoperable web services equipped with user-friendly interfaces.

The importance of interoperability cannot be understated: efforts to establish an SDI as an enabling platform will fail unless a coordinated approach is used to address all the issues and inconsistencies associated with multisource data integration as outlined by Williamson et al. (2010) (see Table 4.2).

SDI implementation

The steps to develop an SDI model vary depending on the background and needs of each country. It is therefore important that countries develop and follow a roadmap for implementing an SDI. Aspects identified in developing an SDI roadmap include the vision, the improvements required in terms of national capacity, the integration of different spatial datasets, the establishment of partnerships as well as the financial support for an SDI. A vision within the SDI initiative is essential for sectors involved within the project as well as for the general public. The SDI vision helps people to understand the government's objectives and to work towards achieving these objectives.

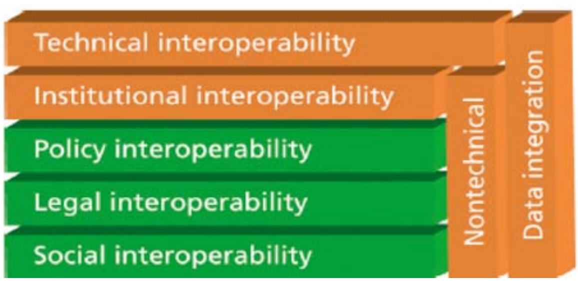

Figure 4.12: *Interoperability components (Mohammadi et al., 2010).*

TECHNICAL ISSUES	NONTECHNICAL ISSUES		
Institutional issues	Policy issues	Legal issues	Social issues
– Computational heterogeneity (standards and interoperability) – Maintenance of vertical topology – Semantic heterogeneity – Reference system and scale consistency – Data quality consistency – Existence and quality of metadata – Format consistency – Consistency in data models – Attribution heterogeneity – Utilization of consistent collaboration models – Funding model differences – Awareness of data integration	– Existence of supporting legislation – Consistency in policy drivers and priorities (sustainable development) – Pricing	– Definition of rights, restrictions, and responsibilities – Consistency in copyright and intellectual property rights approaches – Different data access and privacy policies	– Cultural issues – Weakness of capacity-building activities – Different backgrounds of stakeholders

Table 4.2: *Integration issues that need to be resolved for SDI to function as an enabling platform.*

In support of this vision, there will be a need to identify those components that support an environment where information that is generated and held by governments and systems delivering services will be valued, worked and managed as part of national strategic assets. There is also a need to develop a framework to provide the principles that underpin sound information management and establish the concepts, practices and tools that will drive the successful sharing of information and services across organisational, jurisdictional and national boundaries.

Essentially, an SDI is about facilitation and coordination of the exchange and sharing of spatial data and services. It is often described as the underlying network infrastructure – policies, standards and access networks that allows data to be shared between and within organisations, states or countries. The success of these systems depends on collaboration between all parties and their design to support efficient access, retrieval and delivery of spatial information. It is therefore essential that SDI practitioners understand the significance of human and community issues as much as technical issues, as these determine and contribute to the success of SDI initiatives. SDIs therefore, cannot be regarded primarily as just a technical matter: developing a successful SDI initiative depends at least as much upon issues such as political support within the community, clarifying the business objectives which the SDI is expected to achieve, sustaining a culture of sharing, maintaining reliable financial support and enlisting the cooperation of all members of the community, as upon technical issues relating to spatial data access, networking, and standards. Therefore, developing a successful SDI within a jurisdictional level must be seen as a socio-technical, rather than a purely technical, exercise; the communities concerned are expecting to reap benefits from their investment in SDI in terms of improved corporate performances and cooperation.

Looking to the future

The role that SDI initiatives are playing within society has changed from being organisation-based to becoming an enabling platform for SDIs of different scales and hierarchies. This reflects a growing trend that is demanding access to timely and precise spatial information in real time about real world objects to support more effective cross-jurisdictional and inter-agency decision-making in priority areas such as emergency management, disaster relief and natural resource management, and in meeting sustainable development objectives which are complex and involve temporal processes with multiple stakeholders. As such, SDIs have become a key infrastructure in realising a spatially enabled society.

However, the realisation of spatial enablement is still being impacted by the existence and perpetuation of data silos both within, and between, organisations. This makes the discovery, access, use and sharing of spatial data and services still a significant challenge. More recently, the convergence of many economic, social and environmental drivers with location has provided spatial enablement with an increasingly prominent profile both on local and global stages. In light of the emerging importance of location as the fourth driver in decision-making, alongside the role of the cadastre and land administration in spatial enablement, there is also a continued need for good land governance to facilitate spatially enabled governments, so as to build capacity for addressing the global agenda as well contributing to the primacy of spatially enabled governments in achieving sustainable development and a spatially enabled society.

Conclusion

We are living in an increasingly complex and rapidly changing world. Our relationships with our physical world and the ways we use our social networks are changing as we deploy technology to create new ways of interacting with and understanding each other. Spatial information and technologies assist this transformation because they allow us to understand relationships according to place. These new tools facilitate the realisation of a spatially enabled society, where location, place and other spatial information are ubiquitously available to governments, citizens and businesses as a means of organising their activities and information transparently.

With this in mind, SDIs have emerged as both a fundamental network infrastructure, as well as an enabling platform to help achieve the vision of a spatially enabled society as it aims to connect people to data to facilitate decision-making. An SDI comprises both social and technical components and as such, the successful development and implementation of an SDI depends on practitioners understanding the significance of human and community issues, as much as technical issues, that impact on the exchange and sharing of spatial data and services; that is, its interoperability with other systems and information. A failure to support both social and technical interoperability will inevitably lead to the creation and perpetuation of data silos, impeding the discovery, access, use and sharing of spatial data and services and ultimately, spatial enablement.

More recently, the trend towards a convergence of economic, social and environmental drivers with location has led to the emerging realisation of the importance of location as the fourth driver in decision-making. SDIs will play an important role in providing location-based information and services, and when connected with the cadastre and land administration activities, as well as good land governance, can be a powerful tool for building capacity for addressing the global agenda, achieving sustainable development goals and realising the vision of a spatially enabled society.

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4.5 Land Ownership Information

Paul van der Molen

What is 'land ownership' data, and why is it part of a spatially enabled society?

Although a precise definition of "Spatially Enabled Society" (SES) is still developing (Williamson et al., 2011), the existing body of literature indicates its crux is that governments, the private sector and citizens can better function when data related to location is a common good for everyone (Wallace et al., 2006; Williamson et al., 2010a; Williamson et al., 2010b; Williamson et al., 2011).

In general, we talk about a huge amount of data. Although not exactly proven, it is estimated that 80% of all government data is related to location (Lawrence, 2002; Probert et al., 2009; Steudler and Rajabifard, 2010; Tonchovska and Adlington, 2011). However, location or 'place' is not an easy concept and by consequence many attempts to embed 'place' into location-based technologies and spatial data infrastructures have failed, resulting in consumer frustration with for example web mapping tools and car navigation systems (Winter et al., 2010).

