E-Government/Technology Series

Using Geographic Information Systems to Increase Citizen Engagement

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IBM Center for
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FOREWORD

On behalf of the IBM Center for The Business of Government, we are pleased to present this report, "Using Geographic Information Systems to Increase Citizen Engagement," by Sukumar Ganapati.

Jonathan D. Breul

Professor Ganapati traces the evolution of the use of Geographic Information Systems (GIS) in government, with a focus on the use of GIS by local government. The first wave (desktop GIS) was largely geared to professional planners and was of limited use to citizens. The second wave (web GIS) saw the increased use by citizens of GIS on the Internet. The current third wave (Geospatial Web 2.0 platforms) has seen GIS become more interactive with Web 2.0 features and accessible through mobile phone and other handheld devices.

Curtis Clark

The third wave has seen a dramatic increase in the use of GIS by citizens, such as obtaining transit and crime information. Professor Ganapati presents several case examples of how GIS is now being used by local governments across the nation. The potential use of Internet-ready mobile phones, coupled with enhanced GIS capabilities, is seen clearly by the research firm Gartner's prediction that such devices will surpass the numbers of computers in the world by 2013.

Of special interest to Professor Ganapati is the potential use of GIS in reaching out to citizens to increase their participation in planning and decisionmaking. He concludes that, while progress has been slow in this area, there is great potential for government and other groups to use GIS to increase citizen participation.

This report continues the IBM Center's longtime interest in enhancing citizen participation in government decision-making. Recent reports exploring this important topic include "Leveraging Web 2.0 in Government" (by Ai-Mei Chang and P.K. Kannan) and "Public Deliberation: A Manager's Guide to Citizen Engagement" (by Carolyn Lukensmeyer and Lars Hasselblad Torres). A 2002 study, "From E-Government to M-Government? Emerging Practices in the Use of Mobile Technology by State Governments" (by M. Jae Moon), envisioned the increased use of handheld devices and GIS.

We hope that this report serves as a useful and informative introduction to the potential use of Geographic Information Systems as a tool to improve citizen participation in government at all levels.

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EXECUTIVE SUMMARY

Geographic Information Systems (GIS) are technological tools to depict spatial information visually and to conduct spatial analysis. GIS is commonly defined as "a system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing, and disseminating information about areas of the earth" (Dueker and Kjerne, 1989, 7-8). There has been significant growth since the 1990s in the adoption of GIS by local governments across the United States and in many other countries. In parallel with that growth has been the effort to apply GIS methods to citizen-oriented public services. Indeed, Public Participation GIS (PPGIS), which broadly refers to citizen participation in enhancing public services and decision making using GIS, is a major theme of GIS research. This report examines the future of citizen-oriented services in local e-government due to recent advances in GIS technology.

GIS technology has rapidly evolved since the 1990s in three broad technological waves: the traditional desktop GIS, the Web GIS, and the Geospatial Web 2.0 platform. GIS software across all three waves is both proprietary and open source:

- **First wave:** The traditional desktop GIS encompassed stand-alone GIS applications running on personal computers. These GIS applications offered powerful methods for producing maps on the fly and for conducting spatial analyses.
- **Second wave:** With the advent of Web GIS (also referred to as Online GIS or Internet GIS) in the 1990s, GIS became integrated with the Internet. Web GIS maps broadened GIS accessibility to anyone with a computer and Internet connection.
- **Third wave:** The Geospatial Web 2.0 platform is the adaptation of Web GIS to the Web 2.0 environment, wherein spatial data can be overlaid on existing map servers through application programming interfaces. For example, Google Earth, Google Maps, Microsoft's Bing Maps, and Yahoo Maps provide a base platform on which other spatial data can be added.

The focus of this report is on the prospects of the Geospatial Web 2.0 platform for citizen-oriented public services.

The traditional desktop-based GIS was accessible only to technical experts and professionals, because expertise was needed to use the highly technical software running on a desktop computer. With the adaptation of GIS to the Internet through Web GIS and Geospatial Web 2.0 platforms, GIS became increasingly accessible to lay users. With the newer generations of "smart" phones [equipped with both GIS and global positioning system (GPS) capabilities], social networking sites such as Facebook, and microblogging sites such as Twitter, the Geospatial Web 2.0 platform has the power to harness public participation in real time. For example, citizens can use Geospatial Web 2.0 platforms to report the locations of potholes, water leaks, accidents, and other events that should be addressed by municipal agencies. The recent advances in GIS technology hold great potential for citizen-oriented services.

Four substantive areas of citizen-oriented services for GIS applications are reviewed in this report:

- **Citizen-oriented transit information.** In terms of transit information, the Geospatial Web 2.0 platforms can take advantage of the Internet to provide real-time reports on traffic conditions, directions, and transit options based on the user's origin and destination.

- **Citizen relationship management (CiRM).** With the integration of nonemergency citizen service requests through centralized call centers (e.g., 311), CiRM has become crucial to the routing of such requests to the appropriate department and the tracking of their fulfillment. Integrating CiRM with the Geospatial Web 2.0 platform allows the geographic tracking of citizen demands.
- **Citizen-volunteered geographic information (VGI).** VGI refers to "the explosion of interest in using the Web to create, assemble, and disseminate geographic information provided voluntarily by individuals" (Goodchild, 2007a, 211). Web 2.0 developments and GPS-equipped devices have enabled participatory GIS by allowing amateur citizens to generate and share geographical information quickly over the Internet. Local governments can take advantage of such real-time information to increase their efficiency in service delivery.
- **Citizen participation in planning and decision making.** The Geospatial Web 2.0 platform could enhance participatory planning and decision-making processes. It is a supplementary tool for including geographical information in online deliberative mechanisms. While there is substantial growth in the use of Geospatial Web 2.0 applications in the three areas noted earlier, there also is considerable opportunity for growth in its adoption to increase citizen participation. Despite GIS's technological simplification and broader accessibility by lay users, meaningful participation in local e-government decision-making functions remains a lofty ideal. With the technological simplifications, the barriers to GIS adoption for public participation are less likely to be related to technology, and more likely to be organizational and institutional issues. In this respect, the organizational culture of the public agency must transform to value participatory decision making. Institutionalizing GIS for citizen-oriented services requires significant commitment, and leadership that recognizes the technology's potential to increase government interaction with citizens.

Looking Ahead: Future Trends

The growth of Geospatial Web 2.0 platforms provides opportunities for local governments to enhance their citizen-oriented public services and to seek greater participation. As this report describes, entrepreneurial local governments have begun to take advantage of these opportunities. In principle, GIS should particularly benefit those public services that have a spatial dimension. The transit agencies, planning departments, 311 call centers, and real estate agencies have been among the early adopters of GIS. A number of additional agencies—including public safety, emergency management, parks and recreation, environmental protection, property appraisal, and housing, among others—have adopted GIS. These agencies can take advantage of the Geospatial Web 2.0 platforms for enhancing the citizen orientation of their services. Three trends showing how local governments can adopt Geospatial Web 2.0 platforms to enhance citizen-oriented public services are described below.

Trend One. Transparency: Making an Agency's Geospatial Data Public and Machine Readable

Local government agencies are vast repositories of public information. If the geospatial data are made publicly available in standardized formats, they could be used by citizen groups and private agencies to enhance citizen-oriented public services. Instances of such use are already evident with the standardized General Transit Feed Specification data made available by public transit agencies. Washington, D.C.'s Open 311, which allowed access to the city's public data feeds for its "Apps for Democracy" contest, generated 47 innovative and useful applications for public use. Access to public domain data from other cities and local government agencies could similarly enhance their citizen-oriented public services. For example, the City and County of San Francisco established DataSF (http://datasf.org) as the central clearinghouse for its data sets. Over 25 Geospatial Web 2.0 applications have been developed using the data.

Trend Two. Engaging Citizens: Tapping Citizen-Volunteered Geographic Information

Geospatial Web 2.0 platforms have enabled ordinary citizens to voluntarily create, assemble, and disseminate geographic information. With GPS-enabled devices, amateur citizens can generate and share geographical information quickly over the Internet. Smart phones and cameras with GPS devices can document events and incidents that then can be shared quickly using social networking. As Goodchild (2007b) has argued, citizens are intelligent sensors who can provide useful information about the environment in which they live. The PPGIS efforts of citizen volunteers widen the domain of mapmaking beyond professionals and facilitate democratization of GIS tools. At a time when mapping agencies are facing budget crunches, there are cost advantages to be had from citizen efforts to provide geographical information. Local planning and zoning agencies can support the voluntary mapping efforts of new neighborhoods that are not yet formally included in maps. For example, OpenStreetMap.com has organized online mapping parties to clean up the U.S. Census TIGER data, and has undertaken mapping expeditions in over 50 cities in the United States. Of course, such voluntary efforts need to follow the standards and protocols for geospatial information. Citizen-volunteered geographic information can be useful in a range of areas: planning, disaster management, environmental monitoring, and so on.

Trend Three. Participation: Using GIS to Enhance Citizen Participation in Decision Making

The use of Geospatial Web 2.0 platforms for meaningful participation in planning and decision-making processes is limited. Meaningful public participation entails involvement, collaboration, and empowerment, wherein citizens know that they can make a difference in the decision-making processes. The use of Geospatial Web 2.0 platforms in democratic processes has not yet been fully developed.

There is clear potential for the use of the Geospatial Web 2.0 platform in online deliberative mechanisms in which geographical issues are crucial to decision making. The Portland, Oregon Metro's "Build-a-system" tool, built upon Google Maps to plan the region's High Capacity Transit System (Metro 2009), provides a guide to how the Geospatial Web 2.0 platform could be a useful tool to support public participation in decision making. Enhancing the Geospatial Web 2.0 platform's use in participatory decision making is not only a technological issue; rather, it is also an organizational and institutional issue. In this respect, the organizational culture of a public agency must itself value participatory decision making. Organizational impediments, such as the lack of financial, technical, and personnel capacities, as well as concern about letting non-specialists interpret public data, are also relevant to the current limited use of Geospatial Web 2.0 platforms. Enhancing its use in participatory decision making requires collaborative organizational networks to facilitate user-friendly technologies that can bridge experts and ordinary citizens.

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Introduction: Evolution of Geographic Information Systems

This report examines the potential of recent developments in Geographic Information System (GIS) technology for citizen-oriented, local e-government processes. This is an important examination, since a central aim of e-government practitioners and scholars is to achieve e-democracy and to promote e-participation (Garson, 2006). The different models of e-government have posited e-democracy as an advanced level of achievement (Layne and Lee, 2001; Siau and Long, 2005). Encouraging citizen participation and trust in government agencies is a recurring theme for public administration scholars as well as for practitioners (Cunningham, 1972; Dixon, 1975; Walters, Aydelotte, and Miller, 2000). Consideration of Public Participation GIS (PPGIS) debates is also relevant to enhancing citizen engagement and to increasing the transparency and accountability of decision-making processes.

Technologically, GIS has rapidly evolved since the 1990s. Although it was once accessible only to expert users, GIS has since become more user friendly and more accessible to citizens. The progressive ease in the use of GIS holds prospects for its adoption in public participation and civic engagement mechanisms. Broadly, three distinctive waves of GIS evolution could be identified:

- First wave: Desktop GIS;
- Second wave: Web GIS; and
- Third wave: Geospatial Web 2.0 platform.

Table 1 (p. 10) highlights the main features of these three waves of GIS technology and provides GIS software products illustrative of each. The GIS products in the three waves are not necessarily mutually exclusive; indeed, some of the products span across the waves. ArcGIS and Manifold, for example, feature both desktop and Web GIS versions.

Geographic Information Systems

Geographic Information Systems (GIS) are technological tools to depict spatial information visually and to conduct spatial analysis. Although there are different accounts of what GIS is, the common definition is "a system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing, and disseminating information about areas of the earth" (Dueker and Kjerne, 1989, 7-8).

