Community GIS

Leveraging Technology to Enhance Service Delivery to Local Residents and Businesses

Prepared by

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Executive Summary

Geographic Information Systems (GIS) programmers and researchers have continually sought ways to advance the reach of geospatial data collection and the associated problem-solving capabilities that they offer. As advances have been achieved, users have been able to utilize new ways to gather, visualize, and analyze graphical data.

The development within GIS that we see today offers new possibilities for community leaders and city planners to extend the reach of planning efforts. As computing power and data storage have increased, new tools have been developed to allow for significant new capabilities in urban planning, disaster response, market research, and resource management.

With these capabilities, the advent of "smart cities" carries real potential for continued development. GIS offers capabilities never before seen, and the potential offers new applications for communities.

Developments in GIS

Many date the origins of GIS to 1854, when British physician John Snow mapped the outbreak of cholera in London by tracking the locations of cases and elements of physical infrastructure, including roads, property boundaries, and water lines. His work created a new field of epidemiology, but at the same time, the field of graphically demonstrating geography was just starting as well.[1]

In the 1960s and 70s, work began to move mapping away from paper-based systems and begin utilizing increasing computing capabilities. The use of line printers, data storage in mainframe computers, and recording data coordinates initiated the move of GIS into the modern world. Layered GIS systems could now be used to track soil, drainage, and climate conditions to enable the development of more accurate land planning decisions. The U.S. Census Bureau began to digitize census boundaries with advanced file formats.

As memory size and graphics capabilities continued to advance in the 1980s and 90s, a new breed of GIS software vendors entered the market, each offering an array of mapping and analytics capabilities, leading to the development of increased capabilities for end users. With rapid advances in computing power, software options, and remote sensing technologies, users now had access to a broader array of capabilities, including spatial analysis and vector data mapping. With a burgeoning set of satellites supporting GIS systems, new products like car navigation systems and unmanned aerial vehicles gained traction. Today's GIS continues to grow in breadth and capabilities, leading to a wider set of options.

One of the leading current developments within GIS involves the increasing use of real-time data. Uber uses real-time data so that drivers and passengers have up-to-the second information about locations so that the enterprise works. Bike sharing systems can deliver information to potential riders about the availability of bicycles. City residents can access real-time information about parking locations, traffic conditions, and city services as they happen. Emergency responders have access to real-time GIS information to respond to events – large and small – using satellite imagery, sensor data, statistical models, and crowdsourced data. The reality of real-time data has extended the reach of GIS capabilities.[2]

Originally focused on back office functions aimed at technical users, GIS now delivers a wealth of information to consumers on a variety of issues. A prospective homebuyer now has access to GIS-enabled real estate apps that provide information on the neighborhood. Map layers provide information on home amenities, local schools, and availability of public transportation.[3] Personal fitness devices leverage GIS as they map personal health metrics to geolocated markers.

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[1] "The Remarkable History of GIS". (March 5, 2020). GISGeography.
[2] USC Dornsife, Spatial Sciences Institute.
[3] "GIS Provides Context for Homebuyers", ESRI.

Perhaps the most exciting development in GIS involves the rapidly increasing use of artificial intelligence (AI). Developments have been made in artificial neural networks, algorithms that feature interconnected nodes that facilitate advanced decision making. AI allows for GIS systems to extend far beyond traditional structured data like roads and land boundaries to involve layers of calculation involving unstructured data to enable far greater productivity. The potential applications seem endless:

> *"AI can also add value to structured data for tasks, including predicting geospatial events such as car crashes or crime, estimating drive times, or helping businesses determine where to construct the next new store. The list goes on—we are nowhere close to tapping all the potential of machine learning."*[4]

[4] "AI and GIS: Finally Delivering on the Promise" (March 28, 2019). American Association of Geographers.

Opportunities in Community Engagement

Communities that engage in public projects for the benefit of local residents and businesses depend on feedback from the community to help guide the direction of any effort and to ensure that the project achieves targeted objectives. GIS offers the potential to leverage the power of the Internet to connect with a wider audience and gather timely feedback. By connecting a city's project website, social media, and e-mail, it is now possible to leverage the capabilities of GIS to connect to the public in ways not previously possible.