Looking at the overall goal of spatial enablement – enhancing the capability of governments, businesses and citizens in decision-making about their society's future with regard to sustainable development and Millennium Development Goals – the rationale for understanding, what data should be 'common good' for all is found in the decisions that will determine that future. There is ample evidence that a substantial amount of such decisions have to do with how a society manages its land and water resources, or broader: its physical environment (e.g. GTZ, 1998; Deininger, 2003; EU, 2004; CLEP & UNDP, 2008; Habitat, 2008; FAO, 2010; Williamson et al., 2010b).

Also, when we look at the functions a government has to deliver and at the related interactions between government, businesses and citizens, this becomes clear. First, governments safeguard institutions such as laws and regulations regarding human rights and social equity, property rights and socially desirable land use, economic development and market interventions. Second, governments set policies, for example to achieve sustainable housing and agriculture, poverty reduction, generation of revenues, protection of the environment, transparent markets, and sustainable use of energy. Third, the operational instruments to implement those policies, thus operational rules for access to land and land related benefits, access to land by vulnerable groups and women, protection of ownership and possession of land, for land and credit markets, managing land use, land taxation, and management of state and public land.

To deliver these services, businesses and citizens are faced with many bodies of government. The subsidiarity principle (originally a central principle of EU policy making by the Treaty of Maastricht in 1992, it has meanwhile been adopted by the global community as a general principle) saying that political decisions must always be taken at the lowest possible administrative and political level, and as close to the citizens as possible, leads to a division of roles between local, district provincial, national and federal government bodies. Consequently, in the domain of land management, a prominent role is assigned to local governments, irrespective whether mandates are assigned to state or customary administrations.

Here we find the justification that – for a 'spatially enabled society' – land ownership data comes on the screen.

This has something to do with the concept of 'public goods', formulated by Samuelson (1954) in his article *The pure theory of public expenditure*, in which he argues that some goods in contrast with private goods are to be available for everyone (non-excludability) and without competition (non-rivalry). This concept is later developed into the theory of public goods. As private persons cannot be hold responsible for providing public goods – although they sometimes do, however often on a voluntary basis – it is the State that should guarantee public goods.

The above mentioned government functions reflect this: the government has to safeguard these functions in those instances where it normally does not have the power to dispose over land in private hands. An excellent example is the goal of a society to achieve socially desirable land use through land use planning and control. Regarding land use planning (and related to that, the power of the government to 'take' private land) the public goods theory justifies the intervention of the government in private property rights. It is a political matter however, to what extent the government is allowed to interfere, and with what means. There is for example a discussion whether a municipality can use lease-conditions (private law) to achieve public goals, instead of applying public law. It should be noted that 'general interest' is not always synonymous with the interest of the municipality or the central government. The many court cases against government interventions (e.g. in the case of expropriation and zoning) provide evidence for that (see Kelo vs. Connecticut USA, 2005). It is clear that these government interventions should be legitimate supported by the law (see Figure 4.13).

The interventions of the government often take the form of restrictions based on public law. Within the law, private law rules the relation between natural and legal persons, public law rule the relationship between State and citizen. The nature of these public law measures is often prohibitive: a zoning regulation prohibits certain uses; it does not force the landholder to realize the allowed land use. If the government wishes landholders to do something (a 'positive' act), it has to encourage them with a subsidy, or – if the landholder still refuses – buy the property to realize the land use by itself. The number of restrictions imposed by the government is often impressive (Bennett, 2007).

In sum, in many interactions between government, businesses and citizens, data about land ownership is of a dominant presence. This is in line with Steudler and Rajabifard (2010), who say that a prerequisite to achieve spatial enablement is the modelling of the real world: a crucial element in dealing with global problems is the spatial information regarding landownership, as a cadastre is crucial for establishing the link of people to land.

Figure 4.13: *Private property is to be respected, although the Government as guardian of the public interest has the right to intervene.*

Examples of interactions between government, businesses and citizens in the domain of landownership concern land tenure and land tenure security, and market, mortgage market, land taxation, urban and rural land use planning, managing and upgrading informal settlements, management of state owned land, resolution of land conflicts, large scale investments in agriculture, land "grabbing", adaptation to and mitigation of climate change, gender equity when assessing land ownership, protection of indigenous land rights, land ownership and land use in disaster prone areas (for the latter see Mitchell, 2010).

Because the history and culture of countries is different, it is necessary to define how we should understand 'land ownership' data. Referring to the definition of land administration by the UN (1996), which is "the processes of determining, recording and disseminating information about the ownership, value and use of land when implementing land management policies", it encompasses information about ownership, value and use of land. Broadening this to a global relevance, 'ownership' includes any relationship between people and land whether statutory or non-statutory (customary, social, informal), 'value' includes value for any purpose (market, taxation, credit, expropriation, carbon credit etc) and 'use' might include use for any purpose (land cover, given land use). Defining "ownership, value and use of land" in this broad sense, we seek assurance that this FIG report encompasses all countries in the world. This broadening also sheds light on the use of the word 'cadastre' as being "central to the concept of spatial enablement" (Williamson and Wallace, 2006; Williamson et al., 2010a). This might be true when 'cadastres' are available in a country, other countries might also derive 'landownership' information from other sources, such as social tenure information systems, other land information systems, in sum any collection of relevant data that can be useful (see also Uitermark et al., 2010).

How to connect 'land ownership data' with the concept of spatially enabled society

The tool to connect land ownership information to the concept of spatially enabled society is the spatial data infrastructure (SDI). This is backed by much literature: (UNRCC-AP, 2009a and 2009b; Wallace et al., 2010; Williamson et al., 2010a; Williamson et al., 2011; Tonchovska and Adlington, 2011; Bennett et al., 2012).

The process of land administration, as defined by UN (1996), results in land administration systems, in whatever form: datasets may vary from a manual register of cards to a very modern database. The body of literature reveals that spatial enablement through SDIs is a matter of creating a digital environment of spatial data and capitalizing on investments in land information within the land administration and related systems (Williamson et al., 2010a).

In line with what stated above, land administration systems are more than 'cadastres'. Although land surveyors easily speak of the central role in SDIs of 'cadastres' or of 'digital cadastral databases' (Williamson and Wallace, 2006), or the "central role of cadastres to the concept of spatial enablement" (Williamson et al., 2010a), the 'how' question still remains. The FIG adopted the standardized "Land Administration Domain Model" as an extensible basis for establishing cadastres, which facilitates them to be the cornerstone of SDIs (van Oosterom et al., 2009; Uitermark et al., 2010; Wallace et al., 2010; Bennett et al., 2012). The advantage is that all types of tenure relationships and spatial objects can be accommodated, which excludes no country to create a spatially enabled society.