GIS integrates spatial data such as polygonal areas (e.g., states, counties, cities), lines (e.g., rivers, streets), and points (e.g., buildings) with attribute data of the spatial elements. For example, choropleth maps use thematic colors, shades, or patterns to depict attributes (e.g., population distribution, land use) of spatial elements such as cities and states. Route maps interactively provide the most efficient path to reach a destination from a user's location. GIS simplifies the visual depiction of geographical data that may otherwise be too complex to describe in narrative prose or in an explanatory table.

First Wave: Desktop GIS

The first wave is that of the traditional desktop-based GIS, which encompassed stand-alone GIS applications running on personal computers or in the local area network within the public agency. These GIS applications offer powerful methods of producing maps on the fly, integrating spatial and attribute data. Raster aerial images could also be overlaid on the GIS maps. Unlike static maps, GIS maps are more dynamic, allowing for search, pan, and zoom actions to obtain maps based on the user's parameters. These maps are typically vector-based, which are useful for conducting sophisticated spatial analysis (e.g., point patterns, clustering, neighborhood relationships, path analysis) and complex simulations of alternative scenarios. Maps produced by the public agencies were not accessible to the general public, since users would have had to install the GIS software on their computers and possess sufficient GIS skills (including knowledge of spatial analysis) to manipulate the maps. To elicit public participation, the desktop GIS therefore required a GIS expert to intervene between public agency officials and citizens for even simple tasks. A citizen orientation using traditional desktop GIS is thus hard to achieve. ESRI's ArcGIS is a common commercial off-the-shelf (COTS) desktop GIS application used by many public agencies. However, there are several other general-purpose (e.g., Microstation's Bentley Map, Intergraph's GeoMedia, Manifold, MapInfo, Calipers' Maptitude) and special-purpose (e.g., IDRISI Taiga, Calipers' TransCAD, General Electric's SmallWorld) GIS software packages. Open source software (e.g., GRASS, MapWindow, Quantum GIS) is used to a lesser extent than is COTS software.

Second Wave: Web GIS

The second wave is that of Web GIS (also referred to as Online GIS or Internet GIS), wherein GIS became integrated with the Internet in the 1990s and added more capacity to the traditional GIS. In Web GIS, the public agency typically hosts the GIS software and data on its servers. The thematic maps and data are then deployed to client computers over the Internet. The maps are thus accessible to anyone on a computer with an Internet connection. (Some Web GIS software requires the one-time installation of an ActiveX component on the client computer, which can be done automatically.)

Table 1: Evolutionary waves of GIS

Waves	Main Features	Illustrative Software
First: Desktop GIS 	• Software installed on desktop • Agency's GIS professionals develop and use maps • Maps not accessible to general public users • Superior spatial analytic capabilities • Steep learning curve for developers and users	*Proprietary software:* ArcGIS; Bentley Map; GeoMedia; IDRISI Taiga; Manifold; MapInfo; Maptitude *Open source software:* GRASS; MapWindow; Open Source Software Image Map; Quantum GIS
Second: Web GIS 	• Software installed on public agency's servers • Agency's GIS professionals develop maps • Maps accessible to general public users via Internet • Maps cannot be edited by public • Limited spatial analytic capabilities • Flat learning curve for users	*Proprietary software:* ArcIMS; ArcGIS Server; Manifold IMS; Maptitude for the Web *Open source software:* CartoWeb; GeoServer; MapGuide; MapServer
Third: Geospatial Web 2.0 Platforms 	• Web 2.0 platforms • Agency and nonagency GIS professionals are map developers • Maps accessible to general public users via Internet • Maps editable by public (mashups using application programming interfaces) • Limited spatial analytic capabilities • Flat learning curve for users	*Proprietary platforms:* Bing Maps; Google Earth; Google Maps; MapQuest *Open source platforms:* OpenLayers; OpenStreetMap; World Wind

Proprietary and Open Source Software

Both proprietary and open source suites of products are available across all three waves of GIS. Proprietary GIS is typically commercial off-the-shelf (COTS) software, the source code of which is not made available to users. The commercial vendor generally provides customer support for the proprietary GIS software, taking care of software bugs and other issues. Open source GIS is typically free software that is developed or enhanced by a community of programmers and end users with a shared interest; the source code is generally available for modification and redistribution by users under the General Public License.

Although public agencies largely use proprietary COTS GIS now, open source GIS holds promise for citizen participation because it is freely available. The agencies do not have to invest in software. However, the agencies still will need experienced professionals to operate such open source software, since there is no vendor to provide customer support. Generally, open source software requires an active community of interested and experienced programmers in order to develop specialized applications and address software bugs. As Ramsey (2007) observes, open source GIS requires a high degree of openness and transparency, modular development, and good documentation to be effective.

The advantage of Web GIS over the desktop GIS is that it is more accessible to the general public, since citizens do not have to install expensive software on their computers. Citizens can view the maps in real time, with dynamic data queries. Web GIS's interactive features—such as querying, searching, and mapping dynamically on the fly—further expanded the use of GIS for citizen participation (Kingston, 2007; Tang and Waters, 2005). Web GIS holds more potential for public participation than does the traditional desktop GIS, because the data is accessible to a broader set of citizen groups. The maps, however, cannot be edited by the general public, and unlike the desktop GIS, the scope for advanced spatial analytic methods is quite limited in Web GIS. Furthermore, the public agency needs to have in-house expertise and the financial resources to implement Web GIS. Typically, the proprietary desktop GIS vendors also provide Web GIS solutions, including ESRI's ArcIMS and ArcGIS Server, Manifold's IMS, and Calipers' Maptitude for the Web. Autodesk's MapGuide features both proprietary (MapGuide Enterprise) and open source (MapGuide OS) versions. Other open source Web GIS software includes CartoWeb, GeoServer, and MapServer.

Third Wave: Geospatial Web 2.0 Platform

The third wave of GIS is the adaptation of Web GIS to the Web 2.0 environment, in what is broadly known as the Geospatial Web 2.0 platform. The Web GIS 1.0 environment is associated with basic information dissemination by servers to clients through static Web pages (e.g., using Hypertext Markup Language, HTML), serving proprietary content owned and published by the producers. Unlike Web 1.0's one-way server-client relationship, the Web 2.0 environment is associated with serving two-way, dynamic content. Web 2.0 is a platform that facilitates the collection of intelligence through blogs (including Twitter, a microblogging service), wikis, podcasts, and social networking sites (e.g., Facebook). Extensible Markup Language (XML), which allows for sharing structured data, is more prevalent than HTML (O'Reilly, 2005), and Geographic Markup Language is an XML adaptation for the exchange of geospatial data. A key feature of Web 2.0 is the "mashup," wherein independent third-party programmers can overlay information from multiple Internet data sources into one web service using application programming interfaces (APIs). Technological interoperability issues encountered with the Geospatial Web 2.0 platform are far less pronounced than those that arise with the traditional desktop GIS and Web GIS.

Lake and Farley (2007, 15) define the Geospatial Web 2.0 platform as "the global collection of general services and data that support the use of geographic data in a range of domain applications." It is characterized by two central features. First, it enables a location-based search (unlike the traditional text-based search); e.g., GPS-enabled cell phone "tweets" can embed location information, so that users can search for tweets sent from a particular location (Cohen, 2009). Second, GIS applications need not be hosted by the public agency; rather, the agency's GIS data could be overlaid on other existing map servers through APIs. Thus, both agency and nonagency GIS professionals could develop maps on the top of third-party platforms.

Citizen users can also perform simple edits on the map, which allows for a two-way exchange of data. Since the Geospatial Web 2.0 is Internet platform-based, there is no requirement to install GIS software on the public agency's servers. Instead, the public agency may be required to pay a fee for its customized use of proprietary platforms. The maps could be embedded in the public agency's website. Examples of proprietary platforms include Google Earth, Google Maps, Microsoft's Bing Maps, Yahoo Maps, and MapQuest. Other examples include open source platforms such as OpenStreetMap and NASA's World Wind.

From a citizen-orientation perspective, the strength of the Geospatial Web 2.0 platform is that it can be intuitively used by citizens without extensive training (Rouse, Bergeron, and Harris, 2007; Rinner, Keßler, and Andrulis, 2008). Users also can add information to the online maps. For example, citizens can use Geospatial Web 2.0 platforms to report the locations of potholes, water leaks, accidents, and other events that municipalities potentially should address. Local governments, citizens, and businesses can receive as well as send location-specific information using multiple media (e.g., videos, text, maps, sound) in real time. Sui (2008) refers to this as the "wikification of GIS" which is driven by large-scale, voluntary collaboration among both amateurs and experts using Web 2.0 technology. Despite the relative ease of Geospatial Web 2.0 platforms, APIs require computer expertise; hence, although the Geospatial Web 2.0 platform may be intuitive to end users, deploying it for municipal services requires technical expertise. The separation of GIS platform from local government data raises ownership and property rights issues of the data. Furthermore, there are issues of geographical privacy when local governments use the Geospatial Web 2.0 platforms as its primary agents of online spatial information (Sui, 2008).

Citizen-Oriented Geospatial Web 2.0 e-Government Applications

With the Geospatial Web 2.0 platform becoming increasingly accessible to ordinary citizens, several applications using the technology have been employed in local e-government functions. Although there are many areas using the Geospatial Web 2.0 platforms, four prominent ones are described in this report:

- Citizen-oriented transit information;
- Citizen relationship management (CiRM);
- Citizen-volunteered geographic information (VGI); and
- Citizen participation in planning and decision making.

The use of Geospatial Web 2.0 platforms has taken a significant foothold in the first three areas, with potential for further development in each. However, the use of Geospatial Web 2.0 platforms in participatory decision making has been limited.

Citizen-Oriented Transit Information

The capability of Geospatial Web 2.0 platforms to provide information in real time has been used increasingly to provide both traffic and transit information. Independent commercial web service providers have made traffic directions and reports on traffic conditions available in real time. MapQuest, for example, provides thematic maps of traffic for 85 metropolitan areas that are updated every five minutes (MapQuest, 2009). Bing Maps uses Clearflow technology (an artificial intelligence tool that employs predictive models to estimate traffic flows on surface streets) to provide traffic-sensitive directions (e.g., avoiding congestion) in over 70 metropolitan areas (Figure 1, p. 14). Other private sector Geospatial Web 2.0 platforms such as Google Maps, Yahoo Maps, and Microsoft's Bing Maps provide similar services. These websites generally depend on third-party data sources to provide up-to-date traffic information (e.g., MapQuest draws its data from INRIX; Bing Maps and Yahoo Maps use NAVTEQ). Geospatial Web 2.0 platforms have also been adapted for use with mobile phones. Google Maps Navigation provides free turn-by-turn voice guidance using an Internet-connected GPS navigation system in its mobile phones (www.google.com/mobile/navigation).

