Using Geographic Information Systems to Increase Citizen Engagement

By Sukumar Ganapati

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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." 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 article 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 standalone 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.

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.

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

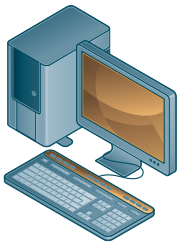
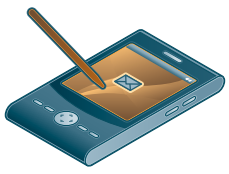
The traditional desktop-based GIS was accessible only to technical experts and professionals, because expertise was needed to use the highly technical software running on a desktop computer. With the adaptation of GIS to the Internet through Web GIS and Geospatial Web 2.0 platforms, GIS became increasingly 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:

- **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 departments 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." Web 2.0 developments and GPS-equipped devices have enabled participatory GIS by allowing amateur citizens to generate and share geographical information quickly

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

This table 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.

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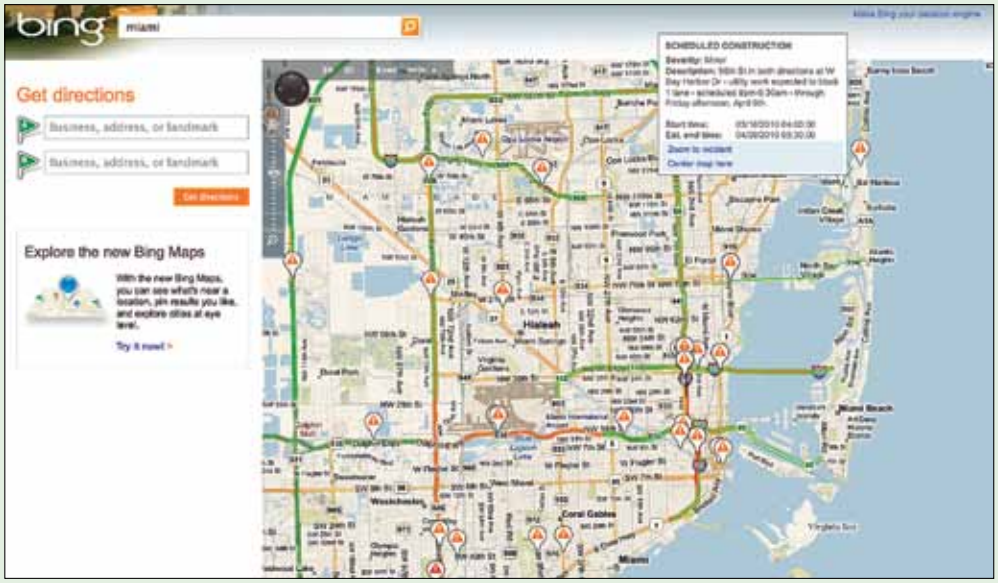
over the Internet. Local governments can take advantage of such real-time information to increase their efficiency in service delivery.

- **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 article describes, entrepreneurial local governments have begun to take advantage of these opportunities. In principle, GIS should particularly benefit those public services that have spatial dimensions. 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,

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



MapQuest, for example, provides thematic maps of traffic for 85 metropolitan areas that are updated every five minutes. 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.

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.

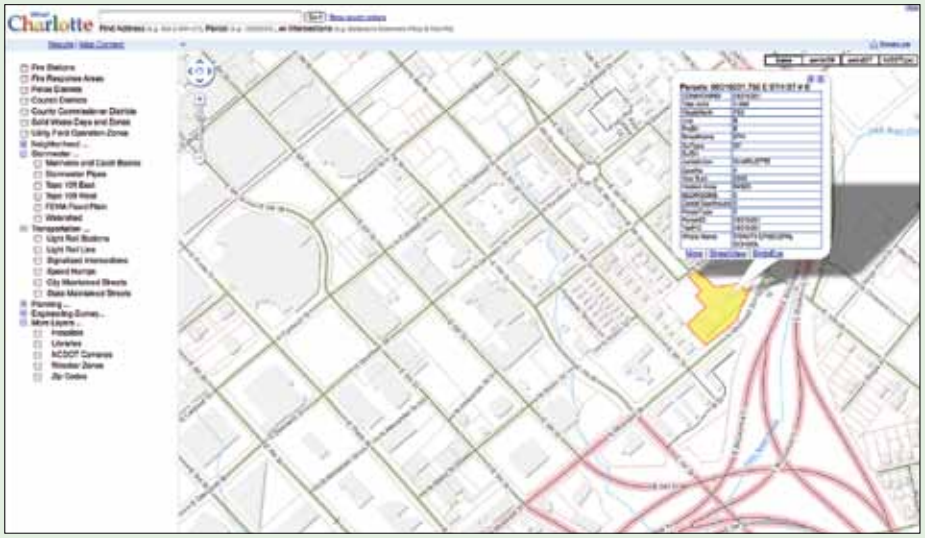
Trend One. Transparency: Making an Agency's Geospatial Data Public and Machine-Readable

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

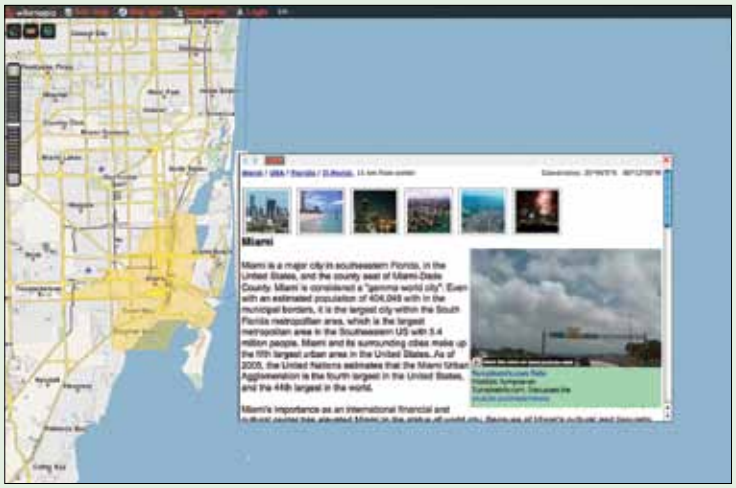
Geospatial Web 2.0 platforms have enabled ordinary citizens to voluntarily create, assemble, and disseminate geographic information. With GPS-enabled devices, amateur citizens can generate and share geographical information quickly over the Internet. Smart phones and cameras with GPS devices can document events and incidents that then can be shared quickly using social networking. As Goodchild 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.

Virtual Charlotte



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 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.

Place description in WikiMapia



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.

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, 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.

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. We've identified entrepreneurial local governments that 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. ■

TO LEARN MORE

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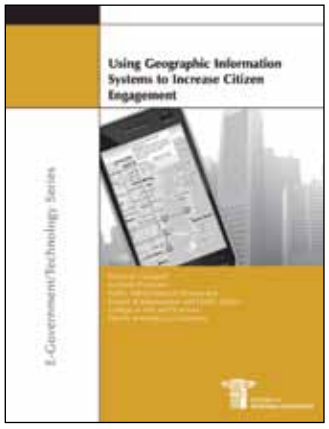

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