Land ownership is connected with 'place', as it concerns ownership, value and use of a defined lot of land. This lot of land can have various spatial dimensions, from a single point value (for example the centroïd of the specific lot) to an accurate representation of the whole lot (through a land survey of its boundaries). Whatever spatial representation is chosen in a country, the average and normal case is representation of the whole lot through the 'cadastral parcel', although the concept of 'parcel' in Cadastre 2014 is broadened by 'cadastral object', extending private law parcels to private and public law 'objects', in response to the increasing number of land rights, which are based on public law (such as restrictions, zoning areas, natural resource areas) because of increasing government interventions in private law rights.

As the nature of cadastral parcels is that they are uniquely defined, making them suitable to serve as the place or location data element in an SDI independent from the technical advance of the spatial reference (from the single point to accurate boundaries).

An example at European level is the implementation of the EU Directive 2007/2/EC establishing an infrastructure for spatial information in the European Community called Inspire (Tonchovska and Adlington, 2011). The cadastral parcel finds itself defined as a core element of Inspire, for which the specifications were developed by a technical working group of the distinguished national organisations responsible for cadastre and land registration grouped in EuroGeographics and the Permanent Committee on the Cadastre PCC (Martin-Varés and Salzmann, 2009). The data specifications are now assigned as official guideline (Inspire document D2.8.1.6).

An example at national level is the role and status of land ownership data as a base register. Implementing an SDI quickly brings the issue of specifications of data sets on the screen: what do they represent, how accurate are they, can they be trusted? In many countries, such as Finland, USA, UK, Lithuania, Germany, and the Netherlands, we observe that governments develop so-called base registers (van der Molen, 2005). In the Netherlands, as an example, after an in-depth government investigation in 2000, it became evident that the underperformance of the government had much to do with how it organized its information infrastructure: non-interoperable data, unknown quality data, conflicting data, inaccessible data, multiple collection of data, non-sharing of data, etc. The proposed solution was the identification or creations of single authentic registers in key administrative areas, which all government and non-government sectors should use. At the core of the system of authentic registers are six key authentic registers: census database, legal entities (businesses), addresses, buildings, cadastral parcels, and registers, topography 1:10,000 (van der Molen, 2005; van der Molen and Wubbe, 2007): an exemplary real life illustration of the use of 'land ownership data' as a core of spatial enablement (compare Figure 4.14).

How can land surveyors contribute?

For countries, which already maintain a country-wide cadastre, it is easier to establish SDIs that include land ownership information than those other countries without a country-wide cadastre. However, land surveyors in those fortunate positions should look beyond their traditional scope. The inclusion of land ownership information requires a comprehensive overview of how government information is organized and a broad understanding of the technical requirements to realize SDIs. Political sensitivity is a must: governments should be persuaded that investment in base-registers, in the development of legal frameworks for single collection, storage and multiple use

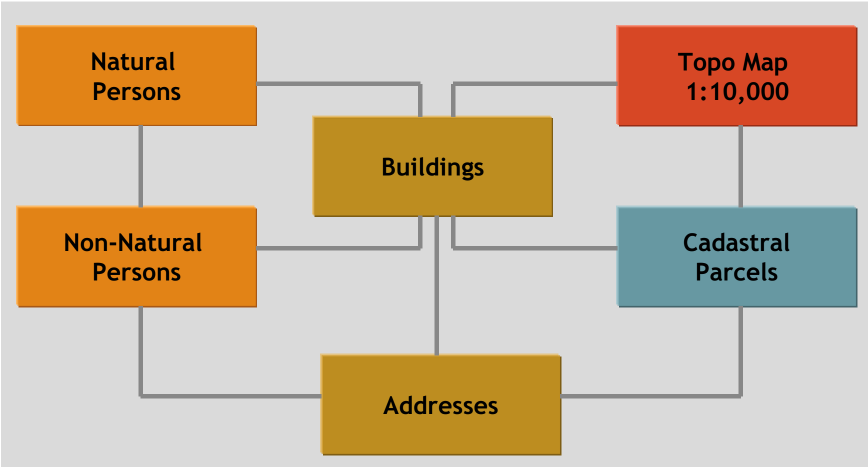

Figure 4.14: *The six key authentic registers in the Netherlands.*

of data, in the application of technology of interoperability, standards, quality indicators, access portals, shall create a desirable return in favour of the performance to the government, at all levels. The arguments for government decisions should come from land surveyors; otherwise other professionals will render land surveyors as irrelevant. Land surveyors in countries, which do not yet have country wide cadastres, should create viable solutions, such as establishing land information systems based on satellite imagery with lower accurate cadastral boundary identification (even single point georeferences), and must try to convince the government in dedicating funds for later upgrading. Adoption of the concept of general boundaries is an option. In sum, land surveyors should take the lead in creating spatial enablement through delivery of solutions, rather than creating problems or erecting obstacles.

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4.6 Data and Information

Robin McLaren

The location revolution

Until recently our interest in geography and locations was probably limited to paper maps. This has changed dramatically as electronic versions of mapping pervade our TVs, games, local government websites and our smart phones. A new generation of Internet products, such as Google Earth and Bing Maps, for example, are stimulating a greater interest and use of geography in society. We are much more location aware and Location Based Services (LBS) are reshaping how we plan trips, meet friends and find good local restaurants. Web 2.0 social media has turned location-based and has moved social media from cyberspace to real place (Sui and Goodchild, 2011). Most location-based social media allow users to know and see on a map where their friends are physically located at a particular time, primarily based on GNSS-enabled mobile phones.

The global market for LBS is projected to reach over US$21 billion in annual revenue by 2015, registering around 1.24 billion subscribers (PRWeb, 2012). The market is being driven by the proliferation of GNSS-enabled smart phones, growing popularity of mobile commerce, and increasing usage of location based social network services, location based shopping applications, location enabled search, and location based mobile advertising. Additionally, increasing demand for personal navigation and LBS that provide users with Points of Interest (POI) information augurs well for the future of this market and the associated geospatial data market.

This location revolution in our personal lives is being mirrored in our professional lives. Geospatial information is increasingly being used to ensure emergency services arrive at incidents in time, to support the formulation of policies to mitigate the impact of climate change, to ensure that services are better targeted to citizens needs and to empower citizens and communities to manage their localities more effectively.

The delivery of the benefits associated with this location revolution is dependent on the availability of geospatial data that is readily accessible for re-use, has minimal restrictions, is affordable, has an appropriate quality and can be easily integrated and linked into collaborative environments using standards from the Open Geospatial Consortium (OGC) and the International Organisation of Standardisation (ISO) and techniques such as linked data (http://linkeddata.org) – used for exposing, sharing, and connecting pieces of data, information and knowledge on the semantic web. A recent McKinsey report (McKinsey, 2011) estimates that in 2020 the worldwide personal geospatial data market will generate over US$100B in revenues for the service providers and generate US$700B of value to end users by 2020; data is the new currency.

Sources of geospatial data to support the location revolution

Public sector response

Many governments are responding to this geospatial data demand by formulating National Spatial Data Infrastructure (NSDI) strategies and implementing policies that produce geospatial data that are (Place Matters, 2009):

- fit for purpose;
- collected once to universally accepted standards;
- appropriately maintained and used many times by the public and private sectors and civil society;
- referenced to a definitive information framework supporting seamless combinations;
- better able to support cross organisational business processes;
- easy to discover, and with clear terms for use;
- simple to access and easy to share and integrate;
- understood sufficiently to maximize its application; and
- aligned with wider regional or global SDI requirements.

