Sarasota County, Geographic Information Systems and Watershed Management

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ABSTRACT

Once only used to create maps, Geographic Information System (GIS) data analysis has become a cost effective tool to identify and prioritize projects within a watershed. Sarasota County has been building a vast library of geographic data for several years and recently utilized this information within the context of watershed management. Two projects are discussed, the reprioritization of the Phillippi Creek Septic System Replacement Program (PCSSRP) and the Age of Development, though they are only two examples using GIS as a tool to manage the watersheds in Sarasota County.

The Phillippi Creek Basin has impairments for both fecal and total coliform bacteria and is posted as a "No Swim" area. Several studies conducted identified septic systems as the probable cause of contamination. The PCSSRP was initiated to provide sanitary sewer service and eliminate septic systems as a source of contamination. The PCSSRP has undergone a reprioritization including GIS analysis to rank areas based on relevant geographic data to maximize the environmental and health benefits. This project will be extended throughout the county to allow management to plan for future projects.

The Age of Development was conceived to differentiate neighborhoods based on lawn care and home values for potential pollutant loading. This project identified a need to develop new event mean concentrations for medium density residential landuses. It also highlighted the fact that many of our oldest communities along the bay where built prior to stormwater regulations, allowing for direct runoff to the bay.

INTRODUCTION

GIS data has been gathered within Sarasota County by many organizations. Currently, approximately 150 different layers describing the spatial and temporal characteristics ranging from landuse and seagrass polygons to road and utility networks are available. Recently, there has been an effort to not only create and publish data but to analyze it in the context of pollution abatement through watershed management. As will be described below, GIS can be a cost effective tool to prioritize areas in need of investigation, target sampling events and present the results with a map rather than the usual graphs. The results of two such projects are presented here: the Phillippi Creek Septic System Replacement Program (PCSSRP) reprioritization and the age of development analysis. These are just two projects looking at the potential of using GIS to plan and support watershed initiatives. As we move forward with programs to manage stormwater loadings and as budgets get tighter, GIS tools will become more advantageous to target those available funds to maximize their effectiveness.

PHILLIPPI CREEK SEPTIC SYSTEM REPLACEMENT PROGRAM

Phillippi Creek is a Florida Department of Environmental Protection impaired water body listed for an accidence of fecal coliform bacteria. It has been known for sometime that Phillippi Creek has elevated occurrences of fecal coliform bacteria. Evidence has suggested that these elevated values can be attributed to septic system failures due to their proximity to the creeks (Hazen and Sawyer, 2000). As a result, Sarasota County has instituted the PCSSRP to provide central sewer service and remove ~14,000 septic systems within the Phillippi Creek Basin. The initial feasibility study divided the area into 16 service areas and 160 sub-areas based primarily on engineering criteria (Figure 1). The program was initiated in 2000. To date, three of the service areas (A, E and F) are either complete or significantly complete.

