Investigations in Coastal Water Quality for OWTS Planning Efforts

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Abstract. Georgia's coastal population is growing rapidly, and coastal cities have limited time and funding to upgrade their municipal treatment plant infrastructure to keep up with this growth. Onsite wastewater treatment systems (OWTS) will therefore continue to be heavily permitted, and they can impair water quality if not maintained and if land use suitability planning is inadequate.

The University of Georgia Marine Extension Service (MAREX) and project partners conducted a survey of geolocating, inspecting and analyzing OWTS in proximity to state waterways of eleven coastal counties. A GIS database, along with maps and a septic pollution susceptibility index for each county were derived from project data. Two pilot studies for further research have begun. Surface water quality is being analyzed in the vicinity of state waterways in relation to OWTS densities in Glynn County, GA. A nonpoint source transport model is being developed with ArcGIS Spatial Analyst tools utilizing project data.

The key to controlling eutrophication in marine systems is managing nitrogen inputs. A nitrogen model was recently developed for conventional septic systems with Piedmont soil types in northern Georgia. Research is underway to utilize the modeling application on a mounded system with coastal Georgia soil types to determine if it can adequately predict nitrification and denitrification processes under these conditions.

BACKGROUND

According to the NOAA's State of the Coast findings[1], over 120 million people (39% of the U.S. population) live along the U.S. coast on just 18% of the nation's land mass. Coastal populations are projected to increase steadily and coastal Georgia is not immune to this trend as this area is one of the fastest growing in the state. Therefore, a major challenge for environmental professionals is nonpoint source water pollution. Continuing urban sprawl has made water quality a primary concern, with the central issue being stormwater runoff, coupled with OWTS failure.

PROJECT SUMMARIES

OWTS geolocation & analysis project

The US EPA/NOAA Findings and Conditions Report[2] noted that coastal Georgia was deficient in areas of nonpoint source pollution controls, especially managing OWTS. In an effort to mitigate these conditions, The University of Georgia Marine Extension Service (MAREX) developed a partnership in 2002 with the Georgia Environmental Protection Division (EPD), Coastal Health District of Georgia (CHD) and the Southern Georgia Regional Commission (SGRC). MAREX served as the coordinator to implement a Clean Water Act §319(h) grant supported project to geolocate, inspect, inventory and analyze OWTS in areas of concern along Georgia's coast. The initiative lasted over four years and spanned eleven counties. The deliverables have assisted the CHD, other governmental agencies, and private organizations with better public health planning as well as valuable data concerning emergency management plans, disaster resiliency and coastal hazards risk assessments.

The project, including Phase III that was managed by the SGRC, mapped approximately 25,000 OWTS parcels. The initiative produced the first GPS inventory of OWTS and wells in EPD's eleven-county Coastal Nonpoint Source region and improved collection and verification of OWTS position locations. Development of geolocation capacity (WelSTROM) has improved local and state management of OWTS and wells for coastal