In Europe the adoption of NSDI strategies and policies has been broadened to include all member states of the European Union (EU). The EU INSPIRE Directive is currently being incrementally implemented and is about improving access to and the interoperability of location information across Europe to better inform environmental policy and the public, e.g. monitoring the effects of climate change across national boundaries

Improved access to public sector geospatial information is also being enhanced by the increasing adoption of Open Government policies across the world. The USA and the UK were the first and launched their open data initiatives in 2009. These Open Government initiatives normally have three main strands:

- **Open Data:** offering government data in a more useful format to enable citizens, the private sector and non-government organisations to leverage it in innovative and value-added ways (see Figure 4.15);
- **Open Information:** proactively releasing information, including information on government activities, e.g. civil servant salaries and budgets, to citizens on an ongoing basis to increase transparency; and
- **Open Dialogue:** giving citizens a stronger say in Government policies and priorities, and expanding engagement through Web 2.0 technologies. For example,

FixMyTransport (www.mysociety.org/fixmytransport) is a website that aims to use the power of the crowds using British public transport to notify operators of problems with rail, bus, tube and even ferry services. It provides citizens with tools to report their public transport problems to the correct operator or authority and to post them online so that other people can see where problems are. The site also aims to become a rallying point for people who have persistent problems by allowing them to create a campaign page. It offers a powerful toolbox to help them spread the word and lobby for change.

The key elements in working out which operators are responsible for each part of a journey has come via the UK government's open data project www.data.gov.uk, launched in January 2010. The data for FixMyTransport comes from the National Public Transport Data Repository (NPTDR) and National Public Transport Access Nodes (NaPTAN) data sets, released through the open data initiative, which provide route names, stops and operators. More than 400,000 bus, train, tube and tram stops are represented on individual pages.

The project is the latest brainchild of www.MySociety.org, a non-profit organisation which has tried to make UK public data and information more accessible to the wider public.

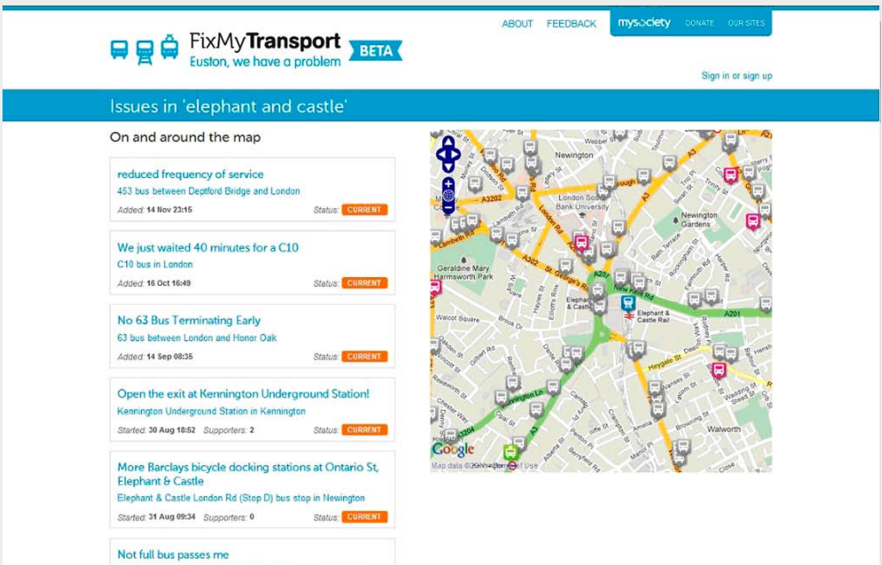

Figure 4.15: *Crowd-sourcing to solve travel problems (Arthur, 2011).*

"It's Your Parliament" (www.itsyourparliament.eu) gives citizens a unique overview of the votes cast in the European Parliament. Citizens can find and compare voting records of members of the European Parliament (MEPs) and political groups, make their own comments and cast their own "votes".

The opening up of governmental data, free for re-use, has been justified on economic grounds (Vickery, 2011; ACIL, 2008) since access to this data will have major benefits for citizens, businesses, and society and for the governments themselves. This public sector sourced data can include geospatial data, statistics, meteorological data, data from publicly funded research projects, and digitized books from libraries. Some of the benefits include:

– **New businesses can be built on the back of this data**: Data is an essential raw material and can be integrated into a wide range of new information products and services, which build on new possibilities to analyse and visualize data from different sources. Opportunities for re-use have multiplied in recent years as technological developments have spurred advances in data production as well as data analysis, processing and exploitation. Facilitating re-use of this raw data will create jobs and thus stimulate growth;

– **Greater Transparency**: Open data is a powerful instrument to increase transparency in public administration, improving the visibility of previously inaccessible information, informing citizens and business about policies, public spending and outcomes; and

– **Evidence-based policy making and administrative efficiency**: the availability of robust public data will lead to better evidence-based policy making at all levels of government, resulting in better public services.

Governments have so far tended to make free for reuse their medium to small scale geospatial datasets through Open Data initiatives. Their more valuable and costly to create and maintain Accurate, Authoritative and Assured (AAA) geospatial datasets (Williamson, 2011), such as cadastral boundaries, administrative boundaries, addresses and large scale topographic datasets, are still sold under license; restricting their wider use across the Spatially Enabled Society.

Private sector response

New technology, such as high resolution satellite imagery, LiDAR and passive crowd-sourced data from mobile phones, has significantly reduced the cost of capturing and maintaining geospatial data. A number of global reach companies involved with navigation and routing, e.g. Tele Atlas now owned by TomTom and Navteq now owned by Nokia, have created or locally sourced road information and points of interest. These data are used world-wide to support commercial and consumer navigation and logistical applications.

The global search engine companies of Google and Microsoft have significantly changed the geospatial data landscape over the past five years. Their business models, based on advertising revenues for example, have allowed them to provide free, on-line access to the global coverage of their geospatial data that includes satellite imagery, street view video and topographic map data. This is being driven by the needs of location based shopping applications, location enabled search, and location based mobile advertising.

These great digital powers, along with Apple, Facebook and Amazon, are now building Digital Civilisations, rather than a series of mere products, individual platforms or even ecosystems around a platform (Fogg, 2011). They are pursuing strategies that reach far beyond the confines of existing markets. They are causing widespread market collisions as they push industries to overlap, merge or cease to exist. They are outflanking and disrupting companies that follow less ambitious corporate strategies, including the geospatial data sector. These new Digital Civilisations use identity to tie numerous disparate products, many devices, multiple platforms and product portfolios together into their long term strategy. Each Digital Civilisation has hundreds of millions of active users – often with credit cards attached – far more than even the largest telecom operators or media companies; Amazon has over 121 million active buyers (November 2010), Apple has over 225 million accounts with credit cards attached (June 2011) and there are over 800 million active Facebook users (November 2011). These Digital Civilisations are increasingly using geospatial data and associated services to entice users to become and stay members.