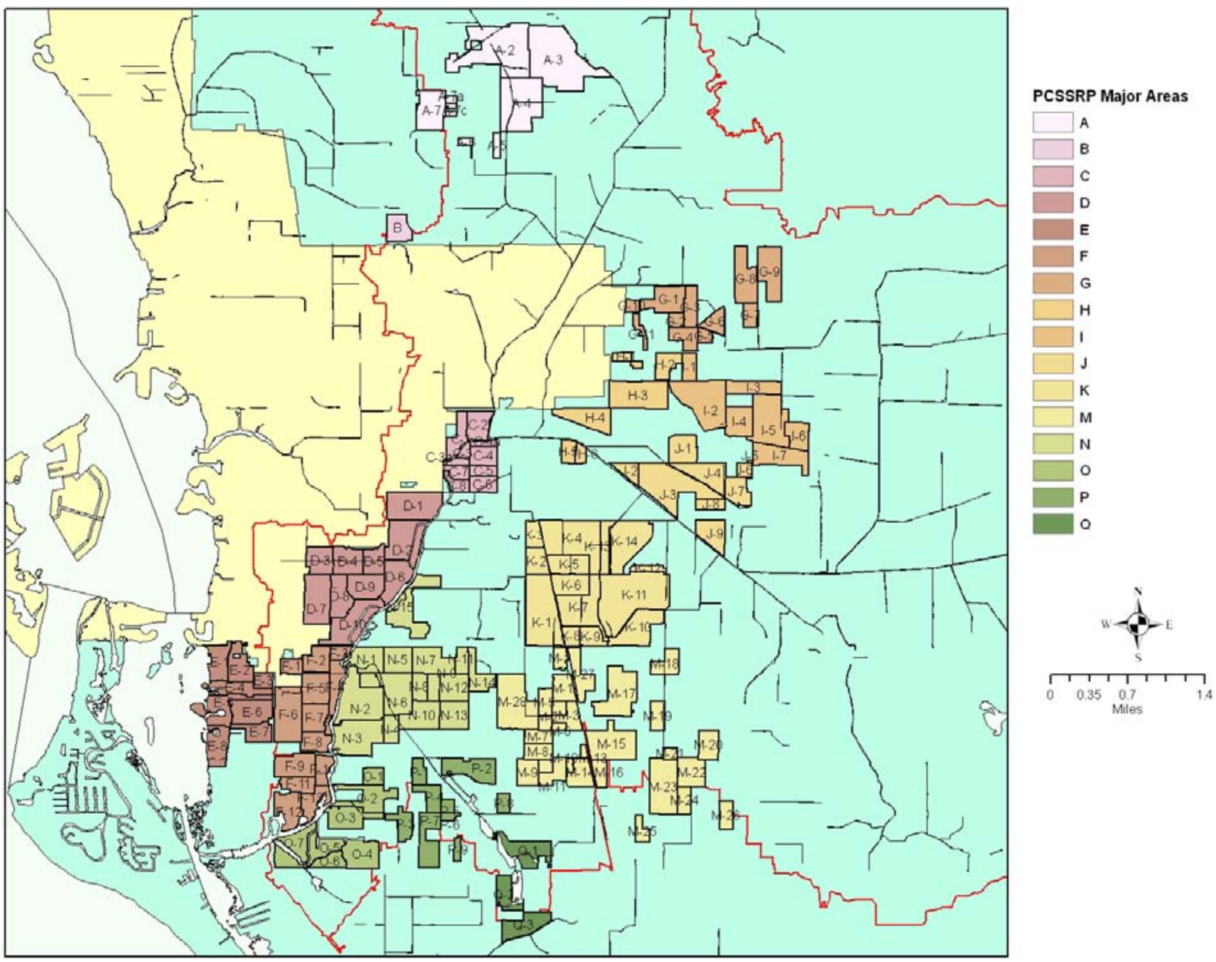

Figure 1: Map of PCSSRP areas and sub-areas within the Phillippi Creek Basin outlined in red.

In 2006, management requested a process to reorganize the construction schedule to emphasize the environmental benefit of removing those areas most likely contributing to the impairment. This process included a GIS analysis to rank those remaining areas to highlight those likely to have issues. The final decision matrix would use the results from this analysis along with the most recent financial and engineering data to realign the construction schedule.

After review of the available data and a series of discussions among staff, the parameters listed in Table 1 where chosen for evaluation. These layers where selected for having an impact on the efficiency of a septic system or the ability to either treat or transport contaminants. Available attributes within each of the layers where assigned a score based on the severity of that effect. Also, in order to weigh the different parameters, the scores where then multiplied by a factor based on a low, medium or high rating of influence. Each of the parameters are described below along with the rational for there use.

Table 1. List of parameters and there corresponding scores.

