Automating GIS Analysis in Rezone Application Reviews

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ABSTRACT

The Watershed Management Department of Sarasota County, Florida processes applications to rezone parcels of land for development. Engineers process rezone applications by analyzing how the proposed changes will affect drainage patterns in the applicant parcel and surrounding land. Engineers previously used paper map sources to formulate estimates and make subjective judgments in their analysis of an application.

Spatial data was developed to enable the engineers to provide a more objective analysis of these rezone applications. Spatial data provides definitive information regarding elevations, soil types, floodplains, hydrodynamic networks, and drainage basins in the applicant area. This GIS analysis was conducted manually. The analysis was soon automated using ArcView 3.3 and Avenue to produce an analysis summary.

The analysis summary provides objective data to the engineers to make an application determination. The automated creation of an analysis summary saves time, enhances productivity, and provides documentation for the application determination.

INTRODUCTION

Founded in 1921, Sarasota County encompasses approximately 575 square miles on the southwest coast of Florida. Sarasota County's beautiful beaches, barrier islands, and pristine natural areas make it a very desirable place to live. According to the United States Census Bureau's 2000 Census, Sarasota County had a total population of 325,457 people in residing in 182,467 housing units. The 1990 Census counted 277,776 people housed in 125,493 housing units. In one decade Sarasota County experienced a 17% increase in population and a 19% increase in housing units. Sarasota County is a rapidly developing area and vacant land is in great demand to support this growth.

Many long-time owners of land have been solicited to sell their vacant parcels for development. These lands are often not zoned for development, but due to growth are now not appropriately zoned for their surroundings. Developers can petition Sarasota County Government for a change in zoning designation to be able to develop these parcels.

The "rezoning" process is a careful examination by Sarasota County Government of how the proposed changes will affect the parcel and the surrounding area. Many factors are considered, including how the proposed changes will affect drainage and water flow in the area. The highest point in Sarasota County is only 110 feet above sea level and is approximately 20 miles from the coast. The lack of topography makes drainage a paramount issue for the citizens of Sarasota County. Sarasota County's drainage is a

delicate system that has been precisely engineered to provide citizens with a maximum level of service. The impact on the drainage system is a key indicator for rezoning. Engineers of Sarasota County's Watershed Management Department are tasked with examining the impact on drainage caused by proposed rezoning petitions.

Engineers had typically used a variety of paper maps to derive the data needed for their analysis. The paper maps were difficult to update and often required interpretation to read. These factors resulted in information being derived in a subjective manner.

The Watershed Management Department soon realized the need for GIS technology to augment this process. Paper maps were converted to digital spatial data. Analysis methodologies were devised to provide engineers with access to the data they needed. The resulting data was provided to make objective decisions based on truth rather than interpretation.

The only problem with the methodology was that the process still required manual analysis to derive the needed data. Sarasota County's Watershed Management GIS Staff endeavored to create an automated process that will provided the needed data. The Avenue programming language was used to develop an application that automated ArcView 3.x's analysis capabilities. This paper details the application and the resulting information.

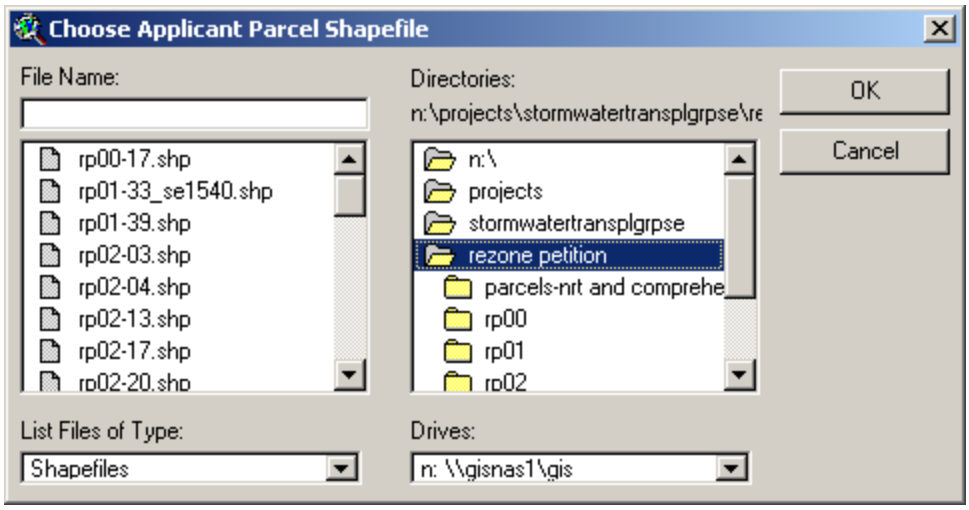
THE TECHNOLOGY

Sarasota County's GIS infrastructure uses Microsoft's Windows operating system. The application was built using ESRI's Avenue programming language. Avenue is designed to run in ESRI's ArcView 3.x environment. Avenue is an objected oriented programming language. The application is being ported to ESRI's ArcObjects with Sarasota County's implementation of ESRI's ArcGIS technology.