The ESRI Community Maps Program (www.esri.com/software/arcgis/community-maps-program) is creating a world-wide mapping resource by publishing and hosting contributions from geospatial data providers interested in making their data content broadly available. Authoritative contributions are preferred as the program attempts to differentiate itself from the comparable Google and Microsoft web mapping resources.

We are also witnessing the emergence of new business models for geospatial data. For example the 'freemium' model understands that "attention" is the currency of data and entices users into initially using free information services, then migrating them to paid information services and value added services. A powerful example is the ESRI Community Maps Program.

The gaming industry is having a major influence on how we expect to use and view geospatial data. Increasingly users are expecting 3D and immersive virtual real worlds, for example Google Earth and C3 Technologies' approach for rendering photo-realistic 3D maps.

Citizen response

Traditionally governments have had their own formal channels for collecting public sector geospatial information through National Mapping and Cadastral Agencies, for example. Originally internal resources were used, but increasingly over the past 30 years the private sector has been involved in the collection and maintenance of data through outsourcing and partnership agreements. However, a dramatic shift in how geospatial data are sourced is unfolding through the direct involvement of citizens in crowd-sourcing. Its roots lie in the increasing convergence of three phenomena: the widespread use of Global Navigation Satellite Systems (GNSS) and image-based mapping technologies by professionals and expert amateurs; the emerging role of Web 2.0, which allows more user involvement and interaction; and the growth of social networking tools, practices, and culture. This crowd-sourcing approach is also known as "Citizen Cyberscience", "Volunteered Geographic Information" and "neogeography" (McLaren, 2011).

The highest profile mapping based crowd-sourcing initiative is OpenStreetMap (www.OpenStreetMap.org) which in 2004 spearheaded the democratisation of mapping. In August 2011 this world-wide initiative involved over 400,000 citizens and 2,480,072,760

GPS points had been uploaded in mapping covering most countries of the world (OSM, 2011). It is perfectly adequate for many applications and is completely free to reuse under the Open Database Licence (ODbL) and has certainly influenced both public and private sector data suppliers. For example, Google Map Maker now provides citizens in 188 jurisdictions with the ability to help populate and update Google Maps' graphical and attribute data (Google, 2011). The licensing regime and the 'fitness for purpose' have set an example to which many public sector suppliers now aspire.

State governments in Victoria, Australia and North-Rhine Westphalia, Germany use a 'private' crowd and employ volunteers to input to their mapping programs (Coleman et al., 2010). In the commercial domain, firms such as NAVTEQ and TomTom use web-based customer input to locate and qualify mapping errors and/or feature updates required in their road network databases.

Not all capture of crowd-sourced information is active. We are increasingly carrying devices that can sense and can be sensed. Ubiquitous sensing has entered the back pocket and handbag. In the case of mobile phones, a significant amount of information is captured passively (usually with the authority of the user). Mobile phones are progressively being spatially enabled through integration with GNSS technology, cell phone triangulation or Wi-Fi positioning. The location of mobile phones can therefore be regularly sampled to determine traffic flows (Cheng, 2008) and to measure signal strengths (www.OpenSignalStrength.org) to create coverage maps, for example. The mobile phone is generating a move to distributed citizen / participatory sensing and supporting Mobile (M)-government as an extension or supplement to e-government and providing information and services through mobile devices (Trimi and Sheng, 2008).

The phenomenal growth of social media, such as Facebook and Twitter, and the more recent development of location based social networking have raised awareness of location issues across society. Location based social media allows users to know where their friends are at any particular time and can see them on a map – for example the Foursquare (www.foursquare.com) social check-in site. These citizen sensors in social media are providing new sources of real-time and dynamic geospatial information that can be used in time-critical or real-time monitoring and decision-making. These will require new spatial analysis tools to understand human behaviour, societal transformations and environmental processes, for example (Sui and Goodchild, 2011).

As well as geospatial information supporting outdoor navigation, the integration of Inertial Measurement Units (IMUs) into future generations of mobile phones will provide geospatial data on the layout of buildings through passive crowd-sourcing to provide more effective support of indoor navigation.

Crowd-sourced data are people centric and have strengths in local knowledge, higher currency, a wider range of geospatial data, greater attribution and good vernacular. However, crowd-sourced data are not normally managed in a systematic manner with moderation and therefore tend to have inconsistent coverage with variable and unknown quality and authenticity. Despite these weaknesses, crowd-sourced geospatial data are being used in an increasing number of professional and social applications where AAA geospatial data are not required. It is delivering significant benefits to developing countries where up-to-date mapping is sparse.

The future of geospatial data

The increasing availability of free to re-use geospatial data from crowd-sourcing, the powerful private technology companies and public sector open data initiatives is putting pressure on National Mapping and Cadastral Agencies (NMCAs) to remain viable in delivering their authoritative geospatial data in challenging economic times. Many NMCAs are developing strategies to incorporate crowd-sourced data into their production processes. These proposed strategies range from: using open crowd-sourced data to just derive change intelligence; through using crowd-sourced data from more trusted targeted sources, e.g. professional map users such as mountain guides; to the NMCA acting as a moderator of semi-structured crowd-sourced inputs similar to the Wikipedia approach. Most NMCAs are cautious about this change as combining crowd-sourced with authoritative data is perceived to devalue the NMCA authoritative products and potentially increase their exposure to litigation.

The global technology companies have understood the power of location and just how effective the use of geospatial data is in generating significant revenues through location based shopping applications, location enabled search and location based mobile advertising. Where these companies cannot source existing geospatial data then they are creating their own sources with increasing levels of detail and quality. These data will be augmented by crowd-sourcing, increasingly sourced through location-based social media and passive crowd-sourcing. This will place further pressure on the survival of NMCAs who will retreat to the diminishing market for authoritative geospatial data.

Geospatial data used to be definitive and expensive and there were no alternatives. The fusion of sources of geospatial information from the public sector, commercial companies, the citizen as a 'prosumer' and the expanding sensors in the 'Internet of Things' is transforming the geospatial information landscape. Society now has access to an ever increasing rich set of geospatial information and associated location based information services that are embedded and pervasive in our professional and personal lifestyles. The delivery of these innovative location based services using the six billion mobile phones across the world will ensure that we have a fully inclusive spatially enabled global society.

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5 DISCUSSION

Daniel Steudler and Abbas Rajabifard

The previous chapters illustrate the challenges that our societies are confronted with on a global scale. They offer solutions and debate how land administration, land management, and land governance are critical in tackling those challenges. Data and information about land and water resources play a crucial role in this. Land administration systems provide the basis for conceptualising rights, restrictions and responsibilities, and form the operational component of land management. Strong frameworks are required by which land and natural resources can be effectively managed to fulfil political, economic and social objectives, that is, to help realize sustainable development objectives. Spatial enablement, and Spatially Enabled Societies (SES), are concepts which have evolved to reflect the trend in using land and spatial information to augment current information resources, to help achieve these objectives by linking information to location.