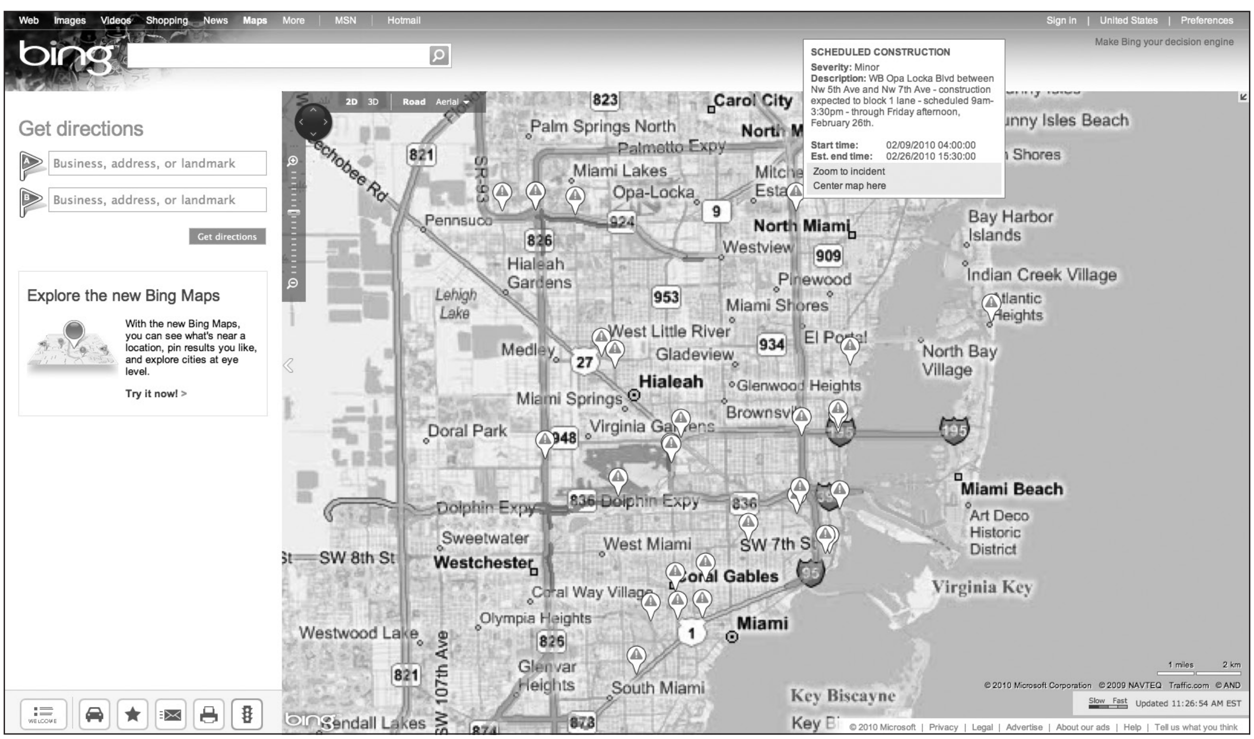
The rapidly growing use of Geospatial Web 2.0 platforms by local agencies is most evident in the context of providing information about public transit. Public Routes is a private effort to provide visitors with information on different modes of transportation. First launched in New York City to provide information on all transportation methods—including city buses, subways, trains, and ferries—Public Routes' services have since expanded to over 30 cities (www.publicroutes.com/maps.aspx). Google Transit has especially transformed the way information is provided by over 430 transit agencies (Google, 2009a). It is a free service that was integrated with Google Maps in 2006. Absent Google Transit, transit agencies typically provide static maps of bus and train routes, with an accompanying schedule of arrival and departure times. Alternatively, transit agencies have to develop Web GIS maps in-house. However, with Google Transit, agencies need only to provide the General Transit Feed Specification (GTFS) data for public transportation schedules and associated geographic information. The GTFS has become the standard for transit data provision, essentially composed of 12 comma-delimited text files (Table 2, p. 15). The files specify transit information such as the stops, routes, trips, stop times, calendar of schedule, fares, frequencies, and transfers. Google Transit then integrates the data with Google Maps to provide transit options based on the user's origin and destination (Figure 2, p. 16).

In municipalities where transit agencies have put GTFS data in the public domain, private software developers have developed innovative third-party applications to serve citizens better. For example, since Portland, Oregon's TriMet made its data publicly available in 2007, independent software developers have created about 28 useful transit tools for riders, including applications for places of interest near transit stops, text alerts when nearing a station, a transit time map, searching for nearest stops, and so on. Similarly, since the public availability of data on San Francisco's Bay Area Rapid Transit (BART), independent developers have produced over 20 free and paid services (BART, 2009). Over 30 transit agencies have currently provided similar broader public access to the GTFS data (Google, 2009c). Reporting on the impact of the OneBusAway system in Seattle, Washington, which provides real-time arrival transit information about buses, Ferris, Watkis and Borning (2010) observe that riders using the system had higher satisfaction and that there was an increase in the number of transit trips per week, a decrease in waiting time at bus stops, and an increase in walking.

Google Transit is advantageous for coordinating trips across neighboring jurisdictions covered by multiple transit agencies. Transit agencies can also avail themselves of cost advantages and complement other modes of providing information. Indeed, a few transit agencies that find it expensive to maintain 511 call centers for delivering transit information are now using Google Transit or Public Routes to provide the same data at little or no cost (Transportation Research Board, 2009). Google also maintains that its Transit program raises the public awareness about public transportation, attracting new riders and increasing agency awareness and web traffic. For example, the Hampton Roads Transit (Virginia) website attracted 60 percent more page views after the agency adopted Google Transit; the web page hosting the Transit trip planner accounted for nearly 7 percent of that increase (Google, 2009b).

Google Transit, however, is not entirely without controversy. The Washington Metropolitan Area Transit Authority (WMATA), one of the largest metropolitan

Figure 1: Traffic and incident report using Bing Maps: Illustrative example from Dade County, Florida



Source: *Bing Maps (www.bing.com/maps)*

Table 2: General Transit Feed Specification (GTFS)

The GTFS has become the standard for transit data provision. The GTFS data comprises essentially 12 comma-delimited text files. As the table shows, the files specify transit information, such as the stops, routes, trips, stop times, calendar of schedule, fares, frequencies, and transfers. Google Transit then integrates the data on Google Maps to provide an online timetable for transit agencies. Users can obtain their transit options based on their origin and destination locations (Figure 2).

File	Required/ Optional	File description
agency.txt	Required	This file contains information about one or more transit agencies that provide the data in this feed.
stops.txt	Required	This file contains information about individual locations where vehicles pick up or drop off passengers.
routes.txt	Required	This file contains information about a transit organization's routes. A route is a group of trips that are displayed to riders as a single service.
trips.txt	Required	This file lists all trips and their routes. A trip is a sequence of two or more stops that occurs at a specific time.
stop_times.txt	Required	This file lists the times that a vehicle arrives at and departs from individual stops for each trip.
calendar.txt	Required	This file defines dates for service IDs using a weekly schedule. Specifies when service starts and ends, as well as days of the week where service is available.
calendar_dates.txt	Optional	This file lists exceptions for the service IDs defined in the calendar.txt file. If calendar_dates.txt includes ALL dates of service, this file may be specified instead of calendar.txt.
fare_attributes.txt	Optional	This file defines fare information for a transit organization's routes.
fare_rules.txt	Optional	This file defines the rules for applying fare information for a transit organization's routes.
shapes.txt	Optional	This file defines the rules for drawing lines on a map to represent a transit organization's routes.
frequencies.txt	Optional	This file defines the headway (time between trips) for routes with variable frequencies of service.
transfers.txt	Optional	This file defines the rules for making connections at transfer points between routes.

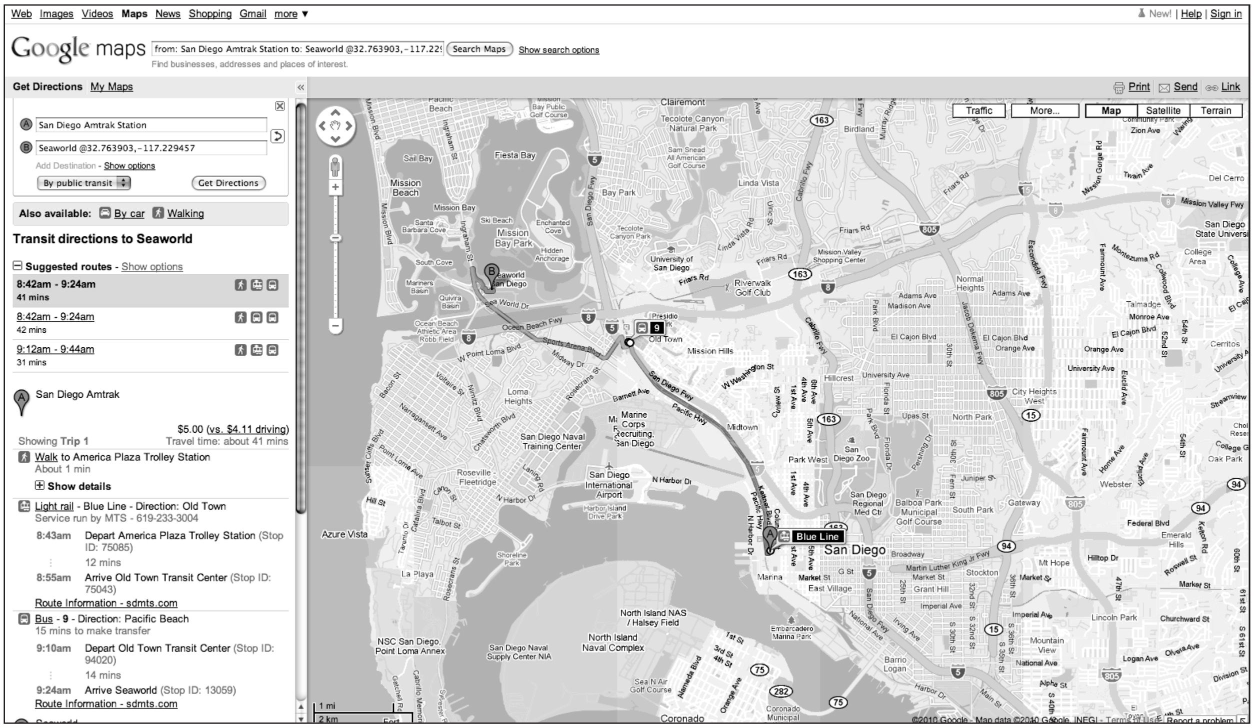
Source: *General Transit Feed Specification, http://code.google.com/transit/spec/transit_feed_specification.html (Accessed October 15, 2009)*

transit agencies in the nation, reached an agreement with Google Transit in October 2009 (WMATA, 2009b). Although WMATA had made its GTFS data available, there were differences between WMATA's terms of use for the data and the standard contractual terms of Google with other transit agencies (Perkins, 2009; WMATA, 2009). WMATA also maintained that Google Transit does not provide information on fares and local transit partners (such as ART, Fairfax Connector, Ride On, and The Bus) and does not give up-to-date information because it is updated monthly. As a result, WMATA maintained a proprietary, in-house, Web GIS-based Metro Trip Planner for providing transit information. (Google Transit maps became available in 2010.)

Citizen Relationship Management

Many local governments have made jurisdictional information available online using Web GIS or

Figure 2: Google Transit: Illustrative example from San Diego, California



Source: *Google Transit (www.google.com/transit)*

Geospatial Web 2.0 platforms as a part of their citizen services. The availability of geographical information over the Internet allows for increased transparency in the delivery of local government services. Citizens, local government officials, and community leaders can monitor the public services available within their jurisdiction. Basic Web GIS maps include the street layout, sites of tourist interest, and real estate information. More advanced Web GIS maps include political boundaries within the local government (e.g., wards, council districts); thematic depictions of demographic and socioeconomic information; natural environment locations (e.g., watershed, forest areas, floodplains); land use and zoning; parks and recreation; and transportation and utility services.

Agency-specific Web GIS maps are specialized in providing information that falls within the agency's domain. For example, property appraiser offices in local governments often provide public domain data such as property appraisals, taxes, and related information using such Web GIS maps. Many commercial websites have also arisen to provide information on real estate and housing markets.

A key area for the use of Web GIS or the Geospatial Web 2.0 platform is in citizen relationship management (CiRM) for the efficient delivery of local government services. In the United States, CiRM systems are crucial to the operation of 311 call centers, which are centralized local government public information entities charged with taking nonemergency service requests from citizens. In 1996, the Federal Communications Commission designated the 311 number for nonemergency use in order to relieve the 911 police emergency lines and keep them from being backlogged and overburdened—delaying genuine emergency calls for life-or-death cases. Such nonemergency requests include the reporting of physical problems in the neighborhood (litter, potholes, etc.), inquiries about bulk trash collection, notifications loss of water service, etc. However, such centralized nonemergency call centers have been slow to develop; according to an International City/County Management Association (ICMA) 2008 study, only 104 out of 710 local governments responding to the survey had a centralized system (Moulder, 2008). Online systems for fulfilling customer service requests also offer a potential avenue for local governments to use to deliver improved services. The advantage of the 311 or online systems is that the citizens do not need to know which department or official needs to be called in order to fulfill a service request; the service requests are automatically forwarded to the appropriate department. Such centralized systems thus represent a departure from the traditional stovepipe model of government to one that is more networked, with the centralized system acting as the face of the government. CiRM systems become crucial in this context for the effective routing of service requests to the appropriate departments, their tracking, and the provision of updates on their status.

