GIS For Public Education Initiatives

Paper Number 5143
By Mary L. Johnson

Abstract: Many municipalities are already using GIS technology for public education and benefit by making it accessible on their official websites. For example, current or prospective residents can view municipal GIS mapping from their personal computers, along with the tabular data made available for their reference. An individual or development firm interested in acquiring property can often determine availability, assessed value, zoning information, land use information, and even development restrictions simply by visiting a municipal website. Since websites are available twenty-four hours a day, seven days a week, public education can be a part of just about anyone's schedule. But even for local community groups without access to web technology, GIS is a tremendous resource tool for public education because of its innate ability to combine graphic and tabular data for display purposes. This paper explores current and potential uses of GIS and web GIS for community education initiatives.

Municipal GIS: Where would we be without maps? Even a simple relativity query, such as establishing the distance between two places, becomes an abstract proposition without a good map to guide us. Most websites offering travel directions routinely provide maps to accompany their step-by-step driving instructions to a specified destination. A good map provides a source of visual reference and fundamental sense of place that is virtually unsurpassed by any other means.

GIS maps are often used in the classroom to inspire interest in geography. Children can relate to the interactive aspects of GIS software programs, which make traditional learning projects seem more like fun. In libraries and universities, GIS is often used for research purposes. GIS allows students, educators, librarians and related users to perform a variety of analytical and investigative functions with one software program that might otherwise take hours of cross-referencing to achieve.

GIS is also used by a variety of other professions outside the traditional education fields, including the civil engineering and municipal mapping industry. Civil engineering and municipal mapping firms provide dedicated services to local communities, government agencies and related organizations, assisting them with projects such as road construction, utility infrastructure improvements, planning and development goals, hazardous waste disposal, and general mapping services. Tax maps, zoning maps, land use maps, election district maps and GIS implementation services are among the products most frequently requested by municipal mapping clients.

A GIS map consists of many layers of information, rather like a stack of transparencies behind the computer screen. For municipal GIS purposes, one layer could contain all the roadway lines in the area, another could represent all the waterways, and yet another could contain the utility infrastructure system. Although the individual layers can be

viewed all at once, they are more often interchanged in a variety of ways to best suit the individual needs of each GIS user. For example, while the Police Department is using GIS to analyze crime scenes in their community, the local Utilities Department may be using the same GIS to study fire hydrant locations or overhead utility lines.

In addition to streamlining the process of obtaining, viewing and analyzing municipal mapping and related data, GIS is becoming an important public information tool for many municipalities. The Open Public Records Act requires that, with certain exceptions, government records shall be made readily accessible for inspection, copying, or examination by interested citizens. GIS technology is becoming an important means of complying with this legislation in a number of areas. Using GIS for public education purposes can be as simple as providing hardcopy maps and related data on a per-request basis, or as complex as maintaining an interactive website accessible to all.

Property Information: From hand drawn sketches to onboard navigation systems, maps have directed our migratory instincts for many years.   Maps are also useful on the homefront to provide a more complete sense of who we are and where we come from. For municipal GIS purposes, the local Tax Assessor's Office can be the springboard to customized digital mapping and related data layers suitable for land use, planning, zoning and relocation applications.

Tax maps, in their true and updated state, reflect the entire layout of a municipality in a black-and-white, outline-style format. Every street, body of water, railroad and right-of-way within the municipality is shown on the maps, all in proportionate scale. Proper boundaries around each property are carefully displayed, and property dimensions are noted along each boundary. Related information about each property, such as ownership, parcel identification number, street address, exemption status, assessed value, overall dimensions and land usage, is also included in the municipal tax assessment database. Incorporating this data into the GIS attributes table is a common means of providing interactive mapping for municipal Internet applications and public education purposes.

Tax assessment information can be particularly helpful to individuals relocating to a new municipality. Prospective residents can often use assessed value, recent sales price or other search criteria to target a specific area or neighborhood that interests them. Depending on the available data, they can even click on a particular property with their mouse to reveal basic information about a home's exterior construction material, number of stories, and even its architectural style. Many municipal websites also link zoning information or local land use ordinances to their interactive tax maps, allowing prospective residents to see if that two-story brick Colonial on the corner can be used for residential or commercial purposes, or whether adding a large in-law apartment would be in conflict with local property setback regulations.

Another variation on the tax map theme is to provide the property boundaries in outline format as an overlay on aerial photography of a municipality or region. Being able to look down on an area from above provides a unique and helpful perspective that a formal tax map alone often lacks. For example, a large tract of land on a tax map simply appears

as a dimensioned outline, like a large, empty square. The same property on an aerial photograph can be instantly recognized as a ballfield, a farm, a schoolyard, or even a parking lot. It is also possible to distinguish potential environmental concerns from the air, including oil storage tanks or sewage treatment plants. Many important features of a municipality can be viewed and experienced on the Internet without ever having visited the area, giving today's house hunters and potential business owners a personal and economic edge that was largely unavailable even ten years ago.