The Task Force has identified six key elements, without which a society cannot become spatially enabled. The contributions of the six authors in chapter 4 focused on those key elements and together, they provide a holistic view of what spatially enabled means and how it can be achieved. The take-away messages of these six contributions are:

- SES needs to be based on a **legal framework**, which takes a whole-of-government approach to spatial data and information, and which enables and supports the broad use of geoinformation;
- it is crucial for SES to have a **common data integration concept**, which ensures interoperability of data and information and which respects the institutional independence of the different actors;
- the concept of SES is built upon a set of several infrastructures: the development of those needs to be based on **business cases**, demonstrating their – mostly long-term – benefits and contributions to the overall goal of sustainable development;
- SES needs a **spatial data infrastructure** that provides the platform to make interoperability happen;
- SES needs complete **information about ownership** of land and water resources in order to guarantee their sustainable management and development;
- **crowd-sourced data** carry a high potential for impact, which public sector institutions need to learn how to deal with.

These issues may not be new, but collectively, they provide a sound basis for spatially enabling public and private data and information, or in other words to reach a maturity level to "manage data spatially".

The development of a society towards spatial enablement can be thought of as a continuum over several steps, which may happen for each key element at different speed. When a society has attained full spatial enablement, decision-making procedures may become feasible, which were not possible before. The following two examples illustrate what this might be (compare Figures 5.1 and 5.2).

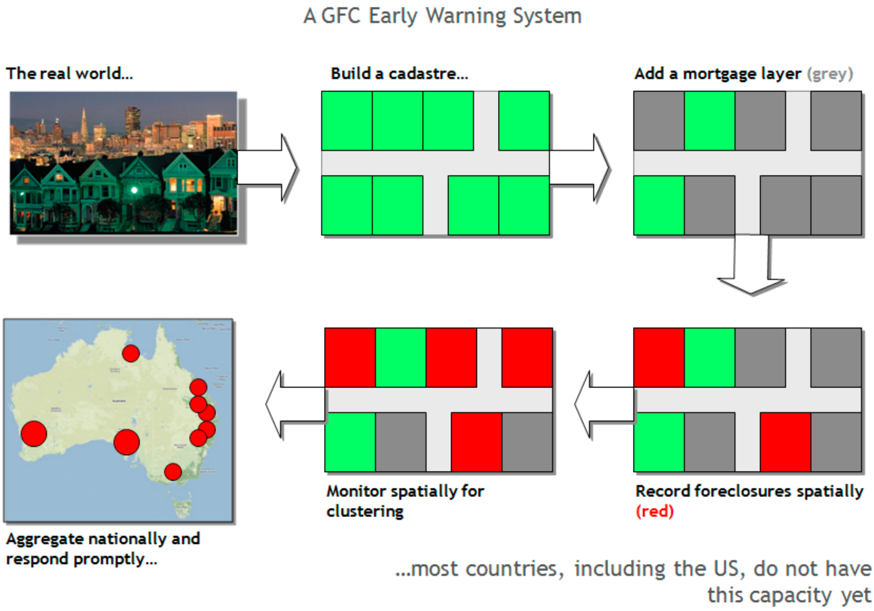

Figure 5.1: *Spatial enablement in action (from Bennett et al., 2012).*

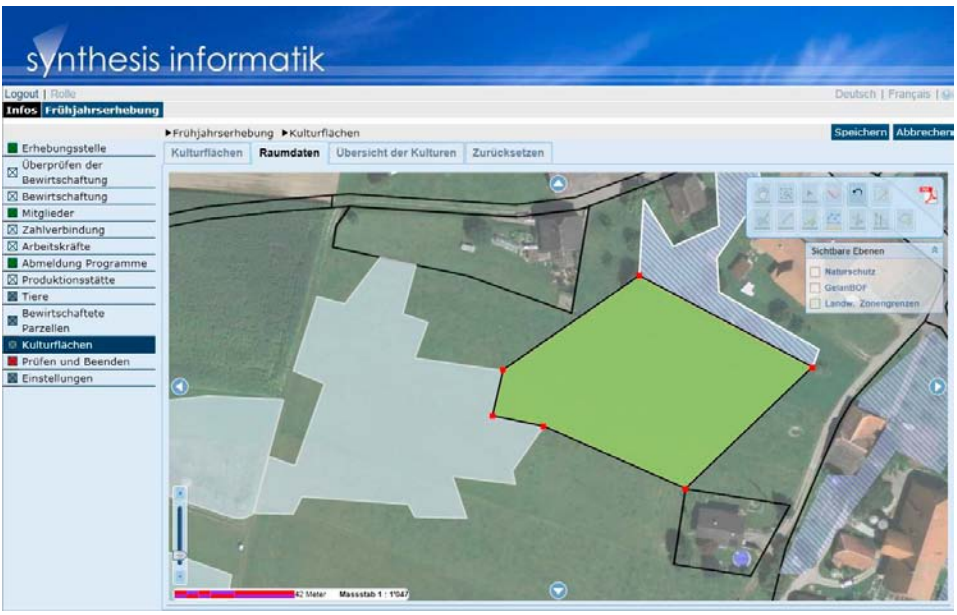

Figure 5.2: *Prototype of web-based tool for farmers indicating their cultivation areas for annual subsidies. © Synthesis Informatik, Gümligen, Switzerland, www.syn.ch.*

A first example is taken from Bennett et al. (2010), where the cadastral landownership layer is complemented with mortgage and foreclosure information. Such information can then be aggregated at a state or national level, which allows detecting patterns or clustering phenomena. The spatial representation of such phenomena can serve important political decision-making processes (see Figure 5.1).

Another example is a project in Switzerland, where a web-based portal is being developed for farmers to declare their annual cultivation areas online. Farmers are receiving subsidies on the basis of the crops and areas that they are cultivating. Based on the cadastral landownership and an orthophoto layer, the portal offers tools such as easy-to-use snapping functions and standard forms to be filled out (see Figure 5.2). This will allow a much more direct and efficient notification process for farmers to provide their data and receive their subsidies. Such a solution would not be possible without a complete documentation of landownership and the interoperability of the information, both of which are in place in Switzerland.

With the technological developments and the web-based possibilities, there will be more such examples and better solutions coming up. These solutions can be pushed by the public sector or in cooperation with the private sector. What is crucial is that the six key elements for a SES are in place and operational. Without them, a society will struggle in its spatial enablement.

References

Bennett, R., Rajabifard, A., and Williamson, I.P. (2012). On recognizing land administration as infrastructure for the public good. Journal of Land Use Policy (accepted in February 2012-In Press).

6 CONCLUSION AND FUTURE DIRECTIONS

Abbas Rajabifard and Daniel Steudler

Summary

The objective of this publication is to provide professional surveyors including land and spatial information professionals and the wider society with an overview of the definition, concepts and elements pertaining to the notion of a Spatially Enabled Society (SES).