Integration of the CiRM systems with GIS enables transparency in service delivery and the reallocation of resources according to jurisdictional needs. GIS allows the geographical tracking of citizen requests for specific local government services (e.g., pothole repairs, trash removal). For example, a clustering of pothole repair requests from the same neighborhood could be indicative of generally poor road conditions in the area—which may require broader intervention from the city's infrastructure department to repair the roads. In Minneapolis, GIS analysis of the city's regulatory services department service requests showed that two districts had the same number of supervisors and support staff, although one had twice the number of exterior nuisance service requests (Moulder, 2008). As the ICMA has noted, "integration of 311/CiRM data into a local government's geographical information system (GIS) technology is critical to understanding where and what type of service requests are being made in a community" (Fleming and Barnhouse, 2008, 8). Yet, according to its survey, only 44 percent of the CiRM systems are integrated with online GIS maps (Moulder, 2008), showing considerable opportunity for the growth of GIS integration with CiRM.

The City of Charlotte's Virtual Charlotte (VC) system provides a first example of the integration of the Geospatial Web 2.0 platform with other citizen services. (It was the winner of the 2009 Exemplary Systems in Government competition conducted by the Urban and Regional Information Systems Association.) The VC system was developed in response to the needs of customer service representatives in the CharMeck 311 call center and to allow city staff to coordinate and manage service delivery seamlessly. The system provides visualization of 311 calls and other information related to the location, such as traffic accidents, construction projects, permits, street maintenance services, and vehicle locations tracked with automated vehicle location technology (Figure 3, p. 18). The VC system is built on a combination of ArcGIS Server and Google Maps, with the server hosting the city's GIS data and Google Maps providing an interface allowing non-GIS specialists to use the system intuitively. The system combines a range of legacy services in a user-friendly manner: the city's CiRM application (Emerald), its asset management system (Hansen), street event data via GeoCLEAR (Geographic Information for Street Closures, Events, and Adverse Weather Response), the city's GIS spatial data warehouse (e.g., streets, neighborhoods, zoning), property deeds and appraisal data, and data from the state's transportation cameras. Most city departments, including 311, transportation, engineering, neighborhood services, planning, etc., are integrated with the VC system. In addition to citizen services, the system also facilitates coordination among the city's businesses located in the same geographic area.

The second example is Washington, D.C.'s 311 application, which is a winning entry from the "Apps for Democracy" contest held by the city in 2009 (Apps for Democracy, 2010). The contest challenged software developers to create applications that make it easier to submit nonemergency requests online. Developers were given access to the city's 270 public data feeds and were required to use open source code, including the city's Open 311, allowing users to build custom applications for submitting service requests. The contest produced 47 innovative applications. The final prize was awarded to DC 311, an iPhone and Facebook combination application that enables users to report physical problems. Using the DC 311 "app," iPhone users can document physical issues by taking photographs of graffiti, potholes, etc., which are then located using the GPS and uploaded to the 311 database for local officials to act on. Facebook users can also view and submit service requests by category and by location on Google Maps.

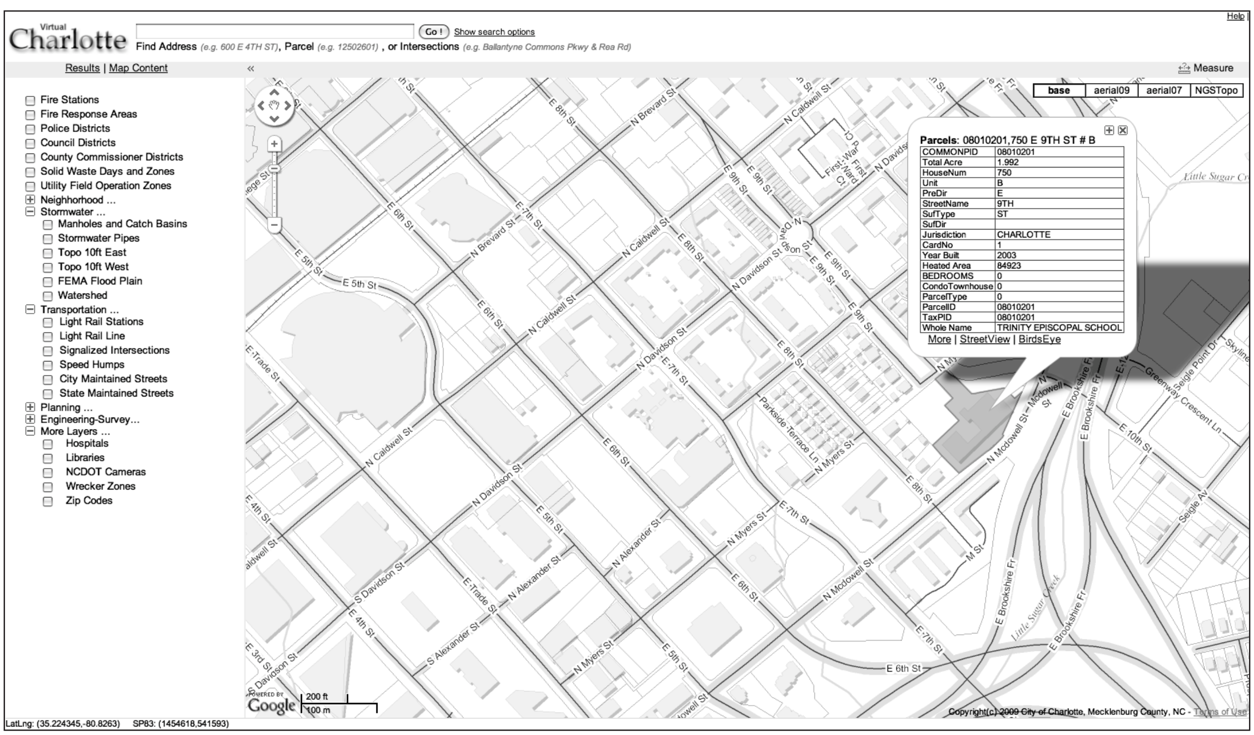
The third example of the online implementation of CiRM hails from the United Kingdom, where public access to online maps has been useful in delivering improved services to local communities through the integration of GIS with public services (Kingston, 2007). FixMyStreet (www.fixmystreet.com/) is an online service developed in 2007 by mySociety, a nonprofit group, and funded by the Department for Constitutional Affairs (now the Ministry of Justice) Innovations Fund. Using the service, citizens report local physical problems (e.g., graffiti, unlit lampposts, abandoned beds, broken pavements) by locating them on an online map and by giving the appropriate description and photographs (Figure 4). These reports are then routed to the appropriate local council government for redress, and citizens can trace online the updates to their service reports. The GIS data are drawn from Ordnance Survey, which is Great Britain's national mapping agency. Built on open source code, the application is also accessible through an iPhone. As of December 2009, over 52,000 problems were cumulatively highlighted through the site, about half of which were reportedly fixed.

SeeClickFix.com is an application in the United States that is similar to FixMyStreet. Since many local governments do not have a 311 call center, the site purportedly is "a place for citizens from anywhere to give their local government a website that tracks local issues" (http://seeclickfix.com/about_us). The site is aimed at increasing community involvement and collaboration, and at enhancing government transparency and efficiency. Using the site, citizens can participate in taking care of and improving their neighborhoods. Citizens can view nonemergency issues in their neighborhood, open a ticket describing an issue and what can be done to resolve it, and report an issue. Community groups, local media, and government officials can receive the alerts and raise awareness for the problem to be fixed. The site's activities are mainly concentrated in Philadelphia, New Haven, Connecticut, and parts of New Jersey. Local news sites and blogs use the SeeClickFix.com services to elicit citizen reports on neighborhood issues and to request the problems be fixed (Slotnik 2010).

Citizen-Volunteered Geographic Information

Coined by Goodchild (2007a, 211), volunteered geographic information (VGI) refers to "the explosion of interest in using the Web to create, assemble, and disseminate geographic information provided voluntarily by individuals." Unlike traditional maps that require professional geographers and cartographers, Web 2.0 developments and GPS devices enable

Figure 3: Virtual Charlotte



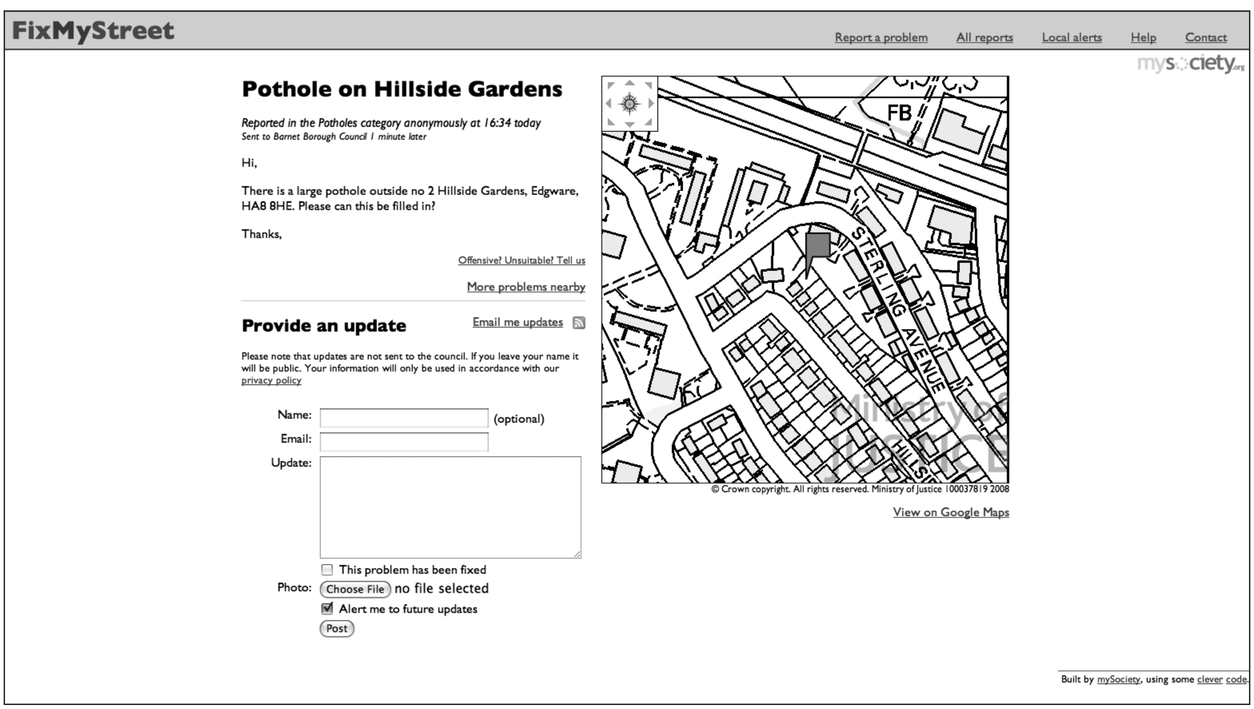
Source: *Virtual Charlotte (http://vc.charmeck.org/)*

citizens to generate and share geographical information quickly over the Internet. Smart phones and cameras (with embedded GPS devices) can be used to geocode and document events and incidents through pictures that can be shared quickly using social networking (e.g., the DC 311 application noted earlier). Goodchild (2007b, 26) argues that citizens are a "large collection of intelligent, mobile sensors, equipped with abilities to interpret and integrate that range from the rudimentary in the case of young children to the highly developed skills of field scientists." For example, Google's editing tools such as Map Maker and Building Maker allow people to collaborate and improve on Google Maps and Earth. The changes are moderated within the user community to increase the accuracy of the Google Maps based on local knowledge and expertise. Over 175 countries have been covered through such voluntary mapping efforts (Google, 2009d).