	High (3)			Medium (2)		Low (1)	
Score	Year of Construction	Density	Soils	Distance from Conveyance	Floodplain	BMP	Repairs/ Hookup
0				> 900	NO	Yes	
1	> 1983	>0.5	A		X		< 25%
2	1973-1982		B/D				25-50%
3	1963-1972	0.25-0.5	C	165 - 900	AH	No	50-75%
4	1953-1962		C/D				> 75%
5	<1952	<0.25	D	< 165	AE		

Year of Construction – The Sarasota County Department of Health (SCDOH) has been tracking the issuance of septic system permits since approximately 1971. That database was converted to a GIS layer by the County's Geomatics group. After visual inspection of that file and comparison with the number of expected hook-ups per sub-area from utility records this layer was deemed unusable because of missing records primarily of systems built prior to 1971. Since the age of the systems was still a desirable parameter, an alternative was developed from the age of the buildings on the parcels. This alternative approximated the age of the septic systems. This information is updated on an annual basis and was obtained from the Tax Assessor's database. Finally, the average age within a sub-area was calculated and a score was assigned on a roughly decadal basis.

Lot sizes within a sub-area – The parcel database created above was also used to assess the density of systems per sub-area. The majority of the lots were categorized into three categories, >0.5 acres, between 0.25 – 0.5 acres or <0.25 acres and assigned a score. For example, if the majority of the lots were < 0.25 acre (high density) in size then the sub-area would be scored a 5. This approached was favored over zoning data due to the mixed nature of sub-areas and the possible number of variances that would contribute greater error.

Soil type – The underlying soil type was used to discriminate areas as well-drained (Type A), moderately drained when dry/not well-drained when wet (Type B/D), somewhat poorly drained (Type C), somewhat poorly drained when dry/not well drained when wet (Type C/D) or poorly drained (Type D). Again a majority approach was used as the total areas of the different soil types were summed, and a percent area was calculated. The score was assigned to the soil type that had the greatest percent area.

This is a parameter that could have been interpreted in two different ways. Well drained soils in this case were assumed to be desirable and were inferred to move effluent vertically through the soil to maintain the drain field. Poorly drained soils were assumed to transport effluent horizontally, inferring frequent failures during the wet season and causing direct connections to conveyances, ditches and canals.

<u>Distance from a water conveyance</u> – This parameter relates to whether or not any portion of a sub-area falls within a buffer placed around a water conveyance, not including ponds or lakes. Two distances were used: 900' and 165'. The 165' buffer relates to a recommendation made by County staff from a literature survey. The 900' buffer relates to the Sarasota Bay Estuary Program recommendation that it would take that distance to treat septic tank effluent to Advanced Waste Treatment standards (SBNEP,1995).

<u>Location within the100-year flood plain</u> – This parameter located those sub-areas within the floodplain and, thus subjected to various levels of flooding. This should account for failures caused by the inundation of the system regardless of its status. Areas prone to excessive flooding were given higher score. It should be noted that the Sarasota County's internally created flood plain layer was used rather than the FEMA flood layer.

<u>Sub-areas served by a stormwater treatment</u> – Although not directly related to wastewater treatment, stormwater treatment facilities have the potential for entrainment and possible treatment of contaminated water. A layer denoting the areas served by stormwater treatment best management practices was created by Jones, Edmunds and Associates (JEA) as part of a pollutant loading model to account for the facility's load reduction. Visual inspection of aerial photographs and permit information was compiled to mark those areas. In this case, if any portion of a sub-area is treated by such a facility, than the whole area is assigned the benefit. This approach was used due to the potential rather than known benefits of stormwater treatment.

<u>Repairs/number of hook-ups</u> – This parameter is based on the SCDOH septic system repair permit database that too was converted to a GIS layer by the County's Geomatics group. The total number of repair permits issued within a sub-area was divided by the number of proposed hook-ups and assigned a score accordingly. Sub-areas with a high percentage of repairs were considered problem areas and received a higher score, though this could also be interpreted that the system was brought up to current standards. Without available data regarding the nature of the repairs, it was assumed that it was indicative of a problem area.