Spatial enablement is a concept that adds location to existing information, thereby unlocking the wealth of existing knowledge about land and water, its legal and economical situation, its resources, potential use and hazards. Societies and their governments need to become spatially enabled in order to have the right tools and information at hand to take the right decisions. SES – including its government – is one that makes use and benefits from a wide array of spatial data, information, and services as a means to organize its land and water related activities.

With the myriad challenges facing society today at multiple scales, location has emerged as a key facilitator in decision-making, so much so that it is now commonly regarded as the fourth driver in the decision-making process, complementing the more traditional triple bottom line approach (social, economic and environmental drivers). Consequently, land-related information has a key role in spatial enablement where good land governance can facilitate the delivery of a spatially enabled government to respond to the global agenda and achieve sustainable development.

In parallel, recent technological developments, such as Web 2.0 and ubiquitous location based services, have made it easier for ordinary citizens and businesses to become spatially enabled, but just as importantly, these developments have provided them with tools to contribute to the flow of spatial information through all levels of society. Such inclusive participation is essential for achieving spatial enablement, as it should be regarded as a concept that permeates all levels of society – government, industry and citizens. SES, and its ability to flow through all levels of society, will depend primarily on the spatial data infrastructure (SDI) and land administration system available in the jurisdiction. Inherent to this, there are essentially six key elements required to help realize the vision of SES:

1. **legal framework**, which provides an important institutional structure to enable data sharing and access, but also to regulate relevant issues such as privacy and liability;
2. a sound **data integration concept** based on legal/institutional independence, common geodetic reference system and standardized modelling concept to ensure data integrity and the ability to harmonize data from multiple sources;
3. **positioning infrastructure** and its role in enabling new levels of spatial enablement by precise positioning through machine guidance;
4. **spatial data infrastructure** (SDI) to reduce duplication and resource waste by providing an enabling platform linking data producers, providers and value adders to data users based on a common goal of data sharing;

5. **land ownership information**, as it is the dominant issue in interactions between government, businesses and citizens, and the key to connecting such information to the concept of SES is the SDI; and
6. **data and information**: increasing availability of free to re-use geospatial data from different sectors of society and public sector open data initiatives is transforming the geospatial information landscape and will help ensure a fully inclusive SES.

In considering the six key elements, it is clear that land and spatial information professionals play a primary role in translating raw data into useable spatial knowledge resources. However, in addition, these professions should provide the link to ensure that both the social and technical systems in which spatial enablement will operate within are understood as spatial enablement can only be effective if it is designed with the specific needs of the jurisdiction in mind.

Future directions

The future of spatial enablement, and therefore the realisation of a spatially enabled society, lies in it being a holistic endeavour where spatial (and land data) and non-spatial data are integrated according to evolving standards and with the SDI providing the enabling platform.

The concept of SES is offering new opportunities for government and wider society in the use and development of spatial information, but it needs to move beyond the current tendency for the responsibility to achieve SES to lie solely with governments. SES will be more readily achieved by increasing involvement from the private sector, and in the same vein, if the surveying and spatial industries start to look toward other industries for best practices in service delivery.

Future activities need to take into account emerging trends in geospatial information and the new opportunities they present for the application of spatial technologies and geographic information. These trends include (but are not limited to):

- location as the fourth element of decision-making;
- differentiating between authoritative and volunteered (including crowd-sourced) information, yet recognising the importance and value of both types of information towards spatial enablement and the enrichment of societies;
- changing directions: simple to complex, autonomous to interdependent, spatial ubiquity;
- growing awareness for openness of data e.g. licensing, and resultant improvements in data quality;
- move towards service provision; and
- recognizing the difference between spatial enablement and spatial dependency.

In light of these trends, future activities will essentially need to be fit-for-purpose, ubiquitous, transparent and seamless to the user. Additionally, there is also a need to consider the developing challenges that are arising from having differing levels of maturity in use and management of geospatial information, and perhaps a need to increase the focus on critical areas that are proving to be challenging. These include:

- improving the appeal of spatial information to attract a broader audience;
- institutional processes to facilitate spatial enablement particularly around information policies, access, and risk management;
- capacity building e.g. research and education, bandwidth;
- standards and licensing as a means to enable and facilitate partnerships; and
- creating a seamless platform.

Even as we begin to think about what the future of SES may look like, at its heart, the realisation of SES will always be predicated on the key elements listed in this publication: legal framework, data integration abilities, positioning and network infrastructures, and the various data and information principles. These key elements need to be embraced by the established professional communities or face the threat of being taken over by those that better understand the messages of change. As surveyors, land and spatial information specialists, it is imperative that we understand the technological changes, developments and possibilities, so that we can convey these messages and requirements to our partners, to political decision-makers, and to society at large.

KL Declaration on Spatially Enabled Government and Society

The following "Declaration on Spatially Enabled Government and Society" is the result of an Expert Group Meeting and an International Symposium on Spatially Enabled Government and Society – "Towards Spatial Maturity" – held on 14–16 February 2012 in Kuala Lumpur, Malaysia. The events were organized by the Department of Survey and Mapping, Ministry of Natural Resources and Environment, Malaysia; kindly hosted by the Malaysian Government; and supported by the Permanent Committee on GIS Infrastructure for Asia & The Pacific (PCGIAP), the International Federation of Surveyors (FIG), the Global Spatial Data Infrastructure Association (GSDI), the International Cartographic Association (ICA), and the International Society for Photogrammetry and Remote Sensing (ISPRS). The resulting KL Declaration is in response to the aims of the UN Initiative on Global Geospatial Information Management (UN-GGIM).

Kuala Lumpur Declaration
on
Spatially Enabled Government & Society

We, the participants of the United Nations sponsored Permanent Committee on GIS Infrastructure for Asia and the Pacific International Symposium on Spatially Enabled Government and Society, with the theme "Towards Spatial Maturity" held at the Kuala Lumpur Convention Centre, Kuala Lumpur, Malaysia on February 15th and 16th, 2012, having met in the context of building trust to promote understanding and to enhance collaboration in the field of geospatial information and spatial enablement that addresses current national, regional and global challenges, hereby issue this **Kuala Lumpur Declaration on Spatially Enabled Government and Society.**

Recalling Resolution 16 at the 13th United Nations Regional Cartographic Conference for Asia and the Pacific in 1994 that established the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP),

Noting Resolution 1 at the 16th United Nations Regional Cartographic Conference for Asia and the Pacific in 2003 on the importance of spatial data infrastructures in supporting sustainable development at national, regional and global levels,

Further noting Resolution 5 at the 18th United Nations Regional Cartographic Conference for Asia and the Pacific in 2009 to understand, compare and determine the state of spatially enabled government and society including levels of maturity and governance of spatial data infrastructure in the region,

Bearing in mind that the rapid development and increased demand for spatial information infrastructures in all countries in past years has made geospatial information an invaluable tool in policy planning and evidence-based decision making,

Mindful that spatial enablement, that is, the ability to add location to almost all existing information, unlocks the wealth of existing knowledge about social, economic and environmental matters, and can play a vital role in understanding and addressing the many challenges that we face in an increasingly complex and interconnected world,