Prime examples of the user-generated geographical content are the open source Wikimapia and OpenStreetMap. Wikimapia is an "online editable map allowing everyone to add information to any location on the globe" (http://wikimapia.org). It is a "mashup" of Google Maps with a wiki, where any person can upload a description of a selected spot in the world, including links to other sources (Figure 5, p. 20). Others can review the descriptions for accuracy, edit the entries, and volunteer additional information. OpenStreetMap is a free map of the world that can be edited by anyone with an Internet connection—a voluntary effort to create local maps through collaborative mapping projects distributed around the globe. OpenStreetMap got a shot in the arm when President Barack Obama's White House website began to use it to highlight the geography of stimulus spending (www.recovery.gov) and voluntary services (www.volunteer.gov). OpenStreetMap has also been used to produce an interactive map of crimes (with timelines) in Oakland and San Francisco (Figure 6, p. 21). Ramasubramaniam (forthcoming) views such voluntary activities as "spontaneous GIS activities" built on freely available mapping platforms such as Google Maps and OpenStreetMap. These activities are niche projects addressing specific community aspirations, advocacy efforts, or communities of interest.

VGI has several implications for PPGIS and e-government. The "participatory GIS" efforts including citizen volunteers in providing geographical information widen the domain of mapmaking, moving beyond professionals and facilitating the

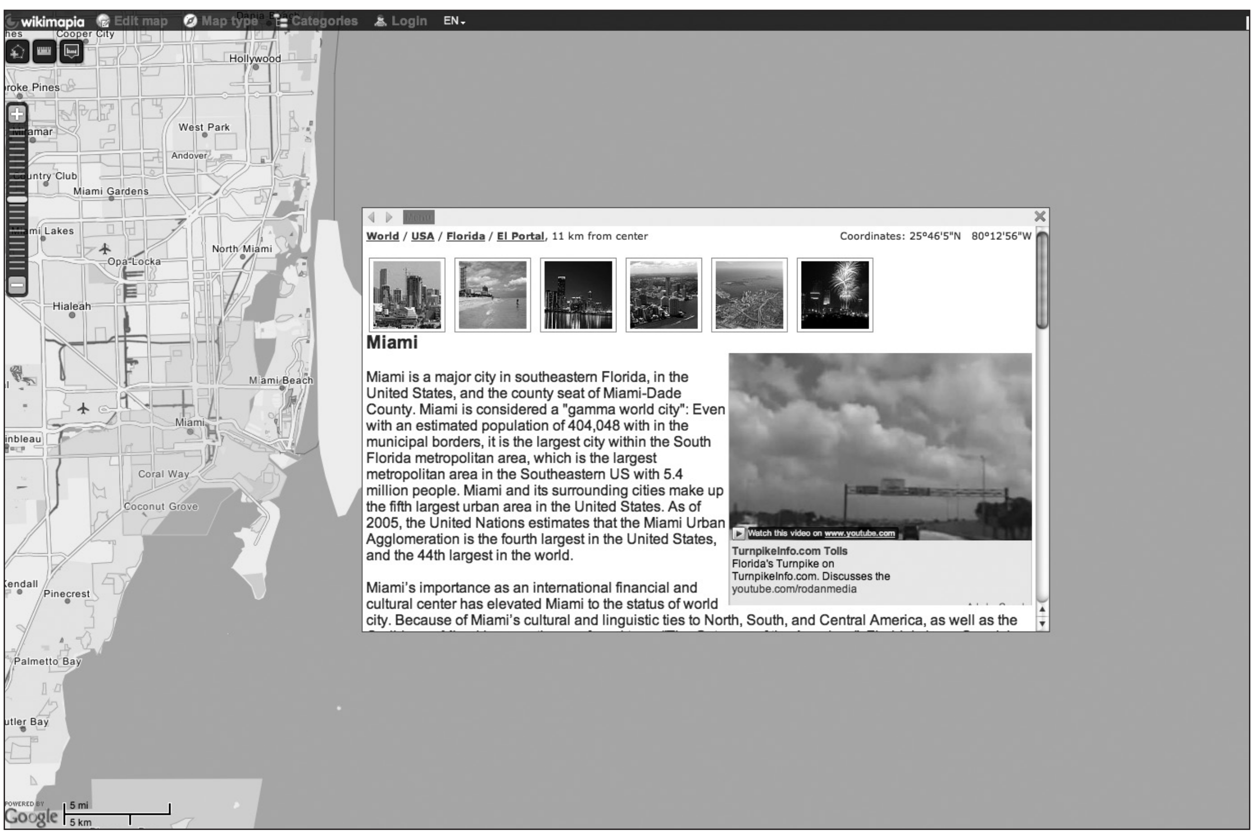
Figure 4: Reporting physical problems using FixMyStreet: Illustrative example from the United Kingdom



Source: *FixMyStreet (www.fixmystreet.com)* democratization of GIS (Dunn, 2007). Cinderby and Forrester (2005, 154) argue that "an ideal form of PPGIS could be where neighborhood residents collect their own spatial data and process it themselves using GIS software." Seeger (2008) demonstrates the application of user-generated spatial information for participatory landscape design and planning. Gouveia and Fonseca (2007) propose an environmental collaborative monitoring networks framework that combines traditional environmental monitoring methods with that of voluntary citizen monitors. Voluntary information is also useful in disaster contexts, where residents have better knowledge about the ground situation and have the potential to provide such information for coordinating quick action with government entities (Goodchild, 2007a).

From an e-government perspective, the voluntary information holds potential for collaborative mapmaking that goes beyond traditional agency domains. The voluntary efforts of mapping are worthwhile at a time when national mapping efforts through national surveying and cartographic agencies are on a decline (Estes and Mooneyhan, 1994; Goodchild, 2007a). In the United States, OpenStreetMap is built on the freely available U.S. Census Bureau's TIGER (Topologically Integrated Geographic Encoding and Referencing) Map Service. OpenStreetMap has organized online mapping parties to clean up the TIGER data and undertaken mapping expeditions in over 50 cities. Efforts by such private and voluntary groups to generate and update maps at various scales based on the community needs (the "patchwork" concept) were highlighted by the U.S. National Research Council (1993) in designing the Spatial Data Infrastructure (SDI), which provides the standards and protocols for geospatial information. Although Goodchild (2007a) views the VGI as fitting the SDI model, Flanagin and Metzger (2008) are skeptical of the credibility of such information. Similarly, while acknowledging overlaps between PPGIS and VGI, Tulloch (2008) observes that the two diverge inasmuch as the former is concerned with process and outcomes, and the latter is concerned with applications and information.

Figure 5: Place description in WikiMapia



Source: *WikiMapia (www.wikimapia.org)*

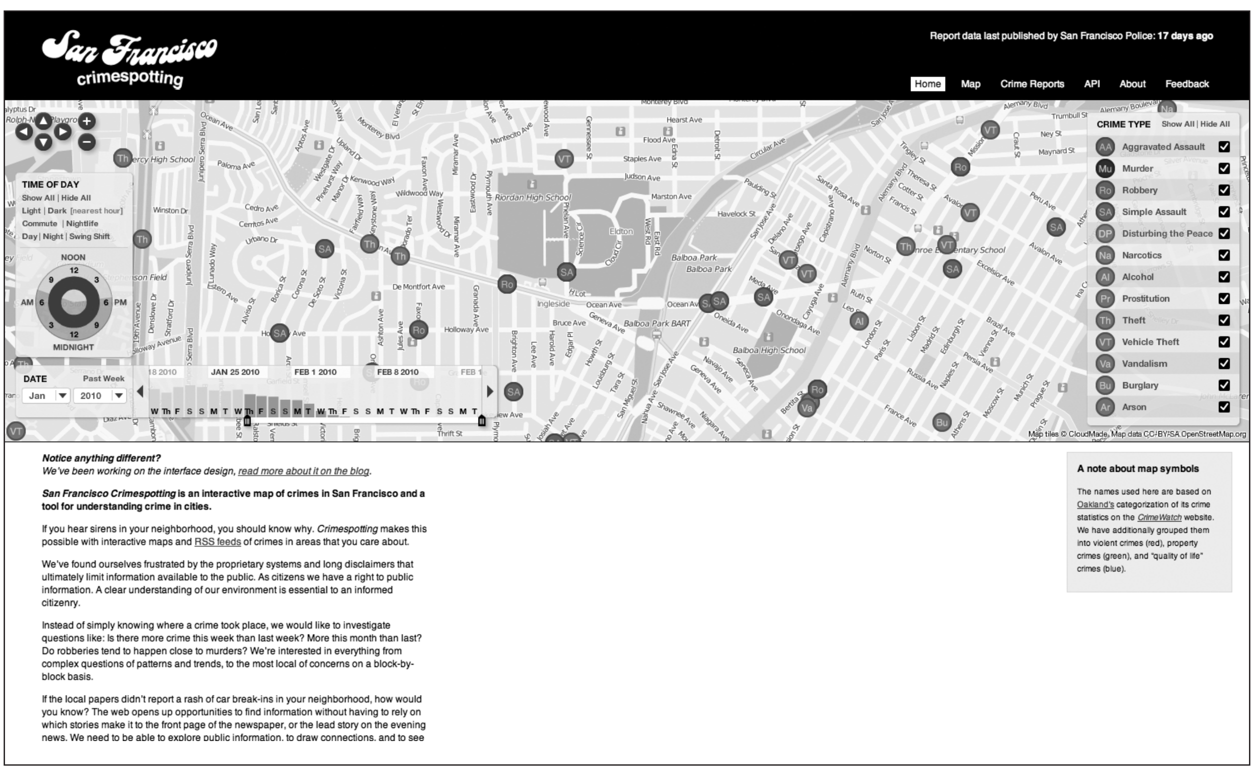
Citizen Participation in Planning and Decision Making

The three areas described earlier represent significant developments of GIS technologically and are all principally related to the creation of a supply of geographical information. While citizens can participate in such information creation and act on it, the three areas are not related to active participation in decision-making processes by adding GIS data. These three areas would not now be considered to be among the higher levels of public participation in decision making, as conceptualized by Arnstein (1969) and others (Connor, 1988; Tritter and McCallum, 2006; Wiedemann and Femers, 1993). Information provision and feedback are at the lower levels of public participation in these schemes. Informing and consultation may use informational tools such as maps, aerial photographs, and interactive websites for public comments.

Higher levels of public participation include involvement, collaboration, and empowerment, wherein citizens take an active role in making an impact on planning and decision-making processes. Such public decision-making processes at the local government levels typically take a protracted time. While public participation is often legally required to undertake such decisions, it is also desirable in light of a need for governmental transparency and public trust building. The use of GIS in face-to-face as well as online public participation could enhance planning and other decision-making processes.

Complex geographical models of simulations of future growth could be simplified in GIS through visual maps that could be understood by citizens. Al-Kodmany (1999), for example, shows that GIS and freehand sketching are effective for problem identification and brainstorming in face-to-face meetings. Researchers have also focused on how GIS could empower local communities in planning processes such as land use (Ventura et al., 2002), public housing (Barton, Plume, and Parolin, 2005), environmental management (Jankowski, 2009; Tulloch, 2002), and other local government functions (Ramasubramaniam, 1999). In online deliberations, the Geospatial Web 2.0 platform could play a supportive role in using planning and decision-making processes to engage citizens (Nyerges, Ramsey, and Wilson, 2006).