The vector data sources in the application are from ESRI's Spatial Database Engine (SDE). Sarasota County's SDE implementation uses Oracle database software for its foundation. The vector data sources in the application are read directly from SDE to ensure data integrity and availability.

THE USER PROCESS

This application was designed in mind that not all staff would be proficient GIS users. The goal was to make an application that would require a minimum amount of interaction with the user. A new button control is added to ArcView's view document interface to start the process. The user clicks on the button and is prompted to supply input of the applicant parcel boundary. The input is in the format of an ESRI shapefile. The user is presented with a file-browsing window where they can select any polygon shapefile for input to the application. An example is included below:



Once the input is supplied the summary report is automatically generated and saved to the same directory of the input shapefile. The summary report is named the same as the base name of the input shapefile, but "_report.txt" is appended to complete the name. The ArcView project file containing the maps is also saved to the same directory of the input shapefile. The ArcView project is named the same as the base name of the input shapefile. Saving all the files to the same location simplifies the management of the generated information while eliminating user intervention.

THE ANALYSIS

The analysis that generates the report and maps is rooted in core GIS science and geoprocessing. The boundary of the supplied input shapefile is used to perform a series of spatial selections, calculations, and statistics. The boundary of the input shapefile is used in analyzing the following indicators:

Input Area
The area of the polygon(s) of the input shapefile is derived. The area is then included in the attribute table of the input shapefile. The area is included in two units – square feet and acreage.

Public Land Survey System (PLSS)
The section(s), township(s), and range(s) in which the input parcel lies are derived. This information is generated by requesting the intersection between the parcel input boundary and Sarasota County's PLSS grid. In case of multiple intersections, each intersection is derived. The acreage and percentage relative to the entire input parcel of each intersection is also derived.

Elevation Contours / Topography
The minimum and maximum elevation contours that surround the boundary of the input shapefile are derived. Requesting the intersection between a 500-foot buffer surrounding the boundary of the input shapefile and Sarasota County's elevation contour dataset

generates this information. A list is created containing each contour's elevation value. The list is then sorted in ascending order. The minimum and maximum elevation value is derived. Elevation values are expressed as feet in the national Geodetic Vertical Datum (NGVD) of 1929.

FEMA Flood Insurance Rate Map (FIRM) Panel
The FEMA FIRM Map Panel(s) in which the input parcel lies is derived. This information is generated by requesting the intersection between the parcel input boundary and Sarasota County's FEMA FIRM Map Panel grid. In case of multiple intersections, each intersection is derived. The square footage and acreage of each intersection is also derived.

FEMA 100-Year Floodplain
The status of the input parcel boundary relative to the FEMA 100-Year Floodplain is derived. This information is generated by requesting the intersection between the parcel input boundary and FEMA's Q3 flood data. In case of multiple intersections, each intersection is derived. The intersections are totaled and the acreage and percentage relative to the entire input parcel is derived.

Sarasota County 100-Year Floodplain
The status of the input parcel boundary relative to the 24-Hour 100-Year Floodplain as delineated by Sarasota County is derived. This information is generated by requesting the intersection between the parcel input boundary and Sarasota County's floodplain data. In case of multiple intersections, each intersection is derived. The intersections are totaled and the acreage and percentage relative to the entire input parcel is derived.

Soil Type
The soils type(s) in which the input parcel lies is derived. A determination regarding the status of each soil type as hydric or non-hydric is also derived. Requesting the intersection between the parcel input boundary and soil data from the Southwest Florida Water Management District (SWFWMD) generates this information. In case of multiple intersections, each intersection is derived. The square footage and acreage of each intersection is also derived.

Hydrodynamic Watershed
The hydrodynamic watershed(s) in which the input parcel lies is derived. This information is generated by requesting the intersection between the parcel input boundary and Sarasota County's hydrodynamic watershed boundaries. In case of multiple intersections, each intersection is derived. The square footage and acreage of each intersection is also derived.