[1] *http://stateofthecoast.noaa.gov/population/welcome.html*

[2] *http://coastalmanagement.noaa.gov/nonpoint/docs/6217ga_fnl.pdf*

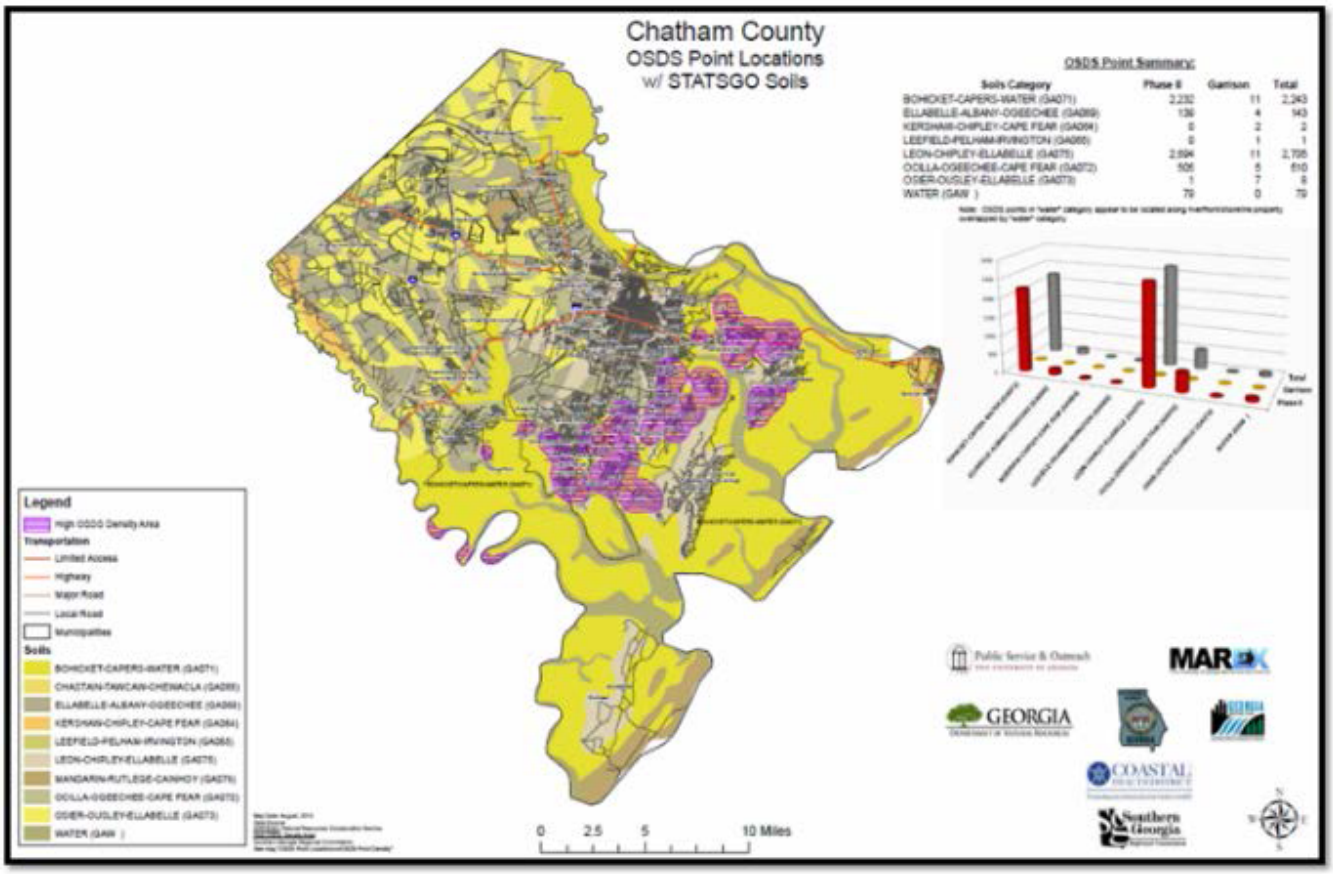

Figure 1: Chatham County OWTS locations and STATSGO soil (NRCS) GIS layer.

Georgia. The project has also produced maps depicting each county's OWTS densities and relevant GIS layers (Example, Fig. 1). From this dataset, a septic pollution susceptibility index (PSI) for each county was derived (Example, Fig. 2).

The PSI methodology was created by a workgroup with oversight from scientists, planners, environmental health professionals and government officials. Utilizing the methodology, the SGRC further developed the index with ESRI's ArcGIS 10 with Spatial Analyst Extension. The septic pollution susceptibility index was created by a varying weighted value system of GIS risk factor layers (Table 1).

OWTS water-quality evaluation

Building upon success of the §319(h) initiative, MAREX was awarded a GA Department of Natural Resources Coastal Inventive Grant to fund a pilot study in Glynn County, GA to investigate OWTS pollution in Georgia's coastal waterways. The goal of the project was to address an issue raised by the Cooperative State Research, Education, and Extension Service (CSREES 2004). Concerns have been raised that combined output from densely packed onsite wastewater treatment systems may exceed the natural ability of soils to receive and purify the wastewater before it reaches groundwater or adjacent surface water.

MAREX developed a surface water sampling plan based on densities of septic system locations found in the previous Phase II OWTS grant project for Glynn County. MAREX is sampling ten stations per month, collecting surface water grab samples, for two years and analyzing the water quality in reference to non-point source pollutants. MAREX worked closely with Glynn County Environmental Health Department in the CHD to select sampling stations in proximity to high densities of OWTS and stormwater outfalls. Analysis parameters consisted of a hydrographic profile using a Hach Quanta Hydrolab (Loveland, CO), which includes dissolved oxygen, conductivity, pH, salinity and temperature. Visibility measurements were taken with a Secchi disk.

