

Water Utility GIS Development and Use in Fulton County, GA

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Abstract

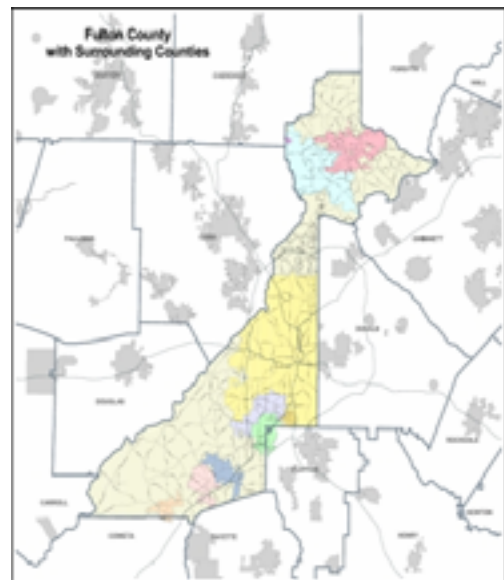
The Department of Public Works in Fulton County, Georgia, is in its fourth year of a five-year initiative intended to create a comprehensive inventory of its water and sewer features. As part of the initiative, Fulton County contracted with Ayres Associates in the spring of 2006 to develop a surface model capable of supporting 2-foot contours from LiDAR (light detecting and ranging) data as well as countywide 6-inch resolution color orthophotography. The new datasets have already proven to be highly useful for infrastructure inventory and watershed analysis – and are also having an immediate effect on how Fulton County engineers make decisions. This paper explores the ways in which County personnel have streamlined business processes by referencing highly accurate and accessible spatial data.

Introduction

Management of countywide infrastructure, especially as it pertains to watershed analysis, has always required highly accurate data. In the case of rapidly growing urban areas such as those found in Fulton County, the data must also be current and directly applicable.

Fulton County found itself in a situation where it wanted to implement a number of new initiatives that required the use of solid geographic data. However, the County lacked confidence in both the accuracy and currency of existing data. Additionally, the technical capabilities of the County's GIS system (and personnel) had far surpassed the data's available formats.

Unwilling to back down from the endeavor that they had undertaken, staff at the County's Department of Public Works made the choice to acquire the needed spatial data in the most efficient, practical, and effective way possible.



Countywide high-resolution color orthophotography was an easy choice as it establishes a fundamental base for effective GIS systems. The County then went further and chose to acquire LiDAR data for the geographic extent of Fulton. This provided the County the assurance that the orthophotography would easily meet all accuracy requirements. Additionally, the choice of LiDAR provided a vast amount of information about the County's land surface – and everything on it. Processed LiDAR data provides a highly accurate model of the “bare earth” terrain. The raw (unprocessed) LiDAR data includes all objects that would reflect a laser pulse back to an airborne sensor – e.g., buildings, tree canopy, and a number of other useful

datasets that can be extracted from the raw data. Note that information regarding the nature of the reflecting surface can be extracted from the LiDAR data allowing for the determination of, for instance, whether the surface struck was concrete or grass.

With this data now in hand, the County is able to put to use accurate, up-to-date information for vital decision making efforts. And the Fulton County GIS staff is now faced with the exciting challenge of stretching their talents and imaginations to fully leverage the wealth of information that the 2006 orthophotography and LiDAR data provide.

History of Situation

In response to the cost of a number of new initiatives, Fulton County began exploring various options for the funding of public works projects. As many counties and communities have done, Fulton County formed a plan to create a taxation structure that would fairly distribute the cost among landowners based upon usage of the wastewater system, as determined by the amount of impervious surface that occupied each parcel.

Early on in the examination of this plan, it became apparent that the spatial information necessary to practically execute the required GIS analysis was not available. In order to acquire the necessary data, Fulton County allocated funds and began the procurement process for a mapping project designed to modernize the spatial data available to inform the County's decision making.

