

Using GIS to Prioritize Outfalls for Stormwater Illicit Discharge Detection

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Abstract

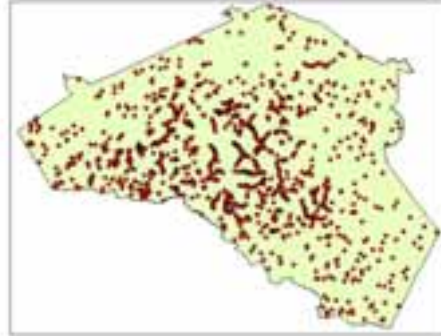
Utilization of GIS in the detection of illicit stormwater discharge creates a more efficient and effective discharge detection program. This paper focuses on the use of GIS to assist in meeting the requirements given to a community in the NPDES Stormwater Phase II Permit Program. Using data such as land use, impervious surface, previous discharge issues, sub-basins delineations, as well as other available data, we have created a priority inspection classification for the outfalls located within our permit area. This classification allows more frequent inspections of outfalls that are more likely to be discharging pollutants into the watershed system.



1. Introduction

The National Pollutant Discharge Elimination System (NPDES) is a permit program administered by the United States Environmental Protection Agency (EPA) that regulates point-source water discharges into the watershed system. With a population exceeding 100,000 people, Athens-Clarke County Georgia is classified as a Phase II MS4 community. With this classification comes the requirement to implement an Illicit Discharge Detection and Elimination program (IDDE) that includes the identification and monitoring of stormwater outfalls.

When Athens-Clarke County undertook the task of inventorying stormwater outfalls, over 1600 outfalls were identified within the permitted area (See figure to the right). While all outfalls are required to be monitored for dry weather discharges, there is potential for areas that are discharging pollutants to go unchecked for a significant time between inspections.






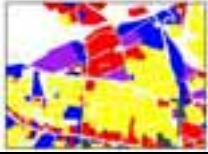



Stormwater Outfalls

In order to create a more effective IDDE within the current manpower allotment, a prioritization score was needed to identify outfalls that would have a higher risk of illicit discharge. With GIS, it was possible to use existing data to create a score that was based on known risk factors.

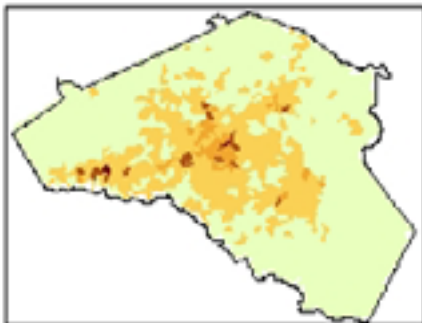
2. Data

Athens-Clarke County has an extensive library of existing data that has been collected through the existing GIS program. This allowed for relatively easy and cost effective access to datasets that would assist in the creation of the outfall prioritization score. Below are the datasets utilized and a brief description:

Air Photos	Color photography including oblique images	
Catchment Delineations	Coverage of stormwater drainage areas 1421 total in the area	

Impervious Surface	Coverage of surfaces which cannot be infiltrated by water	
Land-Based Classification System (LBCS)	Existing land use coverage	
Road Pavement	Paved roads	
Stormwater Outfalls	Location of Stormwater Entering the watershed system	
Waste Water Mains	Network of pipes used in the transportation of waste water	

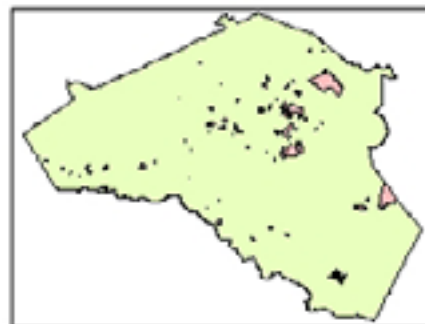
3. Analysis Implementation



Stormwater Catchments with Impervious Surface

Using the catchments, impervious surface layer, and the road pavement coverage, percent of impervious surface per catchment was calculated. This was done by clipping the pavement layer and impervious surface layer by the catchments and calculating the area of impervious surface per catchment. This number was then divided by the total area of the catchment to calculate the percentage.

The LBCS data was used to obtain areas in the county that have a land use classification of industrial. Stormwater outfalls that fall downstream of these facilities could be more likely to contain illicit discharge due to runoff, leaks, or illegal connections to the stormwater system.

