

The Potential of Citizen Volunteered Spatial Information for Building SDI

Kevin McDougall

University of Southern Queensland, Australian Centre for Sustainable Catchments, mcdougak@usq.edu.au

Abstract

The majority of spatial information and mapping has traditionally been captured, managed and controlled by public sector agencies. Over the past decade with the value and potential of spatial information slowly being realised, and the gradual down-sizing of government mapping agencies, the private sector has now become a significant holder of spatial information. However, the mechanisms for the value-adding of spatial information are generally limited to one-way data flows and the creation of new silos within the private sector. A range of institutional factors still limit the potential for sharing of spatial information across governments and the private sector, and hence, the development of spatial data infrastructures at local and sub-national scales.

An emerging trend in the wider information community is the growing use of open portals to collect and share information, both spatial and non-spatial. Shared information portals such as Facebook and Myspace, provide a mechanism for individuals to participate in information sharing and construction of social networks. This trend indicates an acceptance of people to engage in a discourse over the internet which effectively creates an environment for the sharing and distribution of information. Volunteered information, although only a relatively recent phenomena, is now being embraced by many industries including spatial information providers and distributors. The question is “how can governments and industry effectively harness this phenomenon to improve their sharing and maintenance of spatial information?” This paper examines the motivation for sharing data through social networks and the trends in sharing data across open portals. The issues associated with the utilisation of volunteered spatial information such as data quality, ownership and liability will be discussed. Finally, strategies for government and industry to harness citizen volunteered spatial information for building SDI are explored.

Keywords: volunteered spatial information, social networking, SDI

1. INTRODUCTION

During the past decade spatial information holdings in the public and private sectors have matured. It is now commonplace for spatial information portals to be present at national, state and local government levels. Many private sector organisations regularly utilise spatial databases and tools to interact with their customers using value added derivatives of the public spatial databases. There is also growing evidence that the spatial information industry has progressed from spatial data collection as its primary focus, to information integration, application development and the re-use of spatial information. A recent economic study of the SI industry in Australia found that spatial information and technology services have increased the nation's Gross Domestic Product (GDP) by between \$6-12 billion (ACIL Tasman 2007).

However, although spatial information held by both the public and private sector have matured, the potential wider economic and community benefits from this

information are being limited by complex institutional and policy arrangements. For example, although many government agencies have now developed policies for access and pricing of their spatial data, the implementation of these policies is often hindered by issues such as the need to protect existing revenue streams and the lack of resources to maintain or exchange of data. Spatial data infrastructures (SDI) have emerged as a response to declining government capacity and the need to better manage resources through improved co-ordination and reduced duplication. As the number of users of spatial information continues to increase, and as spatial information becomes more widely available, issues such as the currency and accuracy of spatial information data are now more widely being identified.

In recent years, the web and platforms such as Google Earth and Virtual Earth have motivated individuals from all walks of life to explore, utilise, and increasingly share spatially related data to friends and the wider community. Volunteered geographic or spatial information is part of a growing phenomenon which closely parallels the developments in online social networking.

This paper examines the motivation for sharing of information through social networks and the trends in contributing data through open portals. The issues associated with volunteered spatial information such as data quality, ownership and liability will be discussed. Finally, strategies for governments and industry to harness citizen volunteered spatial information for building SDI are explored.

2. SHARING OF SPATIAL INFORMATION

Sharing of spatial data is critical to the development of comprehensive and inclusive SDIs. Sharing of data is more often about people and organisations than the data itself. It seems quite wasteful that publicly funded organisations cannot readily co-operate to share resources or information (Onsrud & Rushton 1995). However, the reality is that it is easier for individual public sector agencies to work within their sphere of influence than outside of it. Historical bureaucratic structures carry with them a significant “organisational inertia” which is reinforced by departmental silo structures, traditional public service systems and an increasingly complex legislative framework that is difficult to change.