Turbidity measurements were taken with an HF Scientific (Fort Meyers, FL) Turbidimeter (US EPA Method 180.1). Using a Hach Lachat Flow Injection Analyzer (Loveland, CO) with QuickChem Methodology,

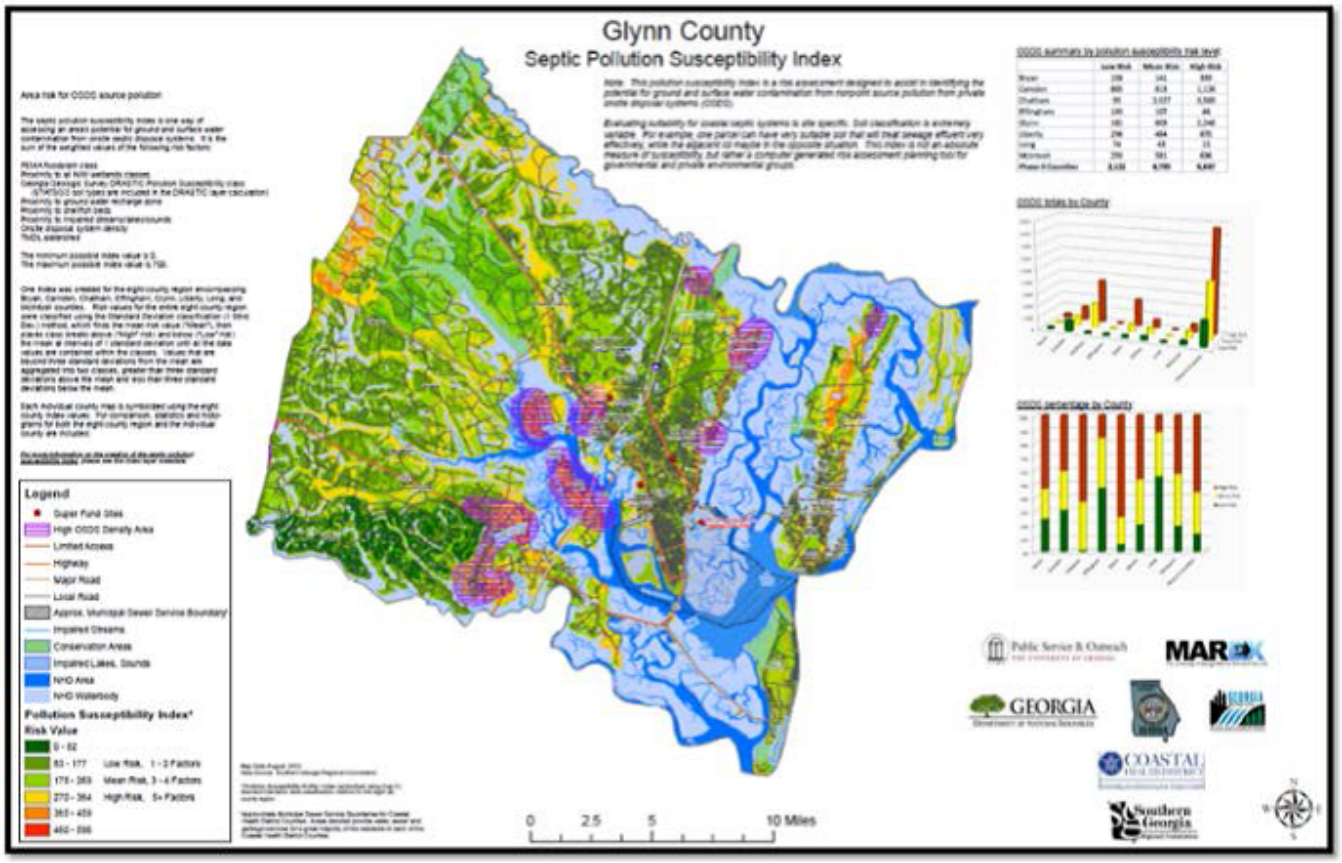

Figure 2: Glynn County pollution susceptibility index.

nutrient parameters analyzed included ammonia-N (US EPA Method 350.1), orthophosphates (US EPA Method 365.3), nitrate-N and nitrite-N (US EPA Method 353.2). Bacteria parameters analyzed included fecal coliform bacteria (US EPA Method 1681) and enterococci (US EPA Method 1600). Chlorophyll-a (US EPA Method 150.1) and biological oxygen demand (BOD) (Clesceri, 1992) were also factors in the analysis. Laboratory data, along with rainfall, tidal and current data, will be used to create a transport model utilizing ArcGIS.

