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Title

Sharing Municipal GIS Resources: A Regional Approach for the New Jersey Meadowlands District

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Abstract

The New Jersey Meadowlands Commission (NJMC) is a regional planning agency for the Meadowlands District of New Jersey, and is comprised of parts of fourteen (14) municipalities in Bergen and Hudson Counties (www.njmeadowlands.gov). Under a statewide regionalization directive to lower costs by sharing resources, the NJMC is undertaking the task of funding and developing a startup GIS for its constituent municipalities that includes transferring GIS data, technology and training. An integral component of this effort is a customized portal, the Municipal Map Viewer, which serves spatially explicit data to these municipalities. Under this program, core municipal data sets are created, maintained, and updated from a centralized location. Datasets include land records ranging from parcel data to assessment information. This paper centers on the development of the GIS infrastructure and data as well as how municipalities are currently using the system.

Introduction

The NJMC is a New Jersey regional planning agency responsible for the land use and zoning control of parts of fourteen municipalities in Bergen and Hudson counties serving approximately 450,000 residents (Figure 1). The municipalities involved in this program are: Carlstadt, East Rutherford, Jersey City, Kearny, Little Ferry, Lyndhurst, Moonachie, North Arlington, North Bergen, Ridgefield, Rutherford, South Hackensack, Secaucus, and Teterboro. The development of a municipal GIS program was initiated through

Figure 1: District Municipalities within the NJMC

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the directive of NJMC's Executive Director, Mr. Robert Ceberio as a way to share resources and reduce costs through a centralized GIS system.

The intent was also to update the spatial information collected over the years and provide a robust and stable system from which to distribute this information to the region. The Meadowlands Environmental Research Institute (MERI), which is the scientific arm of the NJMC, provided the solution through the Municipal Map Viewer. The Municipal Map Viewer enables the NJMC and District municipalities to collectively manage, distribute and visualize geographic information through an enterprise geodatabase.

An advantage of the system is that it reduces the amount of time staff spends searching for records pertaining to properties. Prior to the Municipal Map Viewer, a staff member or municipal engineer/planner would need to search through a paper catalog system, and then look for the paper records in the file room where these are stored. With the new system, updated parcel information on any property is just a click away.

The development and implementation of the Municipal Map Viewer has saved the NJMC and its constituent municipalities thousands of dollars in software licenses, specialized staff and outsourced contracts. It has created an operational system based on Internet browsers where people of different abilities can easily be trained to access and use spatial information via the Internet. Most importantly, the program provides continuous updates, technical support, and training to ensure that the information is up to date and that new users are continuously trained.

The development of the final system and application took place in close consultation with municipal officials and end users. This was a real advantage since users of different abilities who quickly mastered the application were able to suggest useful changes that in the end resulted in a better system. In addition, and as a result of training sessions and new awareness of GIS tools and associated technologies such as Global Positioning System (GPS), new data and information is now flowing in from the different municipalities and populating the central data repository for the benefit of everyone in the region. The objective of this paper is to present the different steps of implementation, lessons learned, and identify the aspects of the program and system that contributed to make it a success.

Background and Community Needs

In the broadest sense, our user community consists of NJMC staff (approximately 120 mainly professional staff) as well as the fourteen constituent municipalities of the Hackensack Meadowlands District (HMD). Each municipality is comprised of different departments and professionals that utilize the Municipal Map Viewer, specifically the tax assessor, fire department staff, municipal planners/engineers, construction officials, public works staff, and the town/borough administration.

Decision makers and emergency responders need to have the most accurate and up to date information at their finger tips. The Municipal Map Viewer is designed to fulfill some of the most common information needs of the day to day management and planning of a municipality and support its emergency management operations (Campagna, 2006).

As an example, prior information management methods of resources, infrastructure and assets included mainly paper files and paper maps. Under the Municipal Map Viewer this information is now readily accessible and easily integrated with other information such as census data or parcel and property data. Management of municipal infrastructure is a highly spatially involved task. Municipal inventories and representation of infrastructure in a spatial context is greatly improved by the Municipal Map Viewer.

Emergency managers and first responders need on-the-ground information to effectively respond to emergency situations. They need to be able to inspect surrounding areas of an emergency and assess the immediate road infrastructure and spaces for deploying heavy equipment, location of fire hydrants and storm water drains, building foot prints and know ahead of time of any potential hazardous chemicals stored in industrial facilities. The ability to have this information readily available greatly improves the quality of their decisions and helps them optimize the allocation of resources (Figure 2).

Figure 2: Example of the ERIS application interface mounted in an emergency vehicle.