The reason to share spatial information was clearly summarised by the Mapping Sciences Committee of the National Research Council in 1993, namely:

“The principle of a spatial data sharing program is to increase the benefits to society arising from the availability of spatial data. The benefits will accrue through the reduction of duplication of effort in collecting and maintaining spatial data as well as through the increased use of this potentially valuable information. The exposure of these data to the wider community of users may also result in improvements in the quality of data. This will eventually benefit the donor and other users” (National Research Council 1993, p. 89)

The sentiments expressed by the Mapping Sciences Committee as they put forward a framework for building a national spatial data infrastructure reflect the true role of governments, namely a service for the common benefit of society. Onsrud & Rushton (1995) argue that the value and utility of geographic information comes from its use, and that the more that geographic information is used, the greater becomes society’s ability to evaluate and address the wide range of pressing problems to which the information may be applied. Another perspective is that the objective of spatial data sharing is to create “connections” among widely dispersed databases (Calkins & Weatherbe 1995). However, spatial data sharing is most commonly

advocated on the basis that there are tangible benefits through improved efficiencies (Azad & Wiggins 1995).

The role of government agencies, particularly those national mapping agencies, has changed dramatically in the past 10-15 years. Production and service based agencies have been downsized and their operations outsourced to private enterprise. The focus of governments is far more business orientated and budget driven in contrast to the traditional "public good and service" perspective. The reasons for sharing public information have remained the same, but it is the imperatives and business needs that have become the new focus. Development of data sharing cultures is important to successful implementation of geographic information technologies and advancement of GIS (Onsrud & Craglia 2003). There is no doubt that the lack of effective mechanism to exchange information among local, state and federal governments and the private sector remains a significant impediment to more effective and efficient use of GIS throughout society (Pinto & Onsrud 1995). The reality is that data sharing is easier to advocate than to practice (Azad & Wiggins 1995).

The value of information can increase when it is shared. Kelly (1995) identified that spatial information is increasingly valuable for making decisions and solving problems in private sector economic development, environmental management, emergency response and public health and safety. However, the author also notes that although the value of the application and sharing of spatial information is often self evident, better quantitative measures are required to measure the benefits and costs. Although GIS technology has been rapidly adopted by many organisations, the propensity to share this information or to make the information publicly available has been disappointing, particularly with respect to the coordination efforts at state government level (Warnecke et al. 2003).

3. VOLUNTEERED GEOGRAPHIC OR SPATIAL INFORMATION

In the past few years the information infrastructure (primarily facilitated through the internet), the growth publicly available spatially enabled applications (such as Google Earth) and accessible positioning technology (GPS) have combined to enable users from many differing and diverse backgrounds to share geographically referenced information. This information has been termed by Mike Goodchild and others as volunteered geographic information (VGI) (Goodchild 2007; Kuhn 2007). Volunteered geographic information is not new, but it has emerged gradually from efforts in areas such as participatory GIS (PGIS) where opinions and perspectives are canvassed through GIS portals either online or within constrained environments. However, the PGIS approaches differ from VGI in a number of respects.

Firstly, PGIS approaches have been traditionally established and controlled either by, or with, the assistance of someone with skills and knowledge in organising and presenting spatial information. This process invariably introduces pre-conceived perspectives, imposes technical limitations in presenting information and introduces individual biases. Although these consequences are unintended, they can undermine the value or independence of the contributed data. Ironically, PGIS approaches were a response to the conventional GIS methods which were found wanting in a number of dimensions including objectivity, value-neutrality, access, ownership and democratic representation.

Secondly, PGIS projects often have defined constraints on the responses which can be provided by participants which are limited either geographically or focused on particular issues of concern. PGIS samples may be further restricted by time or to a

particular group of participants. In essence, the information received through PGIS may be highly focussed and may not clearly fit the definition of volunteered information.

Volunteered information in the broader context has been facilitated by the ability of web platforms to accept and to organise information in a form that is accessible to others. It may be provided as a read only type access or be subject to update, change or modification such as we see in the Wiki environments. Most of this software functionality has emerged in the past 5-7yrs which is really quite a remarkable achievement.

The volunteering of the geographic dimension of information has been facilitated on two main fronts. Geographic portals such as Google Earth and others have brought geography and spatial information to the people. Digital imagery captured by an array of satellite sensors and presented through various geographic portals has enabled citizens to identify real world features and location with relative ease. The other primary source of geographic locations which are volunteered comes through the coordinates generated through the Global Positioning Systems (GPS) receivers which are now found in a range of electronic entertainment and communication devices.