The ways in which communities can utilize GIS systems to guide the progress of engagement efforts can vary quite widely:

- Users can access web-enabled mapping tools to enter data, thereby reducing the work involved in completing project tasks
- GIS-based tools provide a format for the public to provide feedback about such items as design and construction preferences
- Custom mapping tools offer opportunities to create a vision for the public to view related to the vision of project efforts
- Location-based survey data can be gathered on GIS-connected tools to allow communities to respond more adeptly to feedback
- Dashboards offer a comprehensive view into the status of community projects with real-time capabilities

With community-based GIS systems, there exists the possibility for members of the community to interact directly with community leaders, public works, park staff, and even public safety officials about a wide variety of issues – the need for repair of public facilities, a maintenance request, or even availability of services.

We might consider the possibility of utilizing community GIS-enabled tools for a variety of applications that have already been put into practice:

EveryDrop

"*Los Angeles is one of the most beautiful destinations in the world. But being located in Southern California, however, has its challenges. By enabling the EveryDrop platform, cities and counties can put the power of the crowd to work for them. Water waste can be identified quickly, allowing conservation of every drop possible. By using our platform, in conjunction with ESRI's GIS technology, the power of big data comes alive. Water waste can now be isolated, quantified and studied. Education is tantamount in the effort to conserve water, and with the help of EveryDrop it's easier than ever. We have an*

	obligation to be good stewards of our planet's resources, and EveryDrop helps in accomplishing that goal."[5]
Glen Canyon Institute	*"The Glen Canyon Institute, a nonprofit that seeks to restore and preserve southern Utah's Glen Canyon, which was flooded in the 1960s when part of the Colorado River was dammed, has a loyal community of members and people who want to get involved in its conservation projects. One of the ways the institute communicates the importance of its mission is by providing a story map on its website that takes viewers on a virtual tour of the Colorado River, using more than 100 photos of key points of interest."*[6]
RCStats	*RCStats is the City of Rancho Cucamonga's online performance dashboard. This dashboard features performance data about the important services the City provides for its residents in the areas of Public Safety and Community and Cultural Services. Data is collected from the fire department, city fleet vehicles, library services, and community crime prevention.*[7]

How any given community might leverage GIS can vary quite widely. Consider a community with a population of 80,000 that built up their GIS capabilities to enable a set of six specific applications:

- Community Policing – Using citywide optical controllers to extend policing capabilities, reducing crime rates and lowering patrol costs
- Emergency Management – Enabling enhanced dispatching capabilities to increase service levels without increasing operating costs
- Lighting Controls – Using GIS and lighting controllers to ensure proper lighting across the city based on pedestrian traffic
- Residential Monitoring – Integrating optical controllers with GIS to enable 24-hour watch capabilities in residential communities
- Environmental Monitoring – Deploying GIS-integrated environmental sensors to rapidly report problems to city officials
- Parking Management – Facilitating parking program capabilities by integrating system with GIS-connected app that provides real-time information

In total, this community found an excess of $11 million in total value (benefits less capital and operating costs) over a ten-year forecast period:

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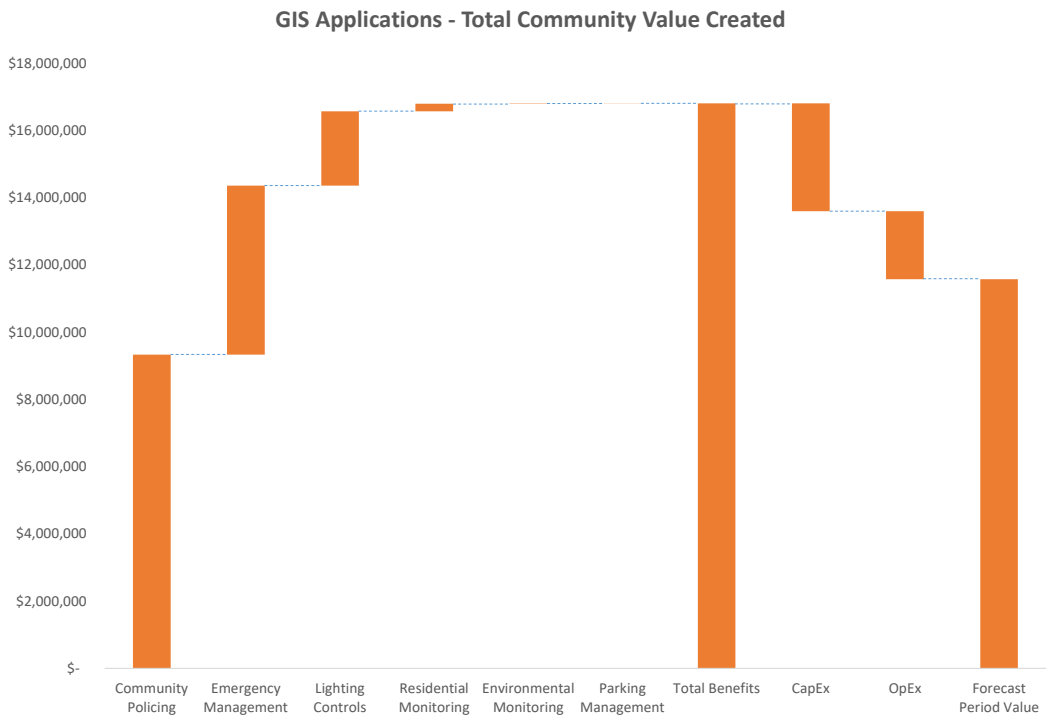
[5] Everydrop Los Angeles by CitySourced, Inc. AppAdvice.
[6] "GIS Empowers Community Engagement" (Summer 2015). ESRI.
[7] City of Rancho Cucamonga, CA.