Once the individual parameters were scored, they were then multiplied by there respective weighting factors: high (x3), medium (x2) and low (x1), and summed to create a total score for that sub-area. The results where mapped for visual comparison and presentation, Figure 2. The higher scores (shown in red) are indicative of areas with the greatest potential for polluting based on this analysis. These results where then added to the decision matrix along with the financial and engineering requirements. Finally, the schedule for completion was revised to move those areas with a greatest need up on the schedule and to postpone those with a lesser need.

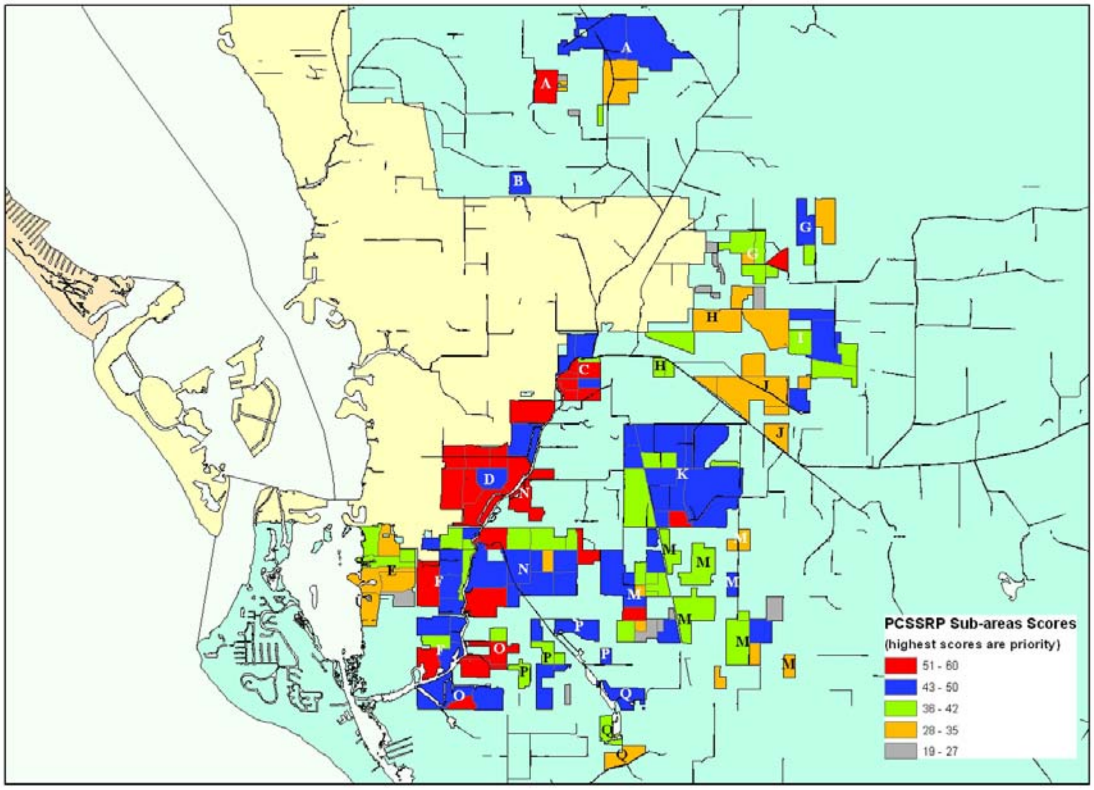

Figure 2. Map of results from the PCSSRP prioritization analysis.

This technique will be used throughout the County to rank other prospective areas for conversion to central sewer. This will allow management to look to the future not only in terms of wastewater capacity but also load reduction to receiving waters. Portions of this method are also being considered for inclusion into the pollutant loading model which is under going modification (JEA, 2005). Currently, the model uses the number of systems per basin and a fixed failure rate to estimate the load attributed to septic systems. This would attempt to put more weight on areas with greater potential for more loading, such as near water conveyances and certain soils types.