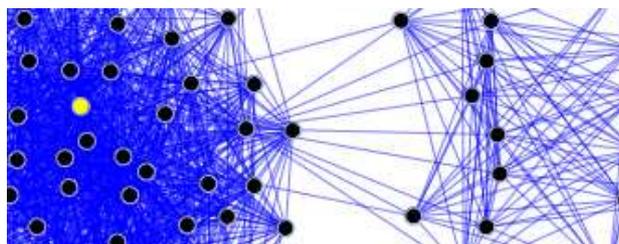
Personal navigation devices or PNDs have grown dramatically in the past few years as both the technology and the availability of street network data has matured. In Australia, total unit sales for in-car navigation sector are expected to grow to approximately two million units in 2009 as the PND moves from being a luxury car item to the mass market (Hearn 2007). Internationally the market for in-car navigation has seen an exponential growth, driven by sales of 20 million PNDs in 2007 in the USA and 30 million in Europe.

Volunteered geographic information represents a new and rapidly growing resource which has already illustrated a myriad of uses. Its near real-time capability has been utilised in the emergency and disaster management environments to broadcast the conditions and situation on the ground. In the absence of other rapid response mapping which invariably is delayed by days or even weeks, VGI may become critical. VGI is also proving to be valuable where traditional sources of fundamental spatial information does not exist or not publicly accessible.

4. SHARING INFORMATION THROUGH SOCIAL NETWORKS

A social network is a network of nodes formed through relationships that may have been established through friendship, ideas, values, hobbies or other linkage mechanisms. Social networking theory is the study of these networks and the mapping of these relationships as they may apply to wide range of human organisations, from small groups to entire nations (Ethier 2009). A primary reason for undertaking the study of social networks is that the understanding of the connections between individuals can be used to evaluate the social capital of the various individuals within the network. The greater the number of connections that a person has is generally indicative of the knowledge, power and influence of an individual.

Figure 1: Mapping a Social Network



The power of social networks is of considerable interest to researchers and organisations, particularly their power to influence group or public opinion. In Australia and all over the world, community advocacy groups such as Getup (<http://www.getup.org.au/>) are exerting political influence on governments through grass-roots support of their network of members. It has been shown that individuals will increase their interest to participate in public processes if they are connected with others with a higher level of influence (or motivation) (Boudourides 2002). Citizen participation in social networking forums such as Facebook, Myspace, Friendster and others has grown dramatically in the past few years with many having over 100 million listed members.

Social networking has been identified by a number of industries and organisations as a potential contributor to a range of areas including innovation, building staff networks, solving complex problems or extending the market reach of products. By its very nature, social networking involves a series of one to one or one to many connections that require the active participation of individuals. This process of active participation can consume large amounts of time for individuals and may not be the most productive way to achieve a particular task within an organisation. Most of these systems are standalone systems that are often outside of the normal business infrastructure which can prove to be problematic. Businesses would rather restrict their information to internal clients for a variety of reasons (security, confidentiality etc) and would prefer a system that was integrated within their existing business relationship management systems rather than outside of the business.

IBM launched an internal social networking site for employees in 2007 which was designed to blur the boundaries of work, home, professional, business and fun (DiMicco et al. 2008). The system, which was called Beehive, was hosted as an experimental platform for studying the adoption and usage of social networking in the workplace. Initial findings indicate that the value to employees include being able to promote ideas more effectively and to build their social capital within the organisation.

Social network analysis (SNA) is the analysis of relationships between actors in a social network and has some important implications for the sharing of information across a social network. Having power within a network may mean that an actor may potentially have better access to information, resources or social support (Mori et al. 2005). A number of measures have been defined to quantify and classify these relationships. Terms such as centrality, closeness, betweenness and degree have been developed to better describe these relationships (Freeman 1979). These measures can assist in defining where an actor sits within a network, where weak links exist or understanding the level of trust that may be associated with a particular actor. These measures may be used to determine if a user will share or diffuse their information or be willing to grant access to their information.