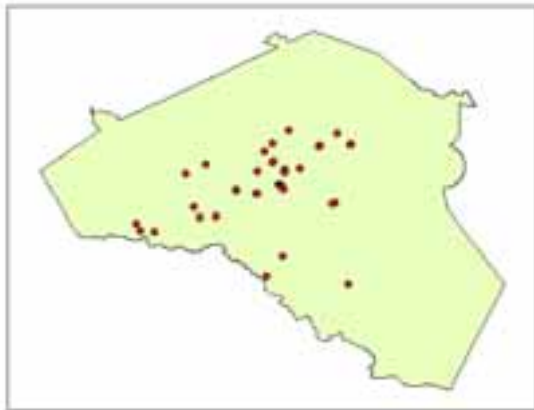


Industrial Uses in Athens Clarke County

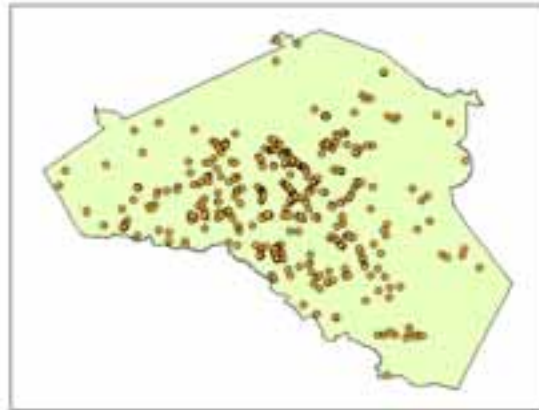
In ArcCatalog, three attributes were added, one for each of the different data layers. Points were given for each of the criteria. In the case of the impervious surface, if the catchment had 0 to 20 percent impervious coverage, then no points were added. If the percentage was greater than 20 percent to 40 percent, then 0.5 points were added. If the percent of impervious surface was greater than 40 percent, then a value of 1 was given. If the outfall was located within 500 feet of an industrial site, then a point value of 0.5 was added to that field. If an outfall is located within 250 feet of an industrial site, then a value of 1 was added. Likewise, if the outfall was located within 25 feet of a waste water main, then a 0.5 points were added. If an outfall was located within 10 feet, then a point was added. Finally, if the previous inspection showed that there was a dry weather flow, then a point was added.

Since most of the data does not lend itself well to the raster format, it makes it difficult to use the Spatial Analyst extension in ArcGIS due to data loss when converting the data from its original format to the raster data format. Due to these issues, it was necessary to use the basic selection feature as the tool to create the prioritization calculation.

After the points were assigned, the calculate function was used to make the total for the outfall prioritization score. Out of the original 1650 outfalls, 48 were assigned a high risk for illicit discharge (a score of 2 or above). 502 outfalls were given a moderate risk (a score greater or equal to 1, but less than 2). The remaining outfalls were given an assessment of low risk.



High Risk Outfalls



Moderate Risk Outfalls

4. Dry Weather Screening

Using the new classification system, the stormwater outfalls are mapped for each of the inspection zones. When in the field, the inspectors use the “Dry Weather Screening” form to collect the pertinent information. This information is then entered into the inspections database upon return to the office.



Inspection Zones

In the case of a dry-weather flow, a sample is taken and tested. Also previous tests are researched to see if there have been any previous positive results for the outfall in question. Using GIS and field sleuthing, the source of the discharge is then located.

5. Future Data Acquisition

As with most GIS projects, there will be ongoing data collection and assimilation for the outfall prioritization project. Currently there are more datasets being created that would provide a more accurate final product.

One layer that is in the process of being created is a point layer of all of the septic tanks in the permit area. This data is being converted from the Health Department's paper records as time allows. Septic tank failure can contribute a significant amount of fecal and chemical discharge into the stormwater system.

Unlike wastewater conveyance links, stormwater conveyance links were not mapped as they were built in the past. This has made it impossible to perform network analysis. We have begun working towards a full inventory of all stormwater structures in our service area. With this new layer, there would be a better chance of tracking down sources of stormwater illicit discharge and it would make it easier to remedy the situation. The mapping of the stormwater conveyance links would also allow for the mapping of stormwater/waste water conveyance link intersections. These are areas where leaks or connections could result in stormwater contamination.

Another step that the Athens-Clarke County Stormwater Department is taking is the testing and characterization of stream segments though out the county. This process involves physically walking all of the stream segments, testing water quality at regular intervals, and looking for pollution sensitive animal species. Outfalls that discharge into impaired stream segments would be at higher risk for illicit discharge.



Technology upgrades are another aspect of the project that could be upgraded. Currently the Athens-Clarke County has one GPS unit that runs ArcPAD. With more units and integration of technology, the program would be more efficient and accurate. Entering data directly into the database in the field would eliminate the

need for significant downtime in the office while converting paper data. Also having data easily assessable in the field lowers the chance for error.

6. Conclusion

The overall goal of this project was to create a usable prioritization system for stormwater outfalls to create a more efficient IDDE. This paper has outlined the beginning of this process. As previously mentioned there is significant room for improvement that would create a product based on a multitude of criteria.

Despite the issues mentioned it was still possible, by using current data and resources, to create a basic system to focus the inspections of over 1600 outfalls. The Athens-Clarke County Stormwater IDDE program has resulted in the detection and elimination of significant flows of illicit discharge with the assistance of GIS and well trained and experienced inspectors.

The complex nature of stormwater, makes it a difficult subject to track. The numerous variables and the lack of accurate historical infrastructure data results in considerable field work in most endeavors pertaining to this subject. While it would be preferable to be able to run full network analysis, the data limitations have created a need for the ability to produce viable results now to meet NPDES requirements. GIS provides a method to bridge the data gap.

References

Brown, Edward, Deb Caraco, Robert Pitt, (2004). Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments. U.S. Environmental Protection Agency.

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