Ultimately, the impervious surface taxation initiative encountered non-technical barriers that it was not able to overcome. Political and legal entanglements put an end to the exploration and the initiative was tabled.

While the original purpose of the 2006 mapping project evaporated, recognition of the limited nature and age of the County's spatial data, and recognition of the benefits of the data's augmentation and modernization, drove the decision to move forward with the mapping project.

Challenges Faced

Although the impervious surface taxation initiative was put on hold, the movement to acquire the spatial data necessary for informed public works decisions progressed. The Department of Public Works continued to examine its data warehouse and categorize its weaknesses as they pertained to core department issues.

The existing data lacked sufficiently modern and accurate terrain information, rendering it useless for properly informing and supporting hydraulic modeling of the existing surface and infrastructure. The Department was unable to provide decision-makers with the technical guidance needed for informed policy decisions. Without current and complete information to drive necessary modeling tasks, the County found it difficult to implement fully informed design tasks.



Fulton County also recognized the opportunity to assist municipalities with their spatial dataset needs. The responsibility for FEMA map maintenance had recently shifted, which created new needs for the municipalities in the Fulton County region. Modern 2-foot contour surfaces were needed to determine accurate floodplains, the accuracy and currency of which would be relied upon for municipal emergency preparedness as well as for conclusive evidence for the financial and legal issues that typically arise when addressing topics related to floodplains.

Long-term initiatives at the Department drove efforts to establish a spatial data warehouse not only to address department business needs but to also act as the countywide mechanism for procurement of the data necessary to meet municipalities' requirements. By acting on a larger region-wide scale, the area's datasets offer greater consistency across Fulton County and, more notably, provided substantial cost savings for the entities within the project area. These initiatives were formed from the foundational ideas that (1) geographic issues do not necessarily recognize political boundaries and (2) to effectively model and design infrastructure within one community, it is necessary to be aware of both the physical and socio-political landscape of the surrounding communities.

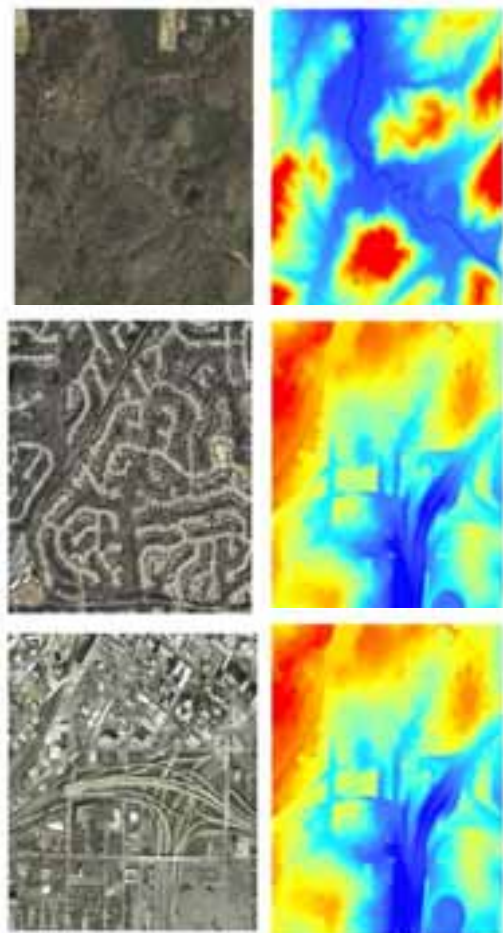
Solution Chosen

Existing efforts to inventory the County's utilities were moving forward as part of an ambitious five-year initiative with the goal of creating a comprehensive inventory of its water and sewer features. These efforts were conducted primarily through an extensive conventional and GPS based survey of water and sewer infrastructure. While the County moved forward with this initiative, it also engaged itself with a second mapping effort that would serve to not only enhance the modeling capabilities of the infrastructure survey, but also provide a larger context that would unify the results of the various surveys into a cohesive spatial warehouse. Another benefit of the remote sensing approach is that much of the ground-based survey work could be replaced by using the orthophotography and LiDAR data. This was an important step considering the investment in time and money that a ground-based survey involves. Additionally, public works tasks by their very nature consider the residents they serve. Ground survey tasks can often be intrusive as crews may need access to private property.