5. MODELS FOR SDI DEVELOPMENT TO HARNESS VGI

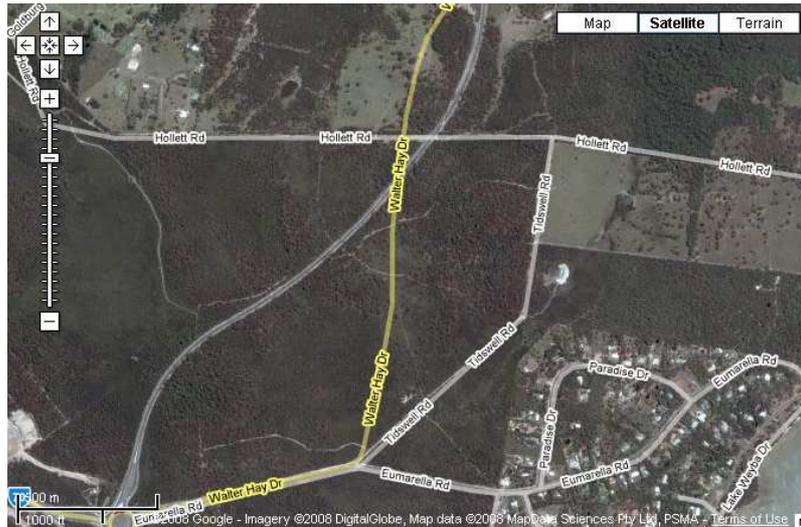
SDI has developed progressively from the early beginnings of land and geographic information systems into a coordinated approach to managing, collecting and distributing data. The first generation of SDIs were primarily driven by mapping agencies and their overwhelming need to coordinate the growing repositories of spatial data. These initiatives were largely product-based with the traditional focus on producing particular map products continuing into the digital age. With the greater maturity of these spatial data repositories, the focus began to shift from this product approach as leading nations in SDI development changed their strategies and updated their SDI conceptual models e.g. USA and Australia (Rajabifard et al. 2003). Approaches moved to be more “process focussed” and included people as an integral component of SDI and with a greater emphasis on the interoperability of data and resources. The concept of more independent organisational committees or partnerships representing different stakeholders is beginning to dominate SDI development. The next generation of SDI is emerging where users will play a vital role for information management (Budhathoki et al. 2008; Goodchild 2008; Rajabifard et al. 2006).

The SDI models that emerged from the mapping agencies of the 1980s continue to have a strong mapping focus are dominated by spatial science professionals such as surveyors, geographers and cartographers. Although automation and technology have advanced, the institutional thinking on control of information and the functions of the organisation are often lagging. However, many map production and service based agencies have been downsized and their operations outsourced to private enterprise. Governments are becoming far more business orientated and budget driven in contrast to their traditional “public good and service” perspective. Although the reasons for sharing public information have remained important, it is the imperatives and business needs that have become the new focus. Meanwhile the demand for spatial information and products continues to grow.

With increasing demands and declining resources, volunteered geographic information may present a potential opportunity for mapping agencies and the future development of SDI. Although VGI may not be readily suitable or appropriate for contributing to the fundamental data sets at the national level, opportunities exist for contributions at sub-national or local levels. The use of VGI for the update of street address and street networks would be an area where there could be immediate application.

In Australia, the custodian of street address data is local government. Street address data is shared and aggregated at both state and national levels. However, due to the complexity of institutional arrangements which exist, the timeliness and accuracy of the aggregated data sets which form the basis of private street data is often very limited. These problems become all too apparent to users of geographical data through portals such as Google Maps, MapQuest etc and vehicle navigation systems as numerous errors in the spatial representation or the description of streets are encountered (see Figure 2). NAVTEK, a private data provider for vehicle navigation data, encourages users of their product to report errors or omissions through a program called MapReporter. This data is then used to improve the quality of their map base and road network. Unfortunately, these improvements remain in the private domain and rarely returned to improve the SDI of the public sector.

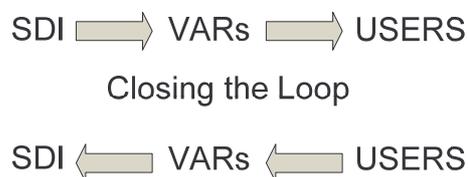
Figure 2. 2008 Satellite image and the digital road network data showing mismatch over an area near Noosa, Australia



Street address and the street network provide an obvious target for improvement by VGI for a number of reasons. Firstly, street address and road networks are common systems of location which are used regularly by citizens. As the system of addressing is well known and utilised the majority of citizens would have no difficulty in reporting corrections to the network. Personal navigation devices (PNDs) are now commonplace and provide accurate geographical positioning anywhere on earth in near real time. Additionally, many of these devices are either integrated or linked with mobile communication devices which allow direct reporting of any geographic corrections.