Community Service: A variety of mapping foundations, including tax maps, can be used to provide helpful information to residents, tourists and businesses in a community. Even by offering a simple link to an Internet mapping website, a municipality can provide customized maps and directions to its town hall or other public offices.

Many municipalities take this concept a step further by providing an interactive map of their own. These maps are often labeled with locations of interest and links to additional information or related websites. Click on the location of the town hall, for example, to see a pop-up picture of the building and its hours of operation. Click on the location of a school and be instantly transported to the school's own website for firsthand information about its educational opportunities. Click on the location of a park and view its recreational facilities or hiking trails without ever leaving your computer.

A map of the downtown business district is a good way to encourage business and retail activity in a community. Interchangeable data layers can include the locations of local restaurants, hometown businesses, retail establishments, public buildings, municipal parking areas, and even banks or ATMs. Hardcopy maps based on this data can be distributed at the town hall or other key locations throughout the community, or made available to new residents moving in to an area.

For municipalities that are transitioning their downtown business centers from one type of use to another, such as from factory/industrial to mixed residential/commercial, GIS can provide tremendous assistance with redevelopment planning. For example, a potential developer may require a certain amount of land for a new project. If a municipality has a GIS database available, a few simple keystrokes may be all it takes to access the locations of all possible sites within the developer's criteria. This information can be printed out and provided to the potential developer as a map, a spreadsheet, a chart, or some combination of the three. Depending on the data entered and stored in the GIS database, additional queries could establish which of these sites has available funding assistance or other redevelopment incentives. Overall maps of community redevelopment areas, sometimes known as Empowerment Zones, Urban Enterprise Zones and Main Street Programs, can also be made available to the public at large on municipal or regional websites.

Public transportation information can also be provided by community websites. Even a simple line map of a region, such as the kind often found in a road atlas, can be overlaid with local bus routes, bike paths, pedestrian corridors and train station locations to provide easy reference. It is also possible to link this type of mapping to regional transit

websites, allowing users to view detailed schedules, fares and important transfer information. Some urban areas even provide real-time traffic information on their websites by color-coding major arteries according to traffic volume or maximum available speed limit. Accident reports can also be linked in real-time to the map, allowing the public to effectively plan the daily commute or a weekend retreat.

Tourist information is becoming increasingly available on the web in areas where attracting visitors forms a large portion of the economic base. Interactive GIS maps on a municipal or urban website allow visitors to view tourist attractions in relation to their surroundings. They can also link to photographs, hours of operation, pre-created printable maps, or site-specific websites with more in-depth information.

The wide variety and increasing availability of municipal information through online GIS technology can also assist in the classroom with more conventional education needs. The Internet often provides an important, up-to-date reference source for students studying about or reporting on cities and towns around the world. What better way to learn about a municipality than from the municipality itself?

Emergency Management and Law Enforcement: GIS has been used for a number of years to direct fire, police and rescue personnel to the location of a fire, accident, crime scene or other emergency situation. By linking the caller's information to the correct location on a map, GIS ensures that emergency personnel are quickly and accurately dispatched. GIS can also be used to promote public awareness and emergency preparedness initiatives.

In areas where wildfires pose a grave concern, municipalities and regional organizations are using GIS to track the spread of fire and make the public aware of potentially hazardous areas. The dry conditions that may precipitate wildfires are also monitored, and public advisories are frequently made available through color-coded maps. Satellite imagery of smoke plumes and charred landscapes, often available in almost real-time format, can be particularly evocative. Maps of fire progression, fire perimeters, damage assessments and traffic detours caused by wildfires can be important tools for residents, visitors and researchers in fire prone areas.

GIS technology can also assist with online evacuation maps for coastal or flood prone areas. During an emergency situation, traffic flow along local highways may be redirected to streamline mass departures, and residents will need to be informed about the best course of action to take. The locations of community shelters and warning sirens can also be provided in areas likely to be affected by hurricanes, tornadoes, flash floods or other weather emergencies. Should disaster occur, the areas and extent of the damage can be mapped and analyzed using GIS.

Local, regional and global health organizations use GIS to track the spread of infectious diseases, including influenza, West Nile Virus, SARS and HIV/AIDS. Internet users can view and query many of these maps to study the impact of disease on specific geographic areas, or in relation to their local schools, hospitals and neighborhoods.

Although it is a crime to distribute illegal drugs anywhere in the United States, many areas are imposing stricter penalties on any person attempting to distribute drugs while in, on or within a specified distance of any Board of Education property used for school purposes, or while near or on any school bus. These penalties are often extended to persons attempting to distribute drugs in the vicinity of a public housing facility, public park or public building. These safety areas are commonly referred to as drug free zones.