AGE OF DEVELOPMENT

Creating a method to approximate the age of development was spawned by the second phase of development of the County's pollutant loading model by JEA (JEA, 2005). The original model utilized the SWFWMD landuse layer as the basis of determining pollutant loading from an area. As part of continuing the development of the model, the County requested refinements or possible additions to the Event Mean Concentrations (EMCs) used by the model. Through several discussions, it was decided to apply resources for the EMC refinement of the medium density residential (MDR) landuse. Unfortunately however, there was no readily available data in the landuse layer to distinguish one MDR polygon from another. After searching through the available information, it was decided to segregate them based on age with the premise that older areas lacked the stormwater treatment now required through regulation.

It was also decided to further break it down to the neighborhood/subdivision level for future management discussions regarding water quality level of service. Unfortunately, the County lacked a true neighborhood or development layer, so for this iteration, plat boundaries were used to group parcels as a surrogate for developments. The age of plat was calculated as the average year of construction of buildings on all the parcels within the plat boundary. It should be noted that undeveloped parcels, representing largely agriculture and public lands where excluded from the analysis. The results of are shown in Figure 3.

As expected, the development began along the coast and expanded inland. The colors shown denote the different milestones in environmental regulation, beginning with the Clean Water Act. Prior to this, flooding was the major concern for many developers, draining the land of stormwater as quickly as possible and thus indicating areas of less stormwater treatment. As the regulations evolved, stormwater treatment gained more importance, so for each regulatory era, a different color was used.

For a majority of the plats, this approach worked reasonably well at meeting our expectations. An example of it not working though is found in the City of North Port. There, the plat boundaries and their parcels and infrastructure were laid down some time ago and left undeveloped with most of the development occurring within the last 10 years or less.

As already stated, the initial focus was on the availability of stormwater treatment. Yet, during a windshield survey conducted by JEA (Memorandum, 11/3/2006)) to verify the appropriateness of the data another correlation presented itself. Property value and lawn care practices, i.e. the use of fertilizer and irrigation, appeared to correlate as well if not better than stormwater treatment. This information identified the need for the development of an EMC for irrigated residential areas and their different sources of irrigation water.