Hydrodynamic Basin
The hydrodynamic basin(s) in which the input parcel lies is derived. This information is generated by requesting the intersection between the parcel input boundary and Sarasota County's hydrodynamic basin boundaries. In case of multiple intersections, each

intersection is derived. The square footage and acreage of each intersection is also derived.

Hydrodynamic Catchment
The hydrodynamic catchment(s) in which the input parcel lies is derived. This information is generated by requesting the intersection between the parcel input boundary and Sarasota County's hydrodynamic catchment boundaries. In case of multiple intersections, each intersection is derived. The square footage and acreage of each intersection is also derived.

Hydraulic Node
The status of the input parcel boundary relative to surrounding hydraulic node(s) is derived. Selecting the hydraulic nodes contained in the selected hydrodynamic catchment boundaries generates this information. In case of multiple selections, the node ID of each selected node is derived.

Hydraulic Link
The status of the input parcel boundary relative to surrounding hydraulic link(s) is derived. Selecting the hydraulic links connecting the selected hydraulic nodes generates this information. In case of multiple selections, the link ID of each selected link is derived.

All the derived information is stored and reported in the form of a "Summary Report" that is used by Sarasota County Watershed Management's engineering staff to make a determination of the rezone petition.

THE SUMMARY REPORT

The report is comprised of technical information that was once gathered from paper maps in a subjective manner. The report is an ASCII text file saved to a user specified directory with a user specified name. The objectivity of the process along with the saved summary report provides the engineering staff with the documentation they need to qualify their determination of an applicant petition.

The report is formulated in three major sections: parcel summary, soils summary, and hydrodynamic summary. Each one of these sections is covered in detail below:

Parcel Summary
The parcel summary section of the summary report contains information about the applicant parcel. This information includes the acreage of the applicant parcel, the section, township, & range that the parcel lies in, the range of elevation contours (topography) in a 500 foot buffer surrounding the parcel, the FEMA FIRM (Flood Insurance Rate Map) panel that the parcel covers, whether or not the parcel is in the FEMA floodplain, and whether or not the parcel is in the Sarasota County derived

floodplain. If the parcel is in either the FEMA or Sarasota County delineated floodplain, the acreage of the parcel in the floodplain and the percentage of the parcel in the floodplain are reported. A sample excerpt is included below:

```
========= PARCEL SUMMARY =========

The Applicant Parcel has 1 Part(s)

Part1 Acreage is: 5.39

The TOTAL acreage is: 5.39

   SECTION, TOWNSHIP, & RANGE ANALYSIS:
1.26 acres of Part1 of the parcel are in "SEC. 04, TWP. 37 S., RGE. 19 E.".
23.44% of Part1 of the parcel is in "SEC. 04, TWP. 37 S., RGE. 19 E.".

4.13 acres of Part1 of the parcel are in "SEC. 09, TWP. 37 S., RGE. 19 E.".
76.56% of Part1 of the parcel is in "SEC. 09, TWP. 37 S., RGE. 19 E.".

   ELEVATION CONTOUR ANALYSIS:
A 500 foot buffer around the parcel intersects the following elevation contour(s):
34 Feet through 45 Feet

   FIRM PANEL ANALYSIS:
5.39 acres of Part1 of the parcel are in FIRM Panel "12514401700".
100.00% of Part1 of the parcel is in FIRM Panel "12514401700".

   FEMA FLOODPLAIN ANALYSIS:
*** THE APPLICANT PARCEL IS NOT IN THE FEMA DELINEATED FLOODPLAIN! ***
0.00 acres of the parcel are in the FEMA Floodplain.
0.00% of the parcel is in the FEMA Floodplain.

   SARASOTA COUNTY FLOODPLAIN ANALYSIS:
1.13 acres of the parcel are in the Sarasota County Floodplain.
20.94% of the parcel is in the Sarasota County Floodplain.
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Soils Summary

The soils summary section of the summary report contains information regarding the soil conditions of the applicant parcel. Every soil type within the parcel is reported. The acreage and percentage of each soil type with the parcel is reported. A key indicator of whether the soil type is hydric or non-hydric is also reported for each soil type within the parcel. A sample excerpt is included below:

```
========= SOILS SUMMARY =========

   0.47 acres of Part1 of the parcel are in soil type: "EauGallie and Myakka fine sands".
   8.80% of Part1 of the parcel is in soil type: "EauGallie and Myakka fine sands".
   --- THIS IS A NON-HYDRIC SOIL ---