A Drug Free Zone Map, when established under an ordinance by a municipality, may be used to aid in the prosecution of any individual attempting to distribute illegal substances within the areas designated as drug free. Properly created and maintained, a Drug Free Zone Map delineates the appropriate drug free perimeter around each qualifying property, including any overlapping areas in which more than one charge can be levied against the offender.

The ability to create buffer zones around the area adjacent to or within a specified distance of a particular property makes GIS an excellent tool for creating these Drug Free Zone Maps. Once completed, a Drug Free Zone Map can be posted on a municipal website, used in anti-drug education efforts, or to assist law enforcement officials seeking to impose the strictest available penalties on alleged drug dealers.

In New Jersey, a similar law was imposed to protect children against drunk drivers when a local crossing guard was struck and killed by a drunk driver in a school crosswalk as she shepherded two little girls to safety. Stricter penalties are now imposed on intoxicated motorists who operate a motor vehicle while on or within 1,000 feet of any school property used for school purposes, or while going through a school crossing. This law also allows for the production of Drunk Driving Free School Zone Maps describing the 1,000-foot perimeter around all qualifying properties, as well as highlighting the locations of all designated school crosswalks. These maps can be posted on municipal websites, used for community education programs, and provided to the County Prosecutor's Office or local police department for criminal prosecution purposes.

Demographic Information: Since 1790, the Federal government has conducted a census every ten years to determine total population and collect socio-economic background information. The population data will determine if a reapportionment of the House of Representatives is needed to ensure fair representation for all States. The socio-economic information can be used to direct new businesses, target customers, identify poverty stricken areas and assess development needs.

Census data is made available by municipality, county and State, or by smaller geographic areas known as tracts and blocks. Municipalities are generally comprised of more than one census tract, and each census tract, in turn, is generally comprised of many individual blocks. The population and socio-economic information about each geographic area can be linked to its location on a GIS map for in-depth analysis and study. Socio-economic data available as a result of the census is provided by percentage of population, and can include racial background, income, marital status, occupation, birthplace, workplace, education and employment status. Many municipalities are

making this information available online to inform residents about population trends and help them better understand the communities they live in.

Census information can be incorporated into conventional education programs through its availability on municipal websites, or directly from the Census Department's own website, where previously prepared mapping data can also be retrieved.

Voter Information: In addition to assisting the nation as a whole with Congressional reapportionment or redistricting, Census data is also utilized locally to assist with legislative and ward boundaries. The most recent decennial census is used as the population determinant in these cases, and various formulas are applied to fairly and evenly distribute political representation in accordance with these figures. Election district boundaries, however, are largely determined by voter population alone. GIS is an effective management tool for the geographic mapping and tabular data involved in our democratic election process.

During the 2004 Iowa Caucuses, the Bush campaign used GIS mapping technology to direct residents to their proper caucus locations. A map and driving directions were provided to residents accessing this online assistance program. The same type of assistance was provided to voters in the New Hampshire primary election. It was necessary only to type in a residential address in order to view a map and driving directions to the correct polling place.

Similar GIS databases are available on various urban, State or County websites, allowing residents to type in an address to receive information about their individual voting districts and elected officials. A map of the voting district, or just the area surrounding a particular address, is provided, along with helpful information about elections ranging from school district to presidential. The map itself often provides additional links to more in-depth resource data about local representatives, such as party affiliation, contact information or website address.

Hardcopy election district mapping is generally made available to the public through local Boards of Elections. An overall Election District Map of each constituent municipality is created in accordance with local legislation. Each map depicts the geographical boundaries of the municipality's election districts, as well as any ward, legislative, freeholder, Congressional or other applicable district in which each election district is contained. The locations of polling places and other public buildings may also be depicted on each map to provide additional reference. This type of map is helpful to political candidates marking their campaign stops, to citizens groups hoping to encourage voters, or even to educators teaching their students about local democracy at work.

The voting process itself can be monitored with GIS technology. Voter information by precinct can be incorporated in various ways with available mapping data. This makes it possible to analyze voting trends by geographic location, party affiliation or available socio-economic information about each voter. Many newspapers are using GIS maps to enhance their election coverage.

In addition, GIS technology is used in the democratic process to monitor campaign contributions at the local, regional and national levels.

Environmental GIS: Our natural resources are precious commodities that must be protected and sustained for future generations. Various municipal, regional and national organizations are using GIS technology to manage environmental data and encourage public involvement in conservation issues.

One of the most important environmental concerns facing many municipalities is the impact of continued growth on the local water supply, sanitary sewer systems, wildlife habitat and general living conditions. A GIS build-out analysis can provide a critical look at the potential consequences of overdevelopment in a municipality or region.