We have seen an exponential growth in the use of the system and expect that as municipalities become increasingly familiar with the applications, they will identify additional datasets and functionalities that help them meet their objectives.

In order to serve users of different abilities, the program provides customized manuals with exercises specific to each individual municipality. Although this has added time to the process, it has proved an effective approach to training a community with disparate abilities and involved in different aspects of municipal operations. In addition to the workbook exercises and fieldwork that trainees go through, we continuously offer refresher courses to intermittent users of the system. Overall, the fourteen municipalities in the program serve approximately one-half million people and we train six to ten people per year for each municipality.

The user-friendly Municipal Map Viewer has increasingly become an integral part in the daily operations of the municipalities, and has earned acclaim from the those utilizing its services. As Michael Gonnelli, Battalion Chief/Superintendent of Public Works in Secaucus, New Jersey stated, "I personally use this system on a daily basis, quite honestly this has become a valuable tool which we could not do without."

Methods

Below are the main steps that were followed in developing the Municipal Map Viewer:

Define the User Community: In order to get a better understanding of the user community, we first evaluated the user requirements. We met with several municipal officials (e.g. Department of Public Works, Firefighters, Town Clerk) and through one-on-one sessions we were able to identify their specific needs. This allowed for effective feedback from municipal staff members. We were able to understand the different business processes from several departments and identify how they were inter-related. This was accomplished by a presentation of what we thought they needed, followed by a feedback session where they had the opportunity to submit to us what they really needed.

Figure 3: Relationships developed for spatial/non-spatial objects defined under the geodatabase design.

Conceptual Model: This consisted of laying out all pertinent data required for development of the geodatabase that would fulfill the requirements of our users (ESRI, 2004). From our interaction with users and analyses we were able to identify geographic layers, tables, attributes, and define how they would need to relate to each other (Figure 3). This allowed us to bridge our ideas between the analysis and design of the geodatabase.

Conceptual diagrams were drawn to depict municipal business workflows. Through this exercise we identified attributes that connect several processes. We concluded that block and lot designations and address are the key attributes in conceptualizing relationships within the municipal and the NJMC departments, and their operations.

Physical Model: This was a discrete diagram of the component datasets. We used Microsoft Visio to diagram components, schema and relationships that were defined in the conceptual model. An instance of this relationship included mapping parcels and their relationship or cardinality with owners. Other components included mapping buildings and establishing a relationship to NJDEP's Right-to-Know (RTK) data (http://www.state.nj.us/health/eoh/rtkweb). Today, these relationships are key features of the current system.

Development and Testing Phase: A functional system was developed to support the municipal GIS and NJMC operation. This system is a geodatabase that encompasses features and components to address geographical, environmental and emergency aspects of municipal governments. Desktop and portable computing devices were equipped with standard and custom applications to access services and information. Other components include tablet PCs for emergency managers, GPS units, high-end servers and high speed Internet connections. Versions were released to the municipalities for Beta testing prior to going fully operational.

Building the Enterprise Geodatabase: This task involved developing the datasets and feature classes (layers) defined in the physical model and included the parcel feature class and all its

attributes and relationships (MacDonald, 2001). The geodatabase includes the following components:

- Classes, subclasses, and subtypes;
- Class attributes, data types, and attributes rules (domains & default values);
- Relationships and relationship rules (cardinality).

Deployment: The Municipal Map Viewer is comprised of three separate applications which were developed and deployed based on the initial conceptual model:

1. General Municipal Map Application
2. Parcel Map Application
3. Emergency Response Information System (ERIS).

The data connections to the General Municipal Map Application (1) and the Parcel Map Application (2) (Figure 4) occur through ArcSDE and ArcIMS, and Internet Explorer is used to view geographic information

Figure 4: Screenshot of the Municipal Map Viewer (Parcel Map Application)

(Thomas, 2005). The ERIS application (3), a stand-alone application independent of the Internet, provides critical information to emergency officials on potential hazards that buildings may contain within their municipality.

Modifications to the original system design were prevalent throughout the development cycle. For example, a number of instances were explored particularly with the fields that were defined in the model. We shortened the number of fields that were originally displayed from the property records and the parcel data. This amounted to the consolidation or elimination of more than 50 fields of non-critical data and the incorporation of 16 fields suggested by municipal and NJMC staffs. As a result, the final system is more user-friendly by only displaying easy to interpret meaningful data.