   3.26 acres of Part1 of the parcel are in soil type: "Holopaw fine sand, depressional".
   60.46% of Part1 of the parcel is in soil type: "Holopaw fine sand, depressional".
   --- THIS IS A HYDRIC SOIL ---

   1.66 acres of Part1 of the parcel are in soil type: "Ona fine sand".
   30.73% of Part1 of the parcel is in soil type: "Ona fine sand".
   --- THIS IS A NON-HYDRIC SOIL ---
```

Hydrodynamic Summary

The hydrodynamic summary section of the summary report contains information regarding the applicant parcel's relationship to Sarasota County's hydrodynamic schematic and hydraulic model. The drainage watershed area that the applicant parcel lies in is reported. The drainage basin area that the applicant parcel lies in is reported. The drainage catchment that the applicant parcel lies in is reported. The hydraulic model nodes that are contained with the reported drainage catchments are reported. The

hydraulic model links that connect to the reported nodes are reported. A sample excerpt is included below:

```
========== HYDRODYNAMIC SUMMARY ==========

      WATERSHED ANALYSIS:
   0.12 acres of Part1 of the parcel are in the "DONA BAY ROBERTS BAY  WATERSHED" Watershed.
   2.24% of Part1 of the parcel is in the "DONA BAY ROBERTS BAY  WATERSHED" Watershed.

   5.27 acres of Part1 of the parcel are in the "SARASOTA BAY  WATERSHED" Watershed.
   97.76% of Part1 of the parcel is in the "SARASOTA BAY  WATERSHED" Watershed.

      BASIN ANALYSIS:
   0.12 acres of Part1 of the parcel are in the "COW PEN SLOUGH" Basin.
   2.24% of Part1 of the parcel is in the "COW PEN SLOUGH" Basin.

   5.27 acres of Part1 of the parcel are in the "PHILLIPPI CREEK" Basin.
   97.76% of Part1 of the parcel is in the "PHILLIPPI CREEK" Basin.

      CATCHMENT ANALYSIS:
   0.0489 acres of Part1 of the parcel are in Catchment "097860".
   0.91% of Part1 of the parcel is in Catchment "097860".

   0.0083 acres of Part1 of the parcel are in Catchment "097865".
   0.15% of Part1 of the parcel is in Catchment "097865".

   0.0638 acres of Part1 of the parcel are in Catchment "097925".
   1.18% of Part1 of the parcel is in Catchment "097925".

   5.2732 acres of Part1 of the parcel are in Catchment "33179".
   97.76% of Part1 of the parcel is in Catchment "33179".

      NODE ANALYSIS:
   The parcel is in close proximity to the following node(s):
   33179

      LINK ANALYSIS:
   The parcel is in close proximity to the following link(s):
   33179
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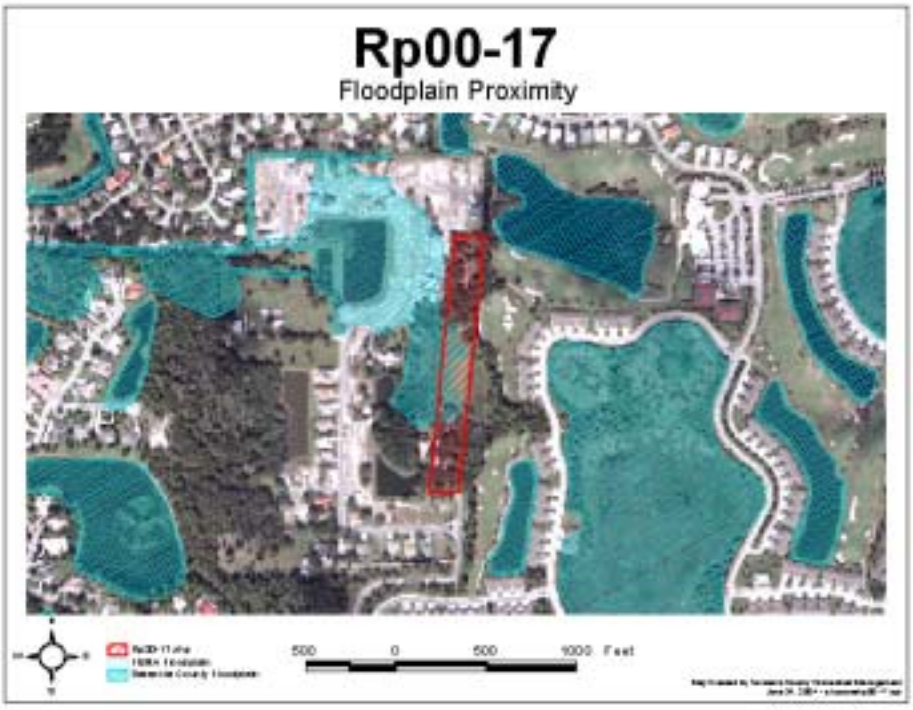
THE MAPS