In order to perform a build-out analysis, it is necessary to utilize an accurate map of the area being studied. The next step is to delineate all land that cannot be developed in the future due to public ownership, deed restrictions, or other factors. It will also be necessary to separately delineate all currently undeveloped land that may possibly be developed in the future, and all land that has already been developed under current land use and zoning guidelines.

Once the worst-case development scenarios have been determined for all area properties, GIS will allow a municipality or region to see into the future. For example, by looking at the capacity of the water distribution system currently in place, and taking the current population into account, it will be possible to study the impact of additional residential and/or commercial development on the available water supply. How many people, properties or businesses can utilize the current water distribution system without overtaxing it? How quickly would area development reach that danger level if a municipality or region left its current land use and zoning regulations intact?

Maximum municipal growth can be averaged out over a period of years to create a progression of maps and data. Maximum growth can also be applied only to specific areas within a municipality, such as the areas most likely to expand, or where current development interest is highest. These areas might include farmland or other large tracts of land where development would be very dense and environmental impact would be greatest. Maps, charts and tables based on this data can be made available at public meetings or over the Internet to graphically display the pros and cons of continued development in an area.

There are a number of other environmental maps that can also assist both municipalities and local citizens groups with public education initiatives.

♦ *A GIS Wetlands Map* will show the boundaries of freshwater, coastal and/or stormwater wetlands within a municipality. These areas often serve as filtration systems for the local water supply, or as buffers against flooding. Therefore, development restrictions will usually apply.

♦ *A GIS Wellhead Location Map* will depict areas where underground sources of drinking water are located. Surrounding areas may have restricted use or access to ensure potable water quality.

♦ *A GIS Open Space/Recreation Map* will depict various types of Open Space by classification, including vacant land, forested land, and protected/non-protected farmland. Many municipalities are acquiring available open land and preserving it from development for environmental protection and future enjoyment.

♦ *A GIS Soil Classification Map* will classify soils by type, making it easier to identify potential areas of poor drainage where new development may be discouraged.

♦ *A GIS Flood Plain Map* will show the areas around streams and waterways that allow the natural spread of water during flood events. This is another area where development restrictions will likely be applied.

The graphic images provided by environmental GIS are helping municipalities across the nation preserve or improve the quality of life for their citizens.

Conclusion: As a fitting tribute to its incredible versatility, GIS technology has become both source and recipient of public education initiatives during recent years.

The fifth anniversary celebration of GIS Day was held on Wednesday, November 19, 2003. GIS Day is a global event sponsored by the National Geographic Society, the Association of American Geographers, the University Consortium for Geographic Information Science, the United States Geological Survey, the Library of Congress, Sun Microsystems, Hewlett Packard, and ESRI. The goal of GIS Day is to raise awareness of this important technology, and how it can streamline the process of information retrieval, comparison, analysis and management for municipal, commercial and educational organizations worldwide.

Since GIS remains a relatively new technology, it seems likely that we have scarcely crossed the threshold into the vast, uncharted world of possibilities it affords. The staggering potential of GIS for both traditional and public education initiatives will ultimately be limited only by our needs, talent and imagination.

REFERENCES/SAMPLE WEBSITES
Remington & Vernick Engineers: Municipal Mapping Projects/CADD, Cartography and GIS Services
http://www.rve.com/services/cadd/projects.html

Englewood, New Jersey: Interactive Municipal Map/Tour of the City
http://www.cityofenglewood.org/tour.htm

Bath, Maine: Aerial Photography and Parcel Maps
http://xmapweb.delorme.com/SABath/XMap.asp

Environmental Protection Agency: Environmental Maps and Related Data
http://www.epa.org

GIS Monitor, February 5, 2004: "Maps, Mapping Services, and the 2004 U.S. Elections"
http://www.gismonitor.com/news/newsletter/archive/020504.php

Los Angeles, California: Interactive Municipal Maps
http://www.ci.la.ca.us/lacity197.htm

Orlando, Florida: Interactive Municipal Maps
http://www.orlandoinfo.com/maps

U.S. Census Bureau: Census Maps and Related Data
http://www.census.gov

San Diego State University, Department of Geography: San Diego Wildfire Maps
http://map.sdsu.edu

World Health Organization: Global Atlas of Infectious Diseases
http://www.who.int/globalatlas

GIS Day 2004
http://www.gisday.com

AUTHOR INFORMATION
Mary L. Johnson, Technical Writer
Remington & Vernick Engineers
232 Kings Highway East
Haddonfield, New Jersey 08033
Telephone: (856) 795-9595
Fax: (856) 795-1882
E-mail: Mary_Johnson@rve.com