Additional modifications included database relationships between owners and parcels. Originally, the relationship was one parcel having many owners which resulted in redundant data. We redesigned the relationship by creating a many-to-many relationship between our owners and parcels. The solution was to create an intermediate table that acts as a link between the parcel data and the owner data (Rigaux, et al, 2002).

Because of specific feedback from municipalities, the initial buffer functionality to select properties near other properties evolved even further so that if a user buffers parcels within a specific distance (e.g. 200 feet), the selected records included in the buffer area can then be exported into a Microsoft Excel table and from here owner's name and address can be used to generate mailing labels for variance notifications.

Other improvements include the Google Directions capability. We integrated the parcel address attribute field with www.maps.google.com. The "get direction" functionality automatically opens and triggers a Google search for the corresponding address. Finally, other post-development modifications included custom designed logos and symbols and more search options for properties by size and land use type or to search properties in a specific municipality.

Discussions

The Municipal Map Viewer is completely transforming and modernizing business processes in District municipalities. The first major enhancement to the business process is the availability of up-to-date information. A case in point would be the frequency of updates to parcel maps. Previous paper parcel maps were typically updated every 10-15 years. From a management perspective, this is simply unacceptable since it significantly impedes a municipality's ability to make rational decisions regarding zoning designations, the issuance of variances, and the passing of future subdivisions. With the Municipal Map Viewer, parcels are updated every time there is a subdivision and this results in information that is always up-to-date and reliable.

The system serves as a central data warehouse, in which all "mission critical" layers of information are available to the different applications. As ground conditions change, such as new subdivisions or a replacement of sewers, historical information is archived and is retrievable. If a court case were to arise regarding previous ground conditions, the necessary information would be tracked as historical information and therefore can be retrieved.

The system has streamlined many procedures and processes. Previously, departments would have to put in a request to another department for certain types of information. The request would have to be processed, and then the information would be released. Likewise, sharing information across municipalities was just as difficult and time consuming. Currently, using Municipal Map Viewer, information is available to many departments within a particular municipality as well as information on adjacent municipalities.

Initially, we considered developing individual ArcIMS applications for each municipality but this approach was discouraged as the amount of time to update and maintain these separate applications became cumbersome and problematic. For easier maintenance and interoperability we proceeded to consolidate and standardize all District data (the fourteen municipalities) into one central data repository. We then created two separate online applications (i.e. one general and one specific for parcels) that draw data and information from this central repository.

A design problem we encountered later on was the relationship between the parcel data and the owner table. The initial design was to have one parcel owned by one or many owners, but upon careful inspection we realized that more than one property can be owned by the same owner. This caused our owners' table to be repetitive and thus, inconsistent. When the user searched for an owner, the search resulted in multiple owners and duplicated owner listings. We improved this by modifying our database design; setting up rules and controls to the search so that results returned by the Municipal Map Viewer are not redundant or repetitive (Flanagan, 1999).

The system presented in this paper is distinguished because although it is shared among different local governments, it is maintained by a central regional planning agency. The system is also unique because each municipality has the ability to include and collect information they want included. Moreover, the entire program arrangement and the way the system is designed supports different degrees of involvement by the municipality and offers options regarding data types and data resolution. Another interesting aspect that differentiates our system is that buildings (building foot-prints) are linked to RTK data. This RTK data is a compilation of the hazardous materials listing for buildings within municipalities that are assembled by NJDEP. Having defined these components, our system is quite unique by providing the ability to inspect for hazardous materials in warehouses by clicking on the building. Systems and applications, such as the one presented here, are usually outsourced to GIS firms and IT-related contractors. In our case, the entire system was designed and developed in-house and we took great advantage of the intrinsic institutional relationships between the NJMC and the municipalities which made possible multiple consultations and feedbacks that ultimately helped shaped the final product.

Conclusion

Municipal Map Viewer has had a profound impact on the quality of services offered by each constituent municipality by improving many aspects of the decision making process. The most significant influence on productivity is reduced turn-around time and the increase in the quality and quantity of information available. Today, the municipalities' emergency services are better equipped with information to handle emergency situations which is ultimately resulting in a higher quality emergency service for the citizens. Finally, the continuous inclusion of GIS technology in municipal workflows has contributed to the awareness of GIS technology to the municipalities. This new awareness has motivated users to expand their business processes beyond paper, and has resulted in a better understanding of information through the ability to perform spatial and tabular analyses. The municipalities that were previously unable to afford GIS expenses are now benefiting from the program; additionally, immense resources are being saved by sharing at a regional level. Since the NJMC is a data warehouse for these municipalities, it has encouraged users to participate in creating additional datasets, and this involvement has not only impacted each individual municipality but the region as a whole.

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