Figure 6: San Francisco Crimespotting using OpenStreetMap



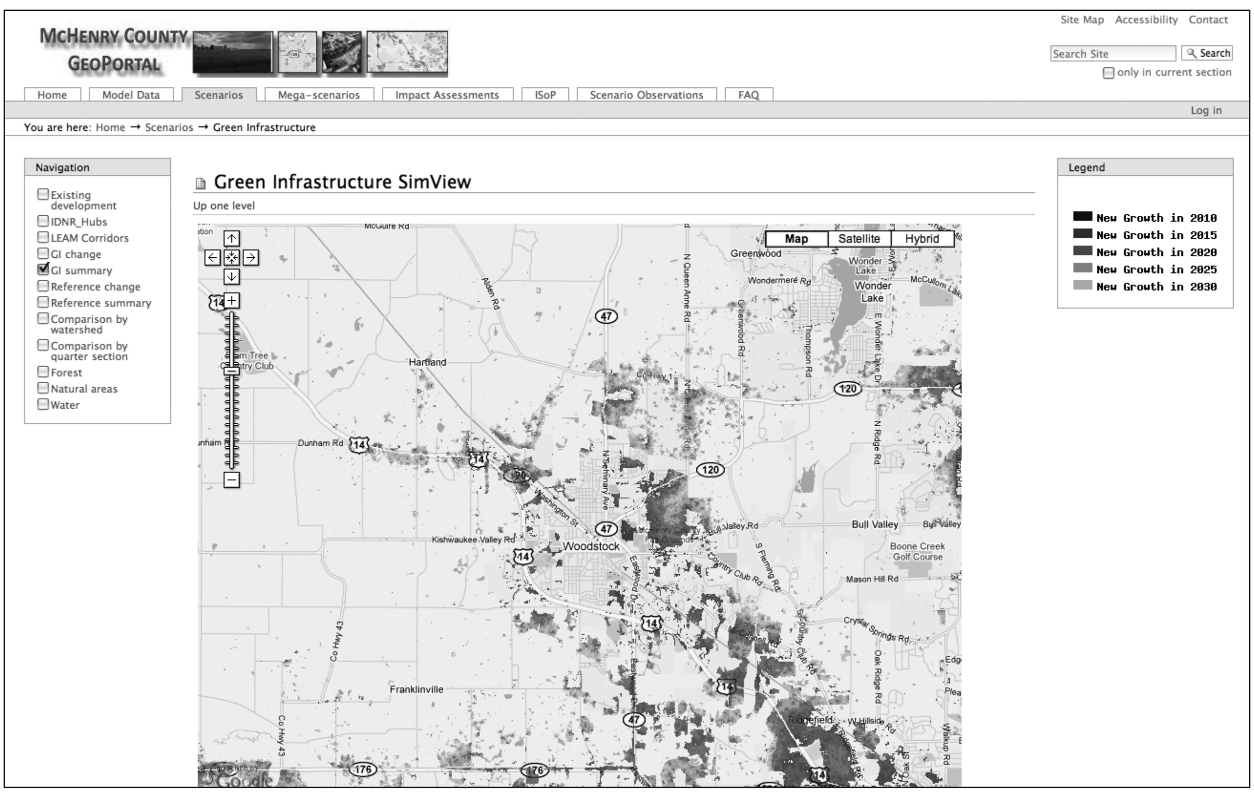
Source: *San Francisco Crimespotting (http://sanfrancisco.crimespotting.org/)*

Two recent examples demonstrate the potential of the Geospatial Web 2.0 platform in enhancing participatory public decision making. Both, however, fall short of actually using GIS for meaningful participation in planning and decision making. The first example is the McHenry County, Illinois GeoPortal developed under the Land Use Evolution and Impact Assessment Model by the University of Illinois, Urbana Champaign, planning and geography departments. The Impact Assessment Model shows how complex planning and decision-making scenarios of the future can be simplified for citizens by depicting them visually through Google Maps (Figure 7). The GeoPortal features 17 different scenarios, displaying a wealth of detailed information regarding each. Although technically sophisticated and accessible to lay users, the GeoPortal has not elicited public participation in decision making *per se*. Public participation is limited to obtaining feedback through the "Add Comment" section at the bottom of each scenario page.

The second example in the use of GIS in decision making is the Portland, Oregon Metro's "Build-a-system" tool for planning the region's High Capacity Transit System. Established in 1978, the Metro is an elected body of the Portland metropolitan area that comprises three counties and 24 cities (Bosworth, Donovan, and Couey, 2002). The Metro initiated regional planning to manage the area's growth over the next 50 years (the Region 2040 program). It developed the Regional Land Information Systems (RLIS) in 1989 as a GIS database with detailed parcel-level information. Residents were supplied with the data and software in order to access the city maps so that they could perform their own analysis, interpret the results, and make policy suggestions. The RLIS has since been adapted to the Internet for broader accessibility and public participation.

The Portland Metro adopted the Geospatial Web 2.0 platform (Google Map) in 2008 for eliciting public participation in the planning of the region's High Capacity Transit System (Metro, 2009). Initially, the Metro obtained public input through an online questionnaire, workshops, community group meetings, and farmers' markets and festivals. Based on the input, it identified 192 potential connections in

Figure 7: Scenario output of land use simulation in McHenry County, Illinois (overlaid on Google Maps)

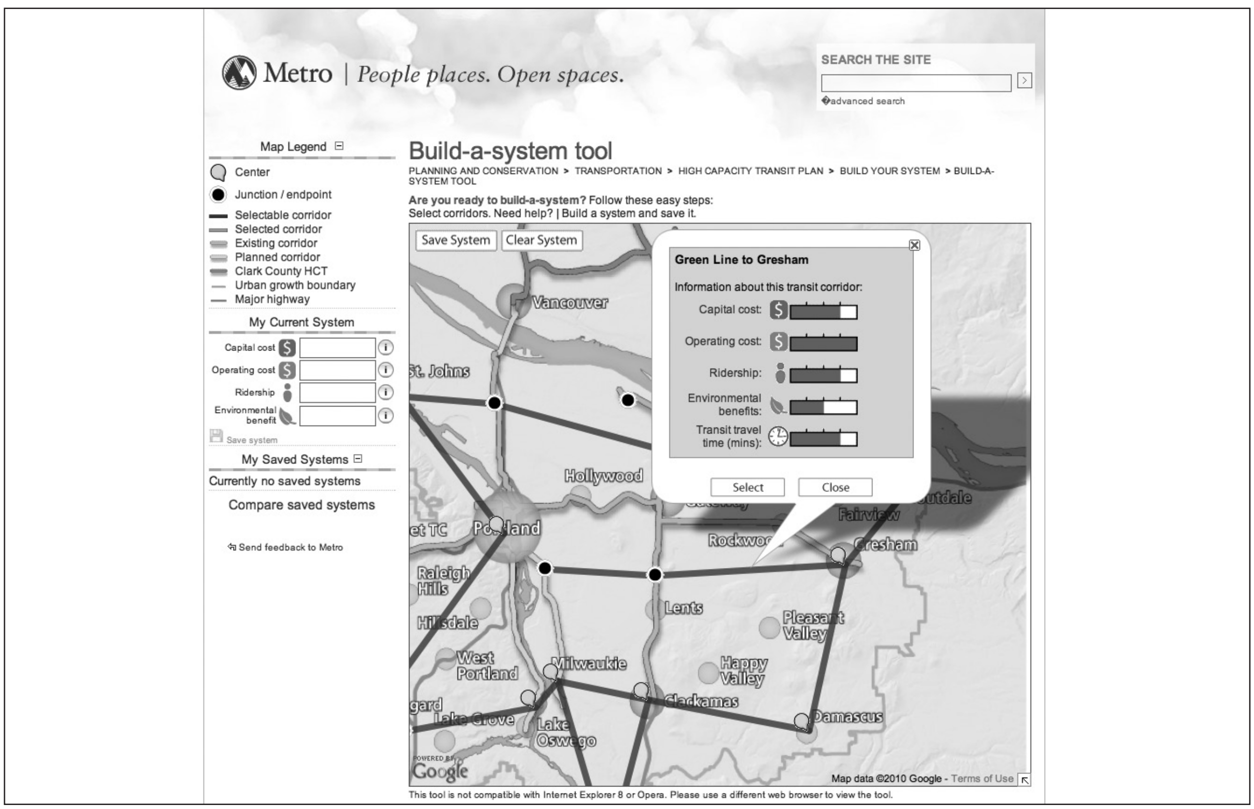


Source: *University of Illinois, Urbana Champaign's Land Use Evolution and Impact Assessment Model (www.leam.illinois.edu/mchenry/scenarios/green-infrastructure)*

55 corridors around the region. Based on various criteria (e.g., ridership, environmental considerations, costs, equitability), the Metro shortlisted 15 corridors, along with several system improvements. After this step, the Metro implemented a "Build-a System" tool on top of the Google Maps platform, for residents to interactively select the corridors to be included in improving the metropolitan system (Figure 8). Using the tool, residents could assess each corridor's capital cost, operating cost, ridership, and environmental benefits. Residents did not select the routes in the decision-making process; rather, the tool was intended mainly as an educational and support tool for them to make more informed decisions while filling out answers to the survey questionnaire. Over 4,250 residents visited the website and over 650 responded to the online questionnaire during the nearly one-month period during which public input was sought (March–April, 2009). This tool shows how the Geospatial Web 2.0 platform can be harnessed as a decision support tool for the transportation planning and decision-making processes.

Examples like the McHenry County GeoPortal and Portland Metro's "Build-a-system" tool for local e-government decision making are, however, few and far between. Even these sites have not been fully oriented toward participatory decision making *per se*. The Metro's "Build-a-system" tool was only a secondary support for eliciting survey responses, not central to the online deliberative decision-making process. For example, the choices of routes could have been directly recorded from Google Maps to further public deliberation on transportation needs. Indeed, few local governments have utilized the Geospatial Web 2.0 platforms to enhance their participatory decision-making processes. The small number of local governments doing so is set against the broader context of participatory democracy in e-government processes. Moon (2002) observed that, although many cities and counties were moving to e-government, they were still in the early stages of information provision; much of the rhetoric of e-government, including participatory democracy, had not yet been achieved. In their more recent assessment, Coursey and Norris (2008, 523) found that "local e-government is mainly informational,

Figure 8: Portland Metro's Build-a-system tool



Source: *Metro (www.metro-goingplaces.org/bast/)*

with a few transactions but virtually no indication of the high-level functions predicted in the models." In this broader context, few local governments have adopted Web GIS or the Geospatial Web 2.0 platform for higher-level participatory processes in decision making.

The limited adoption of the Geospatial Web 2.0 platform is less of a technological issue, and more of an institutional issue related to participation. With the broader accessibility of GIS technology, hurdles in adopting GIS for public participation are less likely to be technology related. As Coursey and Norris (2008) observe, technological barriers also are reduced as local governments gain more experience. Instead, the hurdles are more likely to be institutional, inasmuch as political and other motivations hinder broader participatory processes in decision making. The challenges of adopting the Geospatial Web 2.0 platforms for participatory decision making are explored in the next section.

The Future of GIS-Enabled Citizen Participation in Decision Making: Challenges and Opportunities

Introduction

In the United States, citizen participation in decision making is assumed as a routine aspect of local democracy and has been a standing theme for public administration scholars and practitioners (Cunningham, 1972; Dixon, 1975; Gil and Lucchesi, 1979; Hollander et al., 1988; Walters, Aydelotte, and Miller, 2000). Participatory decision making is considered to be helpful in understanding the preferences of the public, enhancing governmental accountability, advancing fairness and justice, avoiding time-consuming litigious responses from the public, enabling the inclusion of local knowledge, and building the public's understanding and trust in policy makers (Innes and Booher, 2004; Laurian, 2004; Leighninger, 2006; Scott, 1998). Moreover, citizen participation is an essential ingredient of deliberative democratic processes (Friedmann, 1992; Fung, 2004; Healey, 2002; Leighninger, 2006). Yet the Geospatial Web 2.0 applications, in particular, and e-democracy functions, in general, have not been widely adopted by local governments for participatory decision making. Why not?

This section explores the challenges and opportunities for participatory decision making in local e-government. Citizen participation in decision making is not only a function of the technology of the Geospatial Web 2.0 platforms, but of the participatory mechanisms and decision-making processes—where political, organizational, and other motivations shape how participation occurs. The nontechnological factors thus should be considered in assessing the extent to which the Geospatial Web 2.0 platforms might be adopted for participatory decision making.