The simple objective volunteered street address information would be to improve the accuracy of existing data databases through progressive corrections and improvements. Most private data providers or value added resellers (VARs) enhance the fundamental data provided through mapping agencies so that it is suitable for various applications. This enhanced data is provided to the user through application packages such as those included with personal navigation systems. Closing the loop (figure 3) by returning the data via the user through the VAR would appear to be the most logical model for receiving volunteered information such as street address and street network data.

Figure 3: Closing the SDI Loop



The technology to accept VGI is already well established through various portals, however such a model would require the two way exchange of data between users, VARs and mapping agencies.

6. DISCUSSION

The simplistic model described above requires further elaboration on its operation and the challenges that need to be addressed in order to realise the potential of the

volunteered geographic information. There are a range of both technical and institutional issues including the motivation for volunteering information, assessing the quality of volunteered information, privacy, liability, information rights and suitability of the information to various levels of SDI.

Perhaps the first question to ask is “why would individuals volunteer their time and resources to contribute to improving the street networks and address systems?” There is no one answer, but technology and its novelty for some individuals will provide a degree of interest and motivation. Contributing to the improvement of a fundamental data set which is used widely for the benefit of the public and assisting the deployment of community resources such as emergency services may motivate some people. Studies from social network analysis indicate that the ability to build social capital through self-promotion can also motivate individuals. To some individuals, the process of identification of errors or additions can become a game and may verge on becoming an addiction. Financial reward systems can provide incentives, but for many individuals this would not appear to be a primary motivation.

Perhaps the most contentious issue associated with collecting and utilising VGI is the question of the quality of the data. VGI, unlike traditional mapping agency data, has been collected with the minimum of quality measures or standards. Without appropriate mechanisms to standardise and validate data, VGI may well become a liability rather than an asset. However, in reasonably well defined data environments, such as exists in the street address/network environment, data validation mechanisms could be established which may provide quality control.

The registration and identification of volunteers can provide a further level of quality control which may be used to analyse and map the contributions of volunteers. Through social network analysis, volunteers may be identified as being trusted and their contribution within the network could be elevated accordingly. The collaborative editing models such as those used by Wikimapia or Openstreetmap map could serve as an appropriate model with some constraints placed on data that is already known to be of a high quality and therefore considered to be fixed or non-editable.

The application of street address is perhaps best suited to the local or community level SDI. Local government agencies may therefore be the appropriate organisation to implement strategies to incorporate VGI within their corporate SDIs. Local governments also have a potential number of co-opted volunteers or employees that can contribute to the geographic data collection in a more consistent and co-ordinated fashion. For example, garbage collectors drive through neighbourhoods on a weekly basis as part of their work program. GPS and/or video cameras can be added to these vehicles to record the street networks and signage. Drivers can alert the appropriate division to errors or omissions in the data during their runs.

The issues of liability of organisations who utilise VGI is a real concern, but one that is not uncommon in many open data environments. Organisations often identify liability as a reason for why they cannot provide data openly to the public. These concerns can generally be overcome through clarification of the purpose and limitations on the data. Prior to users accessing the system these limitations are advised and accepted hence reducing the risk of misuse of the data. Additionally, if appropriate data validation and checking has been undertaken liability can be reduced dramatically.

The integration of VGI into SDIs will require considerable re-engineering of information flows and institutional arrangements. Partnership models already exist in

some countries where information flows are truly two-way and include business models which identify the contribution of each partner and the information they maintain or enhance. As SDI development continues to move towards greater user involvement, traditional institutional arrangements, particularly those within the public sector must change.

7. CONCLUSIONS

The development of spatial data infrastructures have progressed significantly in around the world. However, with the limited amount of resources available to governments and the increasing amount of spatial information being held within the private sector, new models for building and maintaining these valuable infrastructures need to be investigated. The traditional one way information flow of spatial data from governments and private sector agencies to users must now be reviewed to recognise the changing balance of public and private sector information.

History has shown that at times of resource shortages innovation and collaborations are more likely to occur and thus may provide solutions to better share limited resources and reduce duplication. Improved data exchange models which more appropriately recognise the need to disseminate data and also maintain the data are also a priority. Finally, volunteered geographic information should not be dismissed by mapping agencies as simply amateur musing, but offers significant potential at time when resources in the public sector are declining.