Fulton County chose Ayres Associates, a photogrammetric/remote sensing consultant, to provide mapping services for approximately 700 miles of Fulton County. In March 2006, the Ayres Associates project team conducted two flights over the project area, which includes the geographic area of Atlanta.

The first flight was to acquire high-detail color aerial photography at 1"=660' negative scale. This aerial photography was collected as primary raw material for 6-inch pixel color digital orthophotography meeting ASPRS Class II standards for 1"=100' scale mapping.

The second flight was a LiDAR acquisition mission. The LiDAR data was used directly to provide a



surface for the generation of a countywide 2-foot contour surface model, and to create a surface for the rectification of the orthophotography. Secondly, LiDAR does more than simply offer a cost-effective solution for terrain surface needs. The data contains a wealth of other information about the landscape of the project area, providing information about vegetation, infrastructure, and surface types. LiDAR can be used to fuel tree stand inventories and create 3D cityscapes. It is often used to update and improve existing datasets as well.

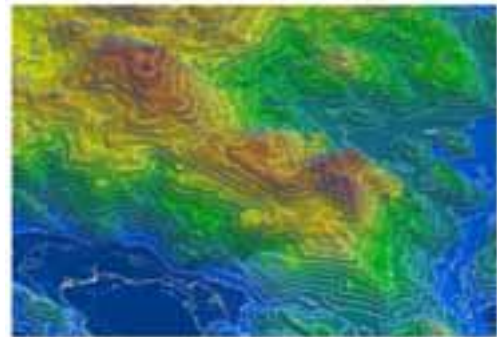
Countywide deliveries for the Fulton County 2006 Orthophotography and LiDAR project included:

- 6-inch orthophotography in TIFF and MrSID format
- 2-foot contours in ESRI shapefile format
- Bare-earth LiDAR data in Arc GRID and ASCII format
- Breaklines in ESRI shapefile format
- Raw LiDAR point-cloud data in Arc GRID, ASCII, and LAS formats

Solution in Action

With a greater understanding of the geographic factors at play in the Fulton County region, the departments responsible for managing environmental permitting processes are able to gather and disseminate spatial data to assist them in the decisions that must be made.

Design. The new topographic surface adds to the data available for watershed analysis and modernization of FEMA maps in the region. Additionally, it is also being used to recalibrate existing datasets to account for temporal change and identify areas of questionable spatial accuracy (and correct them). One example of the benefits of dataset recalibration and data enhancement is the use of the LiDAR data to infer rim elevation for many of the surveyed access points across Fulton County. Another example is the use of the orthophotography to make improvements to the spatial accuracy of tax parcels within the County.



Modeling. The County is now utilizing ArcSDE to store and provide spatial information to its personnel and clients. With fully modern spatial data formats, the County can provide a rich array of data in highly accessible formats for input into modern modeling programs, which makes timely and accurate modeling an easy task. These modeling programs enable the County and its partners to address issues such as those surrounding transportation, water, wastewater, and stormwater design activities. The County's forecasting abilities have also been impacted. The availability of greater amounts of current and accurate data have enabled the County to implement more robust flood risk mapping and subsequent preparation as well as better planning related to law enforcement and disaster planning.