By gathering and analyzing water quality data, this project will provide significant insight into pollution prevention and protection of water bodies in the region that face potential impairment. The primary objectives are to sample and analyze water quality in areas of selected OWTS densities and stormwater outfalls, and develop a transport model for government officials, and public and private environmental professionals for planning purposes. MAREX will be gathering and analyzing water quality data until October 2015.

Nitrogen in a coastal, mounded OWTS

The third project in the investigative process is to determine the fate and transport of nitrogen in coastal soils, using a model being adapted to mounded OWTS in Glynn County, GA. Soils in coastal Georgia tend to be unsuitable for OWTS drainfields, due to low hydraulic conductivity rates and shallow water tables; mounded systems are often permitted to combat this problem. Although mounded systems have been used in other states for decades, they are a relatively new wastewater treatment technology in coastal Georgia. Limited research has been done on mounded systems in coastal Georgia. With nitrogen being a limiting nutrient for eutrophication for marine waters, a study was needed to determine nitrogen fate and transport in coastal soils.

A study was designed and implemented in northern Georgia where a nitrogen model was developed utilizing a conventional OWTS and a Piedmont soil, (Bradshaw and Radcliffe, 2013; Radcliffe and Bradshaw, 2014). Those project's methodologies have been adapted for this coastal Georgia mounded system research study. With help from the Glynn County Environmental Health Department and the CHD, a research site was selected

Table 1: Risk factors and weighted values for pollution susceptibility index.

Risk Factor	Category	Value
FEMA floodplains	Within 100-yr floodplain	50
	Within 500-yr floodplain	30
	Not within	0
Proximity to wetlands	Within 500 ft	100 to 0
Groundwater susceptibility (DRASTIC)*	Medium	50
	High	100
Groundwater recharge areas	Within	50
	Not within	0
Proximity to shellfish beds	Within 500 ft.	100 to 0
Proximity to §305(b)/303(d) impaired waters	Within 1000 ft of impaired stream centerline	100 to 0
	Within 500 ft of impaired lake/sound	100 to 0
Proximiy to surface waterbodies	Within 500 ft of surface waterbody	100 to 0
OSDS density	Low to high density	0 to 100
TMDL impaired watershed	Within	50
	Not within	0

at the county-maintained, Blythe Island Regional Park Campground. This mounded system is designed for a maximum of 1500 gpd and is heavily used, with an estimated average use of 600 gpd. The system is located in the area of water quality sampling stations defined by the Coastal Incentive Grant.

The mounded drainfield was installed and instrumented with lysimeters, tensiometers, an automatic rain gauge, a flowmeter and control boxes (with Campbell Scientific CR-1000 data loggers (Campbell Scientific, Logan, UT)). Ten nested pairs of tensiometers were placed at 24-inch and 42-inch depths to measure soil water pressure. Essentially, the 24-inch depth is at the trench bottom and the 42-inch depth is within the native soil. Lysimeters, which are the collection point for soil water samples, were placed at depths of 42 inches with each nested pair of tensiometers.

Lab data will be further analyzed with the Hydrus 2D/3D Model (Šimůnek et al., 2008) to produce the model depicting nitrogen fate and transport, which will be adapted from Bradshaw and Radcliffe (2013) and Radcliffe and Bradshaw (2014). Nitrogen processes are key to nonpoint source pollution activities in marine waters. Since limited research has been conducted on mounded systems in coastal Georgia, this project will be highly beneficial to water quality and land use planning efforts. The project is ongoing with initial results expected in 2015.

CONCLUSIONS

Once complete, this initiative will have provided a GIS database of OWTS, an evaluation of surface water quality in selected densities of OWTS, and an evaluation of nitrogen fate and transport in mounded OWTS installed in coastal Georgia soils. The tool set can be utilized by government officials, planners and scientists to better articulate and quantify water quality conditions in coastal watersheds. The products can assist in the identification of potential pollution sources and as analytical tools to establishing TMDL processes required for coastal waters. The tool set will also aid in hazard resiliency issues, such as emergency management planning and other vulnerability assessments.

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Data sources. Project reports, maps and pollution susceptibility indices for coastal Georgia can be downloaded from *http://marex.uga.edu/water_quality/*.

The WelSTROM GIS database site is available at: *http://www.sgweb-maps.com/welstrom/*

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