[8]

[8] The Shpigler Group analysis.

Use Cases

Cities are increasingly finding ways to leverage GIS systems to benefit a wide variety of community programs. By better assessing the needs of the community and the resources needed, communities can leverage a disparate set of technologies to enhance more dynamic decision making. Some of the use cases increasingly being put into practice include:

- Spatial Analysis – Spatial analysis utilizes formal techniques to study geographic data. It is a tool that has been used for hundreds of years for a variety of reasons, including developing a deeper understanding of the spread of pandemics – a key issue as epidemiologists in 2020 try to understand the spread of Covid-19. Communities can utilize this same toolset by leveraging citywide GIS data to understand issues like siting new municipal facilities, traffic patterns, and utility network layout.
- Community Engagement – By overlaying community engagement tools like surveys and incident reports with mapping technology, communities have the ability to more deeply aggregate data to perform detailed analytics concerning a variety of community projects.
- Data Mapping – Cities are increasingly using sensors to track issues like CO_2 emissions or noise pollution. By leveraging GIS-enabled platforms, cities can more effectively manage data that stems from these sensors to assess real-time conditions and identify the need for mitigation strategies.
- Smart Cities – More and more, cities are looking to deploy "smart city" programs as a way to leverage technology to enhance the level of services delivered to local residents and businesses. The technologies deployed under smart city initiatives can vary widely – sensors to detect gunshots, optical sensors to report on citywide incidents, traffic management systems to more effectively facilitate citywide transportation, smart mobility systems to enhance transportation capabilities, and others. Without GIS, the capabilities of these systems are limited to one-off programs. With GIS, these programs have the opportunity to interoperate at the city level and support a deeper level of engagement.
- Dynamic Information Processing – With dynamic GIS systems in place, municipalities have access to real-time information that supports a higher level of community service. Applications can include tracking waste management capacity, city transportation system schedules, and storm paths. Information alone helps, but with dynamic mapping, the information becomes more actionable.
- Enhanced City Planning – City leaders and urban planners have the ability to use GIS to enable system modeling and visualization to support planning efforts. 3D visualization tools can help users assess the impact of key items like new construction or mass transit route changes prior to implementation.

Summary

The presence of open-source mapping and web-based tools enable greater usability of GIS than ever before. The potential for communities to utilize GIS systems to enhance capabilities in traffic management, emergency response, city planning, and infrastructure development offers tremendous benefits.

There are some promising areas of development in the field of community GIS[9]:

- Using 3D GIS to enhance visualization capabilities
- Using augmented reality to support enhanced location-based services
- Creating advanced navigation systems for smart transportation systems and self-driving cars
- Deploying dynamic mapping systems

Each community has a fundamental need to plan, and enabling the latest developments in Geographic Information Systems supports that function. By ensuring that advanced GIS systems are in place, communities can move beyond simple spatial data and move into the capabilities associated with advanced analytics to guide decision making that supports the needs of residents and businesses.

[9] "The Evolution of GIS" (October 15, 2019). USC Dornsife, Spatial Sciences Institute.