Environmental applications. A large impact of the 2006 data can be seen in the County's environmental initiatives. Now, Fulton County's GIS warehouse is able to provide important information for determining the issuance or denial of National Pollutant Discharge Elimination System (NPDES) permits. The permits serve to manage and enforce the rules and regulations of the Clean Water Act. Large scale facilities must apply for permits if they plan to discharge

directly into surface waters. The data in the County's GIS warehouse helps identify point sources that discharge pollutants and determine how these sources relate spatially with areas sensitive to the pollutants. The spatial relationships are often simply a matter of proximity. In other cases, models utilizing the County's data place the point source within the larger context of the region's system of waterways. By examining these relationships, decision-makers are able to identify and address the potentially detrimental effects that such discharge may have.

The same case holds true for the issuance of Georgia's Environmental Protection Division (EPD) permits. The EPD program addresses a broader range of environmental issues such as:

- The protection of air quality – including the permitting of chemical release and combustion of materials.
- Hazardous waste disposal.
- Land protection issues – including asbestos remediation, issues surrounding lead-based paint, scrap tire disposal, solid and liquid waste disposal, brown-fields, composting, and biomedical disposal.



The EPD also addresses some of the water resource concerns not covered by NPDES such as well drilling and the identification and inventory of environmentally sensitive areas.

A strong GIS that includes accurate and modern surface information allows recognition of the potentially negative effects that all these activities may cause. These activities take place within the region's broader geographic context. With detailed geographic information, the broader implications of these activities can be made clearer. Being able to make fully informed decisions for the issuance of permits such as these directly affects the quality of the County's physical environment and the health of its population.

Ancillary Benefits

Information sharing with area communities. Fulton County's 2006 orthophotography and LiDAR project represents a major step forward for the County's geographic information initiatives. One such initiative is the establishment of a central spatial data warehouse that can provide easy and uniform access to geographic data for communities within the Fulton County region. The County's aim in the establishment of the warehouse was also to establish grounds for the collaboration between communities and the sharing of data, not only to strengthen the spatial data community within Fulton County but also to leverage the investments that all the communities make in the acquisition of mapping products.

In the spirit of these cost-sharing initiatives, the Fulton County Department of Public Works was able to facilitate cooperation between Fulton County and the



City of Atlanta, whereby the City contributed funds to secure citywide orthophotography and photogrammetric materials. From those materials, the City has begun an impervious surface initiative, which uses photogrammetric mapping for the purpose of creating a citywide dataset of impervious surfaces.

Summary

No matter the size of a community of people – from a small town to a nation – proper governance requires a thorough understanding of the entity’s geographic context. Accurate, up-to-date information is absolutely vital. Geographic data informs and communicates information addressing nearly every aspect of our lives. We live in a multidimensional world; the context of our lives is spatial at its base.

Fulton County staff have taken steps to increase their knowledge of the County. That new knowledge has specifically addressed and informed its transportation, wastewater, water, and stormwater design activities. This process has provided information about Fulton County’s physical infrastructure and its political and legal boundaries for the purpose of tax parcel adjustments. And it has provided data for informed planning and prevention in areas such as flood risk mapping, law enforcement, and disaster planning.

Many of the issues faced by a government can be addressed using less detailed and less accurate data. Widely available USGS digital elevation models or other existing datasets may be sufficient for some data needs. However, Fulton County assessed its needs, weighed mapping costs and advantages, and decided to implement an aggressive 5-year mapping initiative that included both ground survey and cutting-edge remote sensing technology. New movements in spatial acquisition technology allowed Fulton County a cost-effective and highly accurate solution for its specific engineering design and analysis needs, in addition to its larger scale modeling needs. The bottom line for the data Fulton County acquired is that any lesser product would not have served the level of detail needed to fully inform the Department of Public Work’s responsibilities.

The Fulton County 2006 LiDAR and orthophotography project has brought the County from the age of Mylar plots to the age of highly detailed digital geographic information systems with a multitude of potential applications. The newly available datasets are fully up-to-date and are able to address a range of information needs far beyond anything available earlier. Equally important is the giant leap forward in the availability of the data. Cost sharing, a data-rich warehouse, and web publishing was only a dream a few years ago; now these are realities for County staff. The entire region has benefited from Fulton County’s project.

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