The concept of citizen participation in decision making has evolved over the years. In her seminal article, Arnstein (1969) identified eight rungs in the ladder of participation. In her scheme, the first two rungs (manipulation and therapy) are indicative of nonparticipation; the next three rungs (information, consultation, and placation) refer to various degrees of token participation; and the last three rungs (partnership, delegation of power, and citizen control) are most indicative of citizen participation. Many authors have since refined Arnstein's conceptualization. Connor (1988) proposed a cumulative seven-stage model at two levels: education, information feedback, and consultation (related to the general public); and joint planning, mediation, litigation, and resolution/prevention (related to leadership). Innes and Booher (2004) argue that, although participation may be legally required in the United States, many of the commonly used mechanisms (e.g., public hearings, public comment periods, and citizen advisory councils) do not necessarily lead to meaningful participation; rather, they could be counterproductive, often angering citizens and leading to mistrust in authorities. Others note that such methods do not work because they attract an unrepresentative sample of the public, and are often used by decision makers to avert public criticism and proceed with decisions already made, thereby leaving participants little influence on policy outcomes (Checkoway, 1981; Cole and Caputo, 1984, Kemp, 1985; Rowe and Frewer, 2000). Tritter and McCallum (2006) criticize Arnstein's power-centric model of public participation and argue for the intrinsic value of the public's knowledge and experiences.

Arguing for citizen engagement (rather than participation), Lukensmeyer and Torres (2006) identify five elements of engaging the public: informing, consulting, engaging, collaborating, and empowering. In all of the models of public participation noted earlier, information provision is at the lower end of the spectrum of participation. Higher levels of meaningful participation require public engagement, collaboration, and empowerment, wherein citizens "know that their participation has the potential to have an impact" (King, Feltey, and Susel, 1998, 323) on decision-making processes.

The different forms of public participation elucidated here need to be taken into account when examining the opportunities and challenges of using the Geospatial Web 2.0 platforms for enhancing participation. First, in terms of Arnstein's and others' subsequent conceptualizations of public participation, the Geospatial Web 2.0 platforms could be conceived along the continuum—from information provision to empowerment. At the low end of the spectrum, the Geospatial Web 2.0 platforms are mainly information provision tools; at the other end, they are tools to empower the public to actively participate in decision-making processes. Second, the Geospatial Web 2.0 platforms provide the additional capacity to include the geographical element in online public participation methods. With the integration of mobile smart phones equipped with both GIS and GPS capabilities, RFIDs (radio frequency identification devices) that can be read remotely, cameras, and social networking sites such as Facebook, the Geospatial Web 2.0 platform has the power to harness public participation in real time (Turner and Forrest, 2008).

Online participatory methods are of particular significance to e-government functions, in general, and to the Geospatial Web 2.0 applications, in particular. The increasing penetration of broadband and social networks holds prospects for online political and public participation. Online political participation in the national elections has steadily risen since 2000. According to a Pew Internet survey after the 2008 elections, more than half of the voting-age population used the Internet to get involved in the political process during an election year (Smith, 2009). The online participation is facilitated by deeper Internet and broadband penetration in the United States, which were nearly 79 percent and 63 percent, respectively, in 2009 (Horrigan, 2009). Broadband is required for the Geospatial Web 2.0 applications, which are data intensive. The use of online social networks such as MySpace, Facebook, or LinkedIn by adults in the United States increased from 8 percent in early 2005 to nearly 46 percent in 2009 (Lenhart, 2009). These online mechanisms provide additional venues for public participation.

Online participation mechanisms also provide greater flexibility—individuals can participate from any place, at any time. If properly managed, the online mechanisms could also sustain informed discussions over longer periods of time as compared to those for face-to-face dialogues. Moreover, smart mobile phones represent a fast-growing communications phenomenon: Pew's 2008 Internet of the Future survey reveals that most experts envision the mobile device as the primary connection tool to the Internet by 2020 (Anderson and Rainie, 2008). Mobile phones clearly appear to have the potential for increasing real-time participation.

Challenges to Online Participation

Challenges to online citizen participation remain: It may not be representative of the population. People with higher socioeconomic status, greater Internet and computer skills, and of a younger age are more actively represented in online public participation (Best and Krueger, 2005; Krueger, 2006; Smith et al., 2009). Lukensmeyer and Torres (2006) highlight four barriers to online citizen participation:

- Lack of standards for online engagement;
- Fears about information overload;
- Lack of adequate public representation due to a digital divide; and
- Inconsistent website design and user experiences.

From an organizational viewpoint, Moon (2002) identifies impediments such as the lack of financial, technical, and personnel capacities and legal issues (such as privacy) in advancing local e-government. Similarly, Tulloch (2008b) argues that institutionalizing PPGIS requires a significant funding commitment and leadership that recognizes the future value of PPGIS. Robey and Sahay (1996) find that GIS implementation processes that advance users' learning are likely to result in organizational transformation. In his critique, Caquard (2003) argues that the use of Web GIS maps could disguise a centralized management process as a public participatory one. In her exploration of Internet adoption by government agencies, Fountain (2001, 88) observes that technology is adopted within a "technology enactment framework," in which "the embeddedness of government actors in cognitive, cultural, social, and institutional structures influences the design, perceptions, and uses of the Internet." Technologies such as the Geospatial Web 2.0 platforms also are not adopted in a vacuum; rather, they are adopted within contextual settings where political, financial, and human considerations are significant.

Four Aspects of Using GIS to Increase Public Participation

The increased user-friendliness of the Geospatial Web 2.0 platforms, the increased scope of online participation mechanisms, and the growth of mobile communication devices—by themselves—do not imply that GIS adoption would enhance participatory decision making. Four aspects of participatory decision making using GIS can be identified, all of which are relevant for highlighting the challenges as well as opportunities of adopting the Geospatial Web 2.0 platforms for enhancing public participation. The first aspect is that of GIS's role in technological and information empowerment. The other three aspects identified by Sieber are: place and people, technology and data, and institutional governance arrangements (Sieber, 2006).

Empowerment. The first aspect of using GIS to increase participation in decision-making deals with the technological and informational empowerment of citizens and community groups using GIS. There is an emphasis on strengthening GIS skills, data collection methods, enhancing local knowledge, and establishing networks (Cinderby and Forrester, 2005; Talen, 2000). Empirical studies show that GIS could empower marginalized groups by facilitating participatory mapping exercises (Elwood, 2002; Gessa, 2008; Ghose, 2001; Jankowski, 2009; Sieber, 2000). However, there could be asymmetric access to GIS skills and data among various groups, so that GIS could be empowering for some groups while disempowering others (Elwood, 2008; Harris and Weiner, 1998). Empowerment also requires shifts in power relations, which could be difficult in deeply entrenched political structures (Kyem, 2001). Moreover, empowerment may be limited due to opposition from local leaders and to a lack of funding, infrastructure, and skilled GIS personnel.

Place and People. The second aspect of increasing GIS in decision making deals with contextual factors and the characteristics of people in the participatory process. Legal, cultural, and political contexts are important. In the United States, copyright and Freedom of Information Act access laws ensure that federal data such as that from the U.S. Census Bureau is freely accessible; such accessibility enabled greater GIS diffusion in the United States as compared to Canada, where such data access is limited (Sieber, 2003). However, at the local government level, political and other realities may impede access to geospatial data (Elwood, 2008; Laituri, 2003). Lukensmeyer and Torres (2006) argue that federal guidelines for participation are fragmented, outdated, or insufficient; knowledge about the best practices of citizen engagement is also thin. Dwelling on the significance of local political context, Ghose and Elwood (2003) highlight how political relationships among multiple governmental and nongovernmental agencies at different geographical scales play an interconnected role in PPGIS. With respect to the characteristics of people who participate, a persistent debate about participation, in general, and PPGIS, in particular, is the delineation of the boundaries (e.g., geographical or issue-based) of who should participate and who constitutes the "public" (Elwood, 2006; Schlossberg and Shuford, 2005; McCall, 2003; Talen, 2000). GIS may not easily lend itself to full participation by the public, since it requires the intervention of an expert with technological skills to access and manipulate data. Although the Geospatial Web 2.0 platforms are more user friendly, they still require software developers for the applications.

Technology and Data. The third aspect of increasing GIS in decision making is technical, relating to geographical data access and to data ownership. The Federal Geographic Data Committee was established in 1990 as an interagency committee to promote the National Spatial Data Infrastructure (NSDI) for the coordinated development, use, sharing, and dissemination of geospatial data. Many states have also established GIS data clearinghouses and regional SDIs for collaboration (see Appendix for a list of state websites).

Local governments and grassroots groups are important stakeholders in developing such SDIs (Elwood, 2008). Schuurman (2006b) argues for extending existing metadata standards (e.g., ISO 19115) to include context-based and tacit information about semantic attributes of spatial data for PPGIS. Haklay and Tobón (2003) highlight the synergy between PPGIS and Human Computer Interaction (HCI) to argue that HCI and related usability evaluation techniques can be used to make GIS more accessible for public participation. With vast repositories of data, local governments have a particularly crucial role to play in enabling citizens to access the data, yet only large and tech-savvy cities such as Portland, Oregon; San Francisco; Washington, D.C.; New York; and others have made such data available (Sutter, 2009).

Governance. The fourth aspect of increasing GIS in decision making is concerned with the governance arrangements for GIS implementation processes, participation in policy making, and decision-making structures (Sieber, 2006). The presumption is that the institutional conditions affect access to GIS data and consequent participation (de Man, 2003). There are many intermediaries in providing GIS data: government agencies, the quasi-autonomous nongovernmental organizations, university research centers, and nonprofit community-based organizations (Sawicki and Peterman, 2002). In addition, community learning centers (e.g., public libraries with computers and Internet access) could also provide such data. Supportive institutional networks are required to facilitate collaborative decision-making processes using the GIS data. In this vein, Balram and Dragicevic (2006) argue for supportive workspace environments for map-based analysis and visualization, multimodal interfaces for participant interactions, and digital databases. Ramsey (2009), however, argues that a premature orientation toward problem-solving activities could undermine the exploration and reconciliation of diverse problem understandings among stakeholders in a collaborative process in environmental management.

According to Hwang and Hoffman (2009), for neighborhood information systems to be effective, it is important for them to be user friendly, but it is also imperative to understand specific user needs and provide training support. Elwood and Ghose (2004) synthesize four institutional factors that affect community-based organizations engaged in participatory decision making: organizational knowledge and experience; networks of collaborative relationships; organizational stability; and organizational priorities, strategies, and status.

Looking Ahead: Future Trends

Three trends on how local governments can adopt Geospatial Web 2.0 platforms to enhance citizen-oriented public services are discussed below.

Trend One. Increasing Transparency: Making an Agency's Geospatial Data Public and Machine Readable

Local government agencies are vast repositories of public information. If the geospatial data are made publicly available in standardized formats, they could be used by citizen groups and private agencies to enhance citizen-oriented public services. Instances of such use are already evident with the data made available by public transit agencies. Public access to the transit data in the General Transit Feed Specification (GTFS) format has encouraged the development of innovative third-party applications to better serve citizens. Independent software developers in Portland, San Francisco, New York, and other cities have created many useful transit tools for riders, including applications for places of interest near transit stops, text alerts when nearing a station, a transit time map, searching for the nearest stops, and so on.

Washington, D.C.'s Open 311, which allowed access to the city's public data feeds for its "Apps for Democracy" contest, demonstrates how a wide range of applications can be generated when geospatial data are made publicly available. The contest generated 47 useful and innovative applications. The prizewinner, the DC 311 "app," enables iPhone users to report physical issues, such as graffiti, potholes, etc. A few of the other applications developed for the contest include:

- **Park It DC:** an application to check a specific area in the city for parking information;
- **DC Community Gardens:** an application to locate local community gardens;
- **Achieve D.C.:** a tool that shows both the elementary/middle/high school test score levels and the poverty rate in the related areas;
- **Department of Consumer & Regulatory Affairs Building Permit Dashboard:** a tool that sorts data by address and provides Google Street Views of building permit information;
- **DC Bikes:** an application for bike-friendly information about the city; and
- **PointAbout Alerts:** a real-time iPhone application to report crime and building permits.