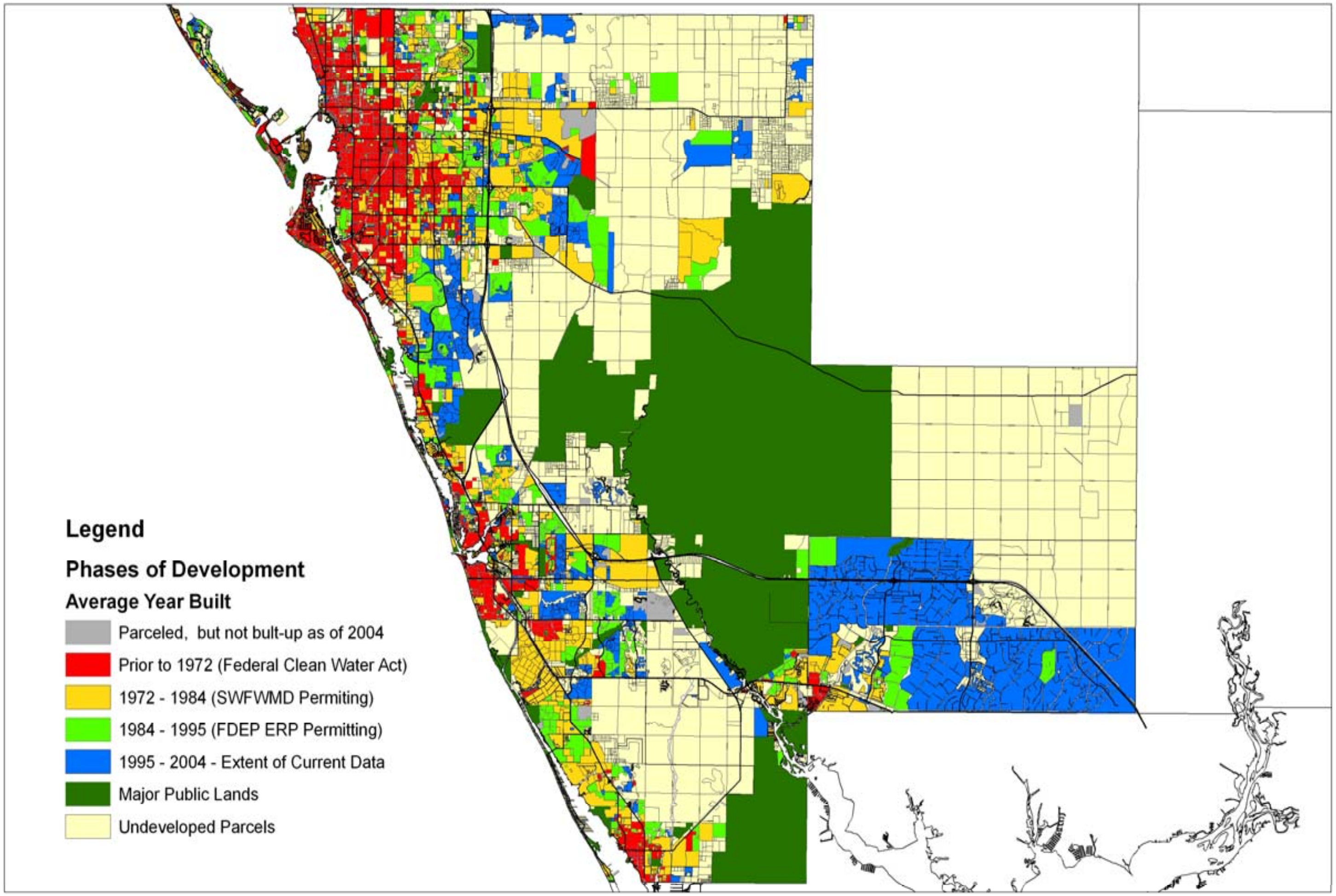

Figure3. Map depicting the phases of development in Sarasota County

Since the intended purpose of the analysis is to provide ancillary data to the SWFWMD landuse, the second iteration under development will use the landuse MDR polygons as the bounding layer instead of the plat boundaries. As well as age, irrigation and value will be added to better characterize the loads produced by these properties.

Finally, management has begun using the graphics from this analysis to start conversations between neighborhoods and city/county commissions regarding the need for stormwater retrofits. One area in particular, the Indian Shores Beach and Whitaker Bayou neighborhoods within the City of Sarasota are interested in these results. Driven to improve the quality of Whitaker Bayou and Sarasota Bay, citizens here see this as a starting point to seek interest in retrofitting their stormwater system.

CONCLUSIONS

As seen here, the use of GIS analysis has provided management with tools to identify areas of possible adverse effects for the environment. Both studies provided a cost effective method to prioritize projects. Both could also help field crews to plan monitoring programs to gauge the extent of the problems highlighted and to see the results from stormwater management techniques deployed.

Other projects in the works include the adaptation of the Landscape Development Intensity Index (Brown, 2004) to support the development of a Tidal Creek Index for the coastal creeks of the County currently being developed by Dr. Ernest Estevez of Mote Marine Laboratory. With these two tools, we hope to gauge the benefits of management efforts on the biota of the creeks and to target those in need of more attention. Landuse analyses are also being incorporated into the study of the creek's oyster populations. As part of our goal to restore oyster habitat, landuse change overtime is being compared to oyster habitat loss, leading to an understanding of how one affects the other.

As we move forward, GIS applications will continue to provide tools to aid in the study of our watersheds. Though not intended to replace ambient data collection, it will allow managers to target and prioritize areas of interest and help to manage the cost in the current climate of decreasing budgets.

ACKNOWLEDGEMENTS

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