The analysis results in a series of maps that are used to clearly present information for the determination of the rezone petition. Maps can easily convey information that is difficult to describe in writing. Citizens and staff who are not experienced with drainage issues are able to easily understand technical situations once the maps are viewed.

Four maps are produced by the analysis. These four maps are key indicators in the determination of a rezone petition. The four maps are:

Contour Map
This map provides a visual depiction of the elevation contours in the rezone applicant area. A sample map is included below:

Floodplain Map
This map provides a visual depiction of the applicant parcel relative to the FEMA and Sarasota County derived 100-Year Floodplains. A sample map is included below:

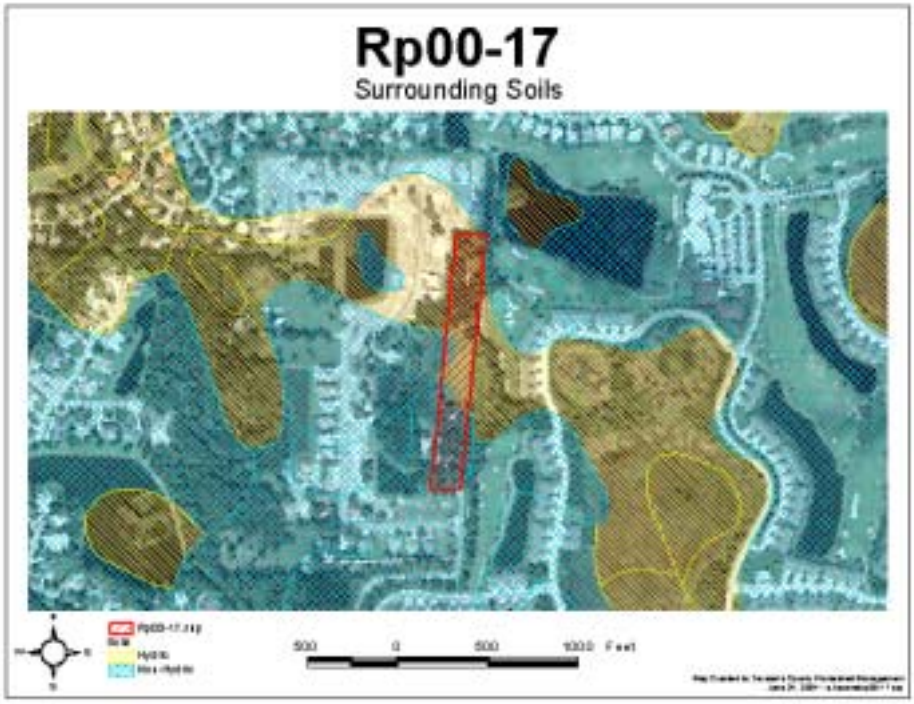


Hydrodynamic Map

This map provides a visual depiction of the hydrodynamic and hydraulic conditions in the rezone applicant area. A sample map is included below:

Soils Map

This map provides a visual depiction of the soil conditions in the rezone applicant area. A sample map is included below:



All the map layouts are automatically generated once the analysis is performed. The four map layouts are created on a letter sized (8.5 inches by 11 inches) page. Each map layout is oriented to "landscape". Each map layout receives an automatically generated view frame, title, neat line, north arrow, scale bar, legend, map citation, and path location. All maps elements are appropriately placed on the page and centered if needed. The maps require no user intervention to be created. The user is able to access or print these maps at their leisure.

CONCLUSION

The growth and development of a community affects all the citizens of the area. Decisions about growth and development should be based on objective facts and proven science rather than speculation and interpretation. The use of GIS technology has proven an effective tool in providing this much-needed information.

Maps generated by GIS convey information visually in an easy to understand format. Reports generated by GIS can be viewed in detail so experienced staff can make informed and documented determinations. The automation of GIS enhances the process by making the gathering and formatting of all this information more efficient.

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