Acknowledging that spatial enablement, by definition, requires information to be collected, updated, analyzed, represented, and communicated, together with information on ownership and custodianship, in a consistent manner to underpin effective delivery systems, good governance, public safety and security towards the well being of societies, the environment and economy,

Recognizing that geospatial information includes 'fundamental data' that is essential and therefore must have authority, currency, resilience and sustainability, be comprehensive, freely available, accessible and usable for informed decision-making, which immediately leads to better policies and sustainable actions, and more open, accountable, responsive and efficient governments,

Agree that spatially enabled societies and governments, recognizing that all activities and events have a geographical and temporal context, make decisions and organize their affairs through the effective and efficient use of spatial data, information and services,

Resolve to fully support the initiative of the United Nations to implement global mechanisms to foster geospatial information management among the Member States, international organizations, and the private sector, and in this regard to make every effort to:

- enhance national efforts including investments towards the managing of all information spatially and the realizing of spatially enabled governments and societies with a focus on citizens and users;
- confirm the importance of governance and legislative frameworks and the need for legislative interoperability;
- confirm the importance of authoritative and assured data and information, encourage the incorporation of volunteered information, develop enabling platforms by locating, connecting and delivering information from different scales, purposes and origins;
- confirm the importance of common geodetic reference frameworks, positioning and network infrastructures;
- avail resources to invest, manage and sustain the capture, collection and collation of fundamental data and information and to reduce duplication in these efforts;
- build and use common standards and frameworks to ensure interoperability;
- enhance institutional arrangements and stakeholder collaborations; and
- improve returns on investment through better coordination, use and reuse of data, information and systems and to enhance innovation and productivity.

Kuala Lumpur
16th February 2012

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Daniel Steudler is a scientific associate with the Swiss Federal Office of Topography swisstopo, working for the Federal Directorate for Cadastral Surveying. He is active in FIG-Commission 7 for many years and is now chair of the FIG-Task Force on "Spatially Enabled Society". He published widely in the cadastral field and consulted internationally in land administration and cadastral issues.

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First of all, we would like to thank Prof. Stig Enemark, immediate past president of FIG, who initiated the idea of a Task Force around this topic. It was his enthusiasm about the high relevance of SES and the potential of professional surveyors’ contribution in current global agendas that triggered this project. This was in line with the dialogue between both presidents of FIG and GSDI Association for collaboration around SES and also the MOU that has been signed between both institutes. We also would like to

thank CheeHai Teo, the current FIG President, who has taken the issue of SES as one of the main topics in his FIG agenda, and carried over the Task Force into his presidency. He made possible a Symposium and Expert Group Meeting in Malaysia in February 2012 to foster the issue. While this publication may have originated with surveyors in mind, we acknowledge the equally important contributions of our colleagues in other spatial professions in addressing societal challenges and hope this booklet may be of interest to them as well.

For the actual work, we would especially like to thank Jürg Kaufmann, who gave the courage and much appreciated support in undertaking this task. He provided ideas, supplied the motivation for the task, and served as a patient sounding board. We also like to thank Serene Ho for her continued assistance in the preparation of this publication. We would also like to thank the different contributing authors – Jürg Kaufmann, Matt Higgins, Paul van der Molen, Robin McLaren, Serene Ho and Jude Wallace – for their very valuable contributions and insights into the six key elements.

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To all of these kind supporters, we give our most cordial thanks.

Dr. Daniel Steudler
Chair of FIG-Task Force on "Spatially Enabled Society"

Prof. Abbas Rajabifard
President GSDI

FIG-TASK FORCE ON "SPATIALLY ENABLED SOCIETY"

The Task Force was established by the General Assembly of FIG in May 2009 in Eilat and has met in Sydney in May 2010, in Melbourne in October 2011 and in Kuala Lumpur in February 2012. It included representations from the Global Spatial Data Infrastructure Association and Working Group 3 of the United Nations sponsored Permanent Committee on GIS Infrastructure for Asia and the Pacific, who were in person Abbas Rajabifard, Ian Williamson, Stig Enemark, CheeHai Teo, Greg Scott, and myself.

It was crucial that CheeHai TEO, the current FIG President, has taken the issue of SES as one of the main topics in his FIG agenda, and sustained the Task Force into his tenure. He worked with the United Nations sponsored Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) and the Department of Survey and Mapping Malaysia (JUPEM) and convened an Expert Group Meeting and an International Symposium in Malaysia in February 2012 to foster this issue. I would like to thank Prof Ian Williamson, the immediate past director of the Centre for SDI and Land Administration (CSDILA) at the University of Melbourne, Mr Greg Scott and Mr. Ahmad Fauzi Nordin of PCGIAP Working Group 3 for their insights, contribution and encouragement.

Dr. Daniel Steudler
Chair of FIG-Task Force on "Spatially Enabled Society"

FIG PUBLICATIONS

The FIG publications are divided into four categories. This should assist members and other users to identify the profile and purpose of the various publications.

FIG Policy Statements

FIG Policy Statements include political declarations and recommendations endorsed by the FIG General Assembly. They are prepared to explain FIG policies on important topics to politicians, government agencies and other decision makers, as well as surveyors and other professionals.

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FIG Guides are technical or managerial guidelines endorsed by the Council and recorded by the General Assembly. They are prepared to deal with topical professional issues and provide guidance for the surveying profession and relevant partners.

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FIG Reports are technical reports representing the outcomes from scientific meetings and Commission working groups. The reports are approved by the Council and include valuable information on specific topics of relevance to the profession, members and individual surveyors.

FIG Regulations

FIG Regulations include statutes, internal rules and work plans adopted by the FIG organisation.

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FIG PUBLICATION 58

This publication on "Spatially Enabled Society" is the culmination of a three-year effort by the FIG Task Force that was established by the General Assembly of the Federation in May 2009. The Task Force included representations from the Global Spatial Data Infrastructure Association and Working Group 3 of the United Nations sponsored Permanent Committee on GIS Infrastructure for Asia and the Pacific. This is a collaborative effort led by the FIG Task Force and the publication has been compiled and edited by Dr. Daniel Steudler, Chair of the FIG Task Force on Spatially Enabled Society, and Prof. Dr. Abbas Rajabifard, President of the GSDI Association.

The rapid development and increased demand for spatial information infrastructures in many jurisdictions these past many years have made spatial information an invaluable tool in policy formulation and evidence-based decision making.

Spatial enablement, that is, the ability to add location to almost all existing information, unlocks the wealth of existing knowledge about social, economic and environmental matters, play a vital role in understanding and addressing the many challenges that we face in an increasingly complex and interconnected world. Spatial enablement requires information to be collected, updated, analysed, represented, and communicated, together with information on land ownership and custodianship, in a consistent manner to underpin good governance of land and its natural resources, whole-of-government efficiency, public safety and security towards the well being of societies, the environment and economy.

The main issue societies have to focus on is probably less about spatial data, but much more about "managing all information spatially". This is a new paradigm that still has to be explored, deliberated and understood in the context of a spatially enabled society.

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