Access to public domain data from other cities and local government agencies also could enhance citizen-oriented public services. "Are You Safe?" is a mobile Geospatial Web 2.0 application available in five cities (Atlanta, Indianapolis, Milwaukee, Sacramento, and Washington, D.C.) to inform users about their safety level based on their current location within a city. The safety level is drawn from the neighborhood's up-to-date crime data available from police and local governments. Public data on crimes in other cities could be similarly harnessed to provide safety information based on a person's location using mobile phones. As discussed earlier, the City and County of San Francisco established DataSF (http://datasf.org) as the central clearinghouse for its data sets. The data are for a range of agencies, including administration and finance, environment, housing, public safety, public works, and transit. To date, over 25 Geospatial Web 2.0 applications have been developed using the data. These applications include:

- **Crimespotting:** an interactive application for mapping crimes;

- **CleanScores:** reports health inspection scores of restaurants;
- **EcoFinder:** an iPhone application to find out where to recycle; and
- **Mom Maps:** an iPhone application to find kid-friendly locations in San Francisco.

Trend Two. Engaging Citizens: Tapping Citizen-Volunteered Geographic Information

The Geospatial Web 2.0 platforms have enabled ordinary citizens to voluntarily create, assemble, and disseminate geographic information. With GPS-enabled devices, amateur citizens can generate and share geographical information quickly over the Internet. Smart phones and cameras with GPS devices document events and incidents that can be shared quickly using social networking. As Goodchild (2007b) has argued, citizens are intelligent sensors who can provide useful information about the environment in which they live. The participatory GIS efforts of citizen volunteers widen the domain of mapmaking from professionals and facilitate democratization of GIS (Dunn, 2007). At a time when mapping agencies are facing budget crunches, there are cost advantages to be had from citizen efforts to provide geographical information. Local planning and zoning agencies could support the voluntary mapping efforts of new neighborhoods that are not yet formally included in maps. For example, OpenStreetMap has organized online mapping parties to clean up the TIGER data and undertaken mapping expeditions in over 50 cities. Of course, such voluntary efforts need to follow the standards and protocols for geospatial information.

The citizen-volunteered geographic information can be tapped by local agencies to enhance their public services. Seeger (2008) shows that marginalized and excluded groups can be included to provide such voluntary geographic information. The local spatial knowledge can assist landscape architects and related designers to create a more informed design solution. In the event of a disaster, the local people in the vicinity of the event are the ones with in-depth knowledge about the ground situation. Citizens can report conditions through mobile phones, using voice, text, or pictures (Goodchild 2007a). Combined with Twitter (a microblogging service), citizens can relay information about incidents instantaneously. Voluntary citizens could assist government agencies with providing local information for environmental monitoring (Gouveia and Fonseca, 2007).

Trend Three. Increasing Participation: Enhancing Citizen Participation in Decision Making

To date, the use of the Geospatial Web 2.0 platforms for meaningful participation in planning and decision-making processes has been limited. Meaningful public participation entails involvement, collaboration, and empowerment, wherein citizens know that they can make a difference in the decision-making processes. Presently, the use of the Geospatial Web 2.0 platforms in such democratic processes has not yet developed in the broader context of participatory processes in e-government. Yet, there is potential for the use of the Geospatial Web 2.0 platform in online deliberative mechanisms for which geographical issues are crucial to the decision-making. As described earlier, the McHenry County GeoPortal (Illinois) provides an illustration of how planning scenarios can be simulated.

The Portland, Oregon Metro's "Build-a-system" tool, built upon Google Maps for planning the region's High Capacity Transit System (Metro, 2009) provides a useful guide on how the Geospatial Web 2.0 platform could be useful to support public participation in decision making. The tool allowed the public to evaluate different routes based on specific criteria (e.g., ridership, environmental considerations, costs, equitability) to make a more informed decision.

Enhancing the Geospatial Web 2.0 platforms' use in participatory decision making is not only a technological issue. Rather, the hurdles are more likely to be institutional, inasmuch as the political and other motivations currently hinder broader participatory processes in decision making. The institutional conditions must therefore be oriented toward enabling citizen participation. This new orientation will require the following:

- The organizational culture of a public agency must itself value participatory decision making. Although participation may be legally mandated, agencies could carry out cursory processes that

Big City iPhone App Comes to Small-Town America

Reprint from *Government Technology*
Karen Wilkinson
February 24, 2010

The days of standing in line at city hall or waiting on hold to make a service request is shifting with the advent of technologies that give citizens easier access to their municipalities.

The Citizen Request Tracker (CRT) application for the iPhone and iPod Touch will give more than 580 cities and counties nationwide the same conveniences those in metropolitan areas like Boston and New York City enjoy. CivicPlus, which provides custom Web sites for these communities, announced Wednesday the release of the CRT application to those already using its CRT system, with hopes of increasing citizen involvement.

“We're bringing an unprecedented level of citizen engagement to small and medium-sized municipalities,” CivicPlus CEO Ward Morgan said in a press release. “This application provides a citizen-centric mobile platform that facilitates 24/7 interaction between constituents and their government—and we're doing it at no additional cost to our clients.”

For non-emergency issues, citizens can access the app, add a description of the issue and a photo if needed, then send it to their municipality's CRT system. Using the phones' GPS technologies, the app automatically pinpoints the location, which will hopefully improve response time, the press release said.

The CRT has been used via the Internet for several years by various cities and counties, but the iPhone and iPod Touch app will expand the methods by which citizens can submit requests.

In Kennesaw, Ga.—an Atlanta suburb of roughly 20,000 people—IT Director Teri Chambers says the CRT has increased efficiency and that citizens “love it.”

“They're not standing at a counter [and] they don't always want to pick up a phone,” Chambers said, noting citizens can also anonymously report issues. “It's a fairly popular feature on our Web site.”

Once a request is submitted, it's filtered through the agency's CRT system, where it's automatically routed to the appropriate staff and tracked. The citizen receives a confirmation e-mail and can then view the status of their request along with comments posted by staff.

“This goes directly to the [appropriate] person's inbox and it copies other people along the way,” Chambers said. For example, a police department request would be copied to the responding staff person's superiors, in case of their absence and to ensure follow-through.

While getting the word out that citizens can simply use a handheld device to make requests will take some time, Chambers is sure the technology will catch on. “I really do think this is the way the future will be,” she said. “It's a really interactive feature.”

The CRT app is compatible with any iPhone or iPod Touch with operating system version 3.0.

Source: *Government Technology website (www.govtech.com/gt/746977)*

pay lip service to participation in order to avoid public criticism of top-down decisions (Thomas, 2000; Weiner and Harris, 2008).

- Despite increased GIS accessibility over time, online participation may still attract an unrepresentative sample of the population—those who have access to computers and the Internet.
- Organizational impediments to advancing e-government, such as the lack of financial, technical, and personnel capacities (Moon, 2002) must be overcome in order to advance the Geospatial Web 2.0 platforms (Tulloch, 2008). Robey and Sahay (1996) find that GIS implementation processes that advance users' learning are likely to result in organizational transformation.
- Enhancing the Geospatial Web 2.0 platforms in participatory decision making will also require collaborative organizational networks to facilitate user-friendly technologies (Balram and Dragicevic, 2006; Hwang and Hoffman, 2009). Such collaborative networks can bridge experts and citizens.

Overall, the growth of Geospatial Web 2.0 platforms provides opportunities for local governments to enhance their citizen-oriented public services and to seek greater participation. As this report has identified, entrepreneurial local governments have begun to take advantage of these opportunities. While agencies such as transit authorities, planning departments, 311 call centers, and property appraisal offices have been among the early adopters, Geospatial Web 2.0 platforms are also useful to enhance citizen-oriented services for a number of additional agencies, including public safety, emergency management, parks and recreation, environmental protection, and others.

Appendix: State Geospatial Data Clearinghouses

The federal government's much-heralded transparency website, www.Data.gov, offers a substantial amount of federal agency data—and geodata, as well. Many states have created their own geospatial data clearinghouses. Following are links to each state's GIS resource center(s):

State	Website	Web Address
Alabama	Alabama Metadata Portal	http://portal.gsa.state.al.us/Portal/index.jsp
Alaska	Alaska Geospatial Data Clearinghouse	www.asgdc.state.ak.us/
Arizona	Arizona Electronic Atlas	http://atlas.library.arizona.edu/map.html
	Arizona State Cartographer's Office	http://sco.az.gov/downloads.htm
Arkansas	Arkansas GIS Gateway	www.gis.state.ar.us/
	GeoStor	www.geostor.arkansas.gov/Portal/index.jsp
California	Cal-Atlas Geospatial Clearinghouse	www.atlas.ca.gov/
Connecticut	Map and Geographic Information Center	http://magic.lib.uconn.edu/
Delaware	Delaware Spatial Data Clearinghouse	http://gis.smith.udel.edu/fgdc2/clearinghouse/
Florida	Florida Geographic Data Library	www.fgdl.org/
Georgia	Georgia Spatial Data Infrastructure	http://gis.state.ga.us/
Hawaii	State of Hawaii Office of Planning GIS Hawaii Statewide GIS Program	http://hawaii.gov/dbedt/gis/
Idaho	Inside Idaho	http://insideidaho.org/default.htm
Indiana	IndianaMap	http://inmap.indiana.edu/index.html
Kansas	Kansas Geospatial Community Commons	www.kansasgis.org/
Kentucky	Kentucky Office of Geographic Information	http://technology.ky.gov/gis/
	Kentucky Division of Geographic Information	http://dgi.ky.gov/gisdata.htm
Louisiana	Atlas: The Louisiana Statewide GIS	http://atlas.lsu.edu/
	Louisiana Geographic Information Center	http://lagic.lsu.edu/
Maine	Maine Office of GIS	http://megis.maine.gov/catalog/
Massachusetts	Massachusetts GIS	www.mass.gov/mgis/massgis.htm

State	Website	Web Address
Michigan	Michigan Center for Geographic Information	www.michigan.gov/cgi
Minnesota	Minnesota Geographic Data Clearinghouse	www.lmic.state.mn.us/chouse/index.html
	GeoGateway	http://geogateway.state.mn.us/documents/index.html
Mississippi	Mississippi Automated Resource Information System	www.maris.state.ms.us/
Missouri	Missouri Spatial Data Information Service	www.msdis.missouri.edu/
Nebraska	Nebraska Geospatial Data Bank	http://www.dnr.ne.gov/databank/spat.html
New Hampshire	New Hampshire GRANIT	www.granit.unh.edu/
New Jersey	New Jersey Geographic Information Network	https://njgin.state.nj.us/NJ_NJGINExplorer/index.jsp
New Mexico	New Mexico Resource Geographic Information System	http://rgis.unm.edu/
New York	NY State GIS Clearinghouse	www.nysgis.state.ny.us/
North Carolina	North Carolina Geographic Data Clearinghouse	www.cgia.state.nc.us/
North Dakota	North Dakota Geographic Information Systems	www.nd.gov/gis//
Ohio	Ohio Geographically Referenced Information Program	http://ogrip.oit.ohio.gov/
Oklahoma	Oklahoma Center for Geospatial Information	www.seic.okstate.edu/
	Oklahoma State GIS Council	http://okmaps.onenet.net/index.html
Oregon	Oregon Geographic Data Clearinghouse	www.oregon.gov/DAS/EISPD/GEO/index.shtml
Pennsylvania	Pennsylvania Spatial Data Access	www.pasda.psu.edu/
Rhode Island	Rhode Island Geographic Information System	www.edc.uri.edu/rigis/
Tennessee	Tennessee Spatial Data Server	www.tngis.org/
	TNMap	http://tnmap.state.tn.us/portal/
Texas	Texas General Land Office	www.glo.state.tx.us/gisdata/gisdata.html
Utah	Utah GIS Portal	http://gis.utah.gov/ http://agrc.its.state.ut.us/
Vermont	Vermont Center for GIS	www.vcgi.org/ www.vcgi.org/dataware/
Washington	Washington State Geospatial Clearinghouse	http://metadata.gis.washington.edu/
West Virginia	West Virginia States GIS Technical Center West Virginia State GIS Data Clearinghouse	http://wvgis.wvu.edu/data/data.php
Wisconsin	Wisconsin Land Information Clearinghouse	www.sco.wisc.edu/wisclinc/

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