REFERENCES

- ACIL Tasman (2007). *Spatially Enabling Australia*, Australian Spatial Information Business Association, Canberra.
- Azad, B. and L.L. Wiggins. (1995). "Dynamics of inter-organizational data sharing: a conceptual framework for research" in HJ Onsrud and G Rushton (Eds). *Sharing geographic information*, Centre for Urban Policy Research, New Brunswick, NJ. pp. 22-43.
- Boudourides, M. (2002). "A review of network theories on the formation of public opinion." *Proceedings of EURICOM Colloquium*, Nijmegen, Netherlands, 9-11 October, 2002, pp.
- Budhathoki, N.R., B. Bruce and Z. Nedovic-Budic. (2008). Reconceptualizing the role of the user of spatial data infrastructure. *GeoJournal* 72 149-60.
- Calkins, H.W. and R. Weatherbe. (1995). "Taxonomy on spatial data sharing" in HJ Onsrud and G Rushton (Eds). *Sharing geographic information*, Centre for Urban Policy Research, New Brunswick, NJ. pp. 65-75.
- DiMicco, J., D. Millen, G. Werner and D. Casey. (2008). Research on the use of social software in the workplace. San Diego, California, 8-12 November 2008.
- Ethier, J. (2009). Current Research in Social Networking Theory. 20 January 2009, <<http://www.ccs.neu.edu/home/perrolle/archive/Ethier-SocialNetworks.html>>.
- Freeman, L. (1979). Centrality in social networks. *Social Networks* (1): 215-39.
- Goodchild, M.F. (2007). Citizens as sensors: the world of volunteered geography. *GeoJournal* (69): 211-21.
- Goodchild, M.F. (2008). Commentary: whither VGI? *GeoJournal* 72 239-44.
- Hearn, L. (2007). Navigating the future of GPS. *Sydney Morning Herald*. 28 September 2007.
- Kelly, K., T.A. Pardo, S.S. Dawes, A. DiCaterino and W. Foderingham (1995). *Sharing the Costs, Sharing the Benefits: The NYS GIS Cooperative Project*, Report, Center for Technology in Government, University at Albany, Albany, NY.

- Kuhn, W. (2007). Volunteered Geographic Information and GIScience. NCGIA, UC Santa Barbara, 13-14 December, 2007.
- Mori, J., T. Sugiyama and Y. Matsuo. (2005). Real-world orientated information sharing using social networks. ACM, Sanibel Island, Florida, 6-9 November 2005.
- National Research Council. (1993). *Toward a coordinated spatial data infrastructure for the nation*. National Academy Press, Washington DC.
- Onsrud, H.J. and G. Rushton. (1995). "Sharing geographic information: an introduction" in HJ Onsrud and G Rushton (Eds). *Sharing geographic information*, Centre for Urban Policy Research, New Brunswick, New Jersey. pp. xiii-xviii.
- Onsrud, H.J. and M. Craglia. (2003). Introduction to the special issues on access and participatory approaches in using geographic information. *URISA Journal* 15 (1): 5-7.
- Pinto, J.K. and H.J. Onsrud. (1995). "Sharing geographic information across organisational boundaries: a research framework" in HJ Onsrud and G Rushton (Eds). *Sharing geographic information*, Centre for Urban Policy Research, New Brunswick, New Jersey. pp. 45-64.
- Rajabifard, A., M.-E.F. Feeney, I. Williamson and I. Masser. (2003). "National SDI Initiatives" in I Williamson, A Rajabifard and M-EF Feeney (Eds). *Developing Spatial Data Infrastructures: From Concept to Reality*, Taylor & Francis, London, UK. pp. 94-110.
- Rajabifard, A., A. Binns, I. Masser and I. Williamson. (2006). The role of sub-national government and the private sector in future spatial data infrastructure. *International Journal of Geographical Information Science* 20 (7): 727-41.
- Warnecke, L., D. Decker, L. Pelch, S. Davis and J. Gilligan (2003). *Statewide Leadership and Coordination of Geographic Information and Related Technology in the 50 States - NSGIC State Summaries*, Report to National States Geographic Information Council.