GEORGIA AGRICULTURAL WATER QUALITY WATERSHED ASSESSMENT

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Abstract. Increasing concerns over water quality in the past five years have focused more attention on agriculture, and it's potential for non-point source [NPS] pollution. A small number of agricultural operations not adhering to a sound conservation ethic can encourage more regulations for all agricultural operations. When this happens, many producers become unfair targets for remediation efforts at the agricultural producer's expense. The lack of reliable data at the watershed scale is serving to fuel this debate. Total Maximum Daily Loads [TMDLs] are being developed using outdated or insufficient agricultural data. The Agricultural Water Quality Watershed Assessment [AWQWA] is a resource inventory and analysis process designed to improve watershed scale estimates of farm management and its influence on agricultural NPS. Following the Georgia Environmental Protection Division's River Basin Planning Schedule, AWQWA generates watershed scale estimates of agriculturally based Fecal Coliform, Total Nitrogen, Nitrate, Ammonium, Total Phosphorus, and Sediment for each of Georgia's 357 10-digit watersheds over the next five years.

INTRODUCTION

Agriculture is the largest industry, and second largest land user, in Georgia. Therefore, it commands significant attention. Some of the attention directed to this industry; however, is subject to question. Recently, agricultural activities have become the target of perceptions. Agriculture is often portrayed as the country's most significant contributor of nonpoint source [NPS] pollution. This portrayal has led to many connotations about the impact that agricultural activities can, and do, have on our waterbodies. As a result, many agricultural operations may unfairly become targets of remediation efforts at the agricultural producer's expense.

While it is true that an agricultural operation can be a significant environmental threat, the vast majority of operations are not. Non-agricultural organizations are attempting to quantify agricultural nonpoint source [NPS] pollution without consideration of farm management. Farm management activities significantly influence the fate and transport of potential agricultural pollutants. The lack of reliable data at the watershed scale is serving to fuel this debate.

In 1993, the Soil Conservation Service, now the Natural Resources Conservation Service [NRCS], estimated the potential for agricultural nonpoint source [NPS] pollution at an 11-digit watershed scale. The report, "Georgia Watershed Agricultural Nonpoint Source Pollution Assessment", documents how NRCS assessed the potential agricultural pollutants of sediment, total nitrogen, and total phosphorus. The results of that study indicated that there were no large-scale agricultural NPS water quality problems across Georgia, but it did identify over 90 watersheds where agriculture was considered to have some potential to impair water quality. NRCS, and other organizations, utilize information contained in this report, to direct significant resources, both financial and technical, to priority watersheds for the purpose of implementing agricultural best management practices [BMP]. The AWQWA process updates the 1993 NRCS study for three key reasons:

1. **Agricultural data used to conduct watershed assessments in the 1993 NRCS study was based on a 1985 – 1990 time period.**
   Agricultural markets change rapidly and are the basis for land management decisions on farms. Numerous market influences in Georgia agriculture have changed dramatically over the past ten to fifteen years. For example, in 1985 there were over 1,000,000 acres of corn planted across the State compared to only 350,000 acres planted in 1999. Many acres that were once used to produce corn are now being used to produce cotton. Shifts from one commodity to another,

or expansions of the same commodity, require different management strategies and can significantly change an agricultural operation's potential for NPS pollution.

2. **The 1993 NRCS study is based on an 11-digit NRCS watershed map.**
Some 549 watersheds were assessed using the NRCS watershed map, which was developed in 1990. This map is currently undergoing revision, and expansion, by the Georgia Interagency Hydrologic Unit Group [GIHUG]. GIHUG is a coalition of water resource agencies in Georgia principally co-chaired by NRCS, USGS, and EPD. The new watershed map for Georgia is nearing completion and will contain 10-digit and 12-digit watershed delineations below the 8-digit watershed level. There will be 357 10-digit scale watersheds ranging in size from 40,000 acres to 250,000 acres. There will also be 1,962 watersheds delineated at the 12-digit scale, which typically range in size from 10,000 to 40,000 acres, on the new Georgia watershed map.
Many organizations do collect agricultural data. However, this data is compiled and stored in a variety of formats and on a variety of data platforms. Additionally, most of the data that is collected conforms to county boundaries rather than watershed boundaries. This process takes current county level agricultural data for Georgia and spatially allocates that data to an appropriate 10-digit watershed within each county.

3. **Current watershed assessments are considering an expanded list of potential pollutants.**
As previously stated the parameters of focus in the 1993 NRCS study were sediment, total nitrogen, and total phosphorus. However, current watershed assessments for TMDL development, TMDL implementation, and local community waste-load allocation are considering additional pollutants, and specific nutrient fractions in their attempt to infer agriculture's contribution to water quality impairments. Many decisions that have the potential to impact how agricultural producers can/should manager their farms are currently based on inconsistent and broad manipulations of county level agricultural statistics. This process will expands the list of potential pollutants to those commonly addressed in today's watershed assessments, and employ a detailed, consistent methodology for collecting and analyzing agricultural data at the watershed scale.

OBJECTIVE

The objective of this process is to develop a geo-spatial agricultural database of relevant agricultural pollutants at the 10-digit watershed scale. While the 1993 NRCS study made some inferences regarding agricultural potential for NPS pollution, this process DOES NOT. Instead this process focuses on the spatial allocation of agricultural data, and assessing how farm management activities affect the fate and transport of potential agricultural pollutants ON THE FARM, including mass balance estimates. It is beyond the scope of this process to determine the fate and transport of agricultural pollutants OFF THE FARM. Information generated through this process will serve data input for water quality models.

METHODOLOGY

The objective of this process is accomplished through a variety of data collection and analysis methods that include, but are not limited to, database development, geo-spatial analysis, field interviews, ground truthing, and the application of publish research. This process is conducted in three phases: Database Development Phase, Inventory Phase, and Analysis Phase

Database Development Phase: Many organizations collect agricultural statistics. However, this data is compiled and stored in a variety of formats and data platforms. To adequately assess the potential for agricultural NPS pollution, a consistent database is required. During this phase of the project, an electronic repository of county level statistical data for agriculture is developed. This repository database includes, at a minimum, the following:

- Agricultural Land Use
    - Commodity Acreage [Corn, Cotton, Oats, Pasture, Peaches, Peanuts, Pecans, Rye, Sorghum, Soybeans, Tobacco, Vegetables, Wheat]
- Animal Operations
    - Number of Cattle [Beef, Dairy, Calves]
    - Number of Horses

Number of Swine [Free Ranging, Confined]
Number of Poultry [Broilers, Layers, Pullets]
Animal Waste Production Estimates by Animal Type
Animal Waste Application to Cropland and Pasture Commercial Fertilizer Application Estimates
Conservation Adoption Rate Estimates
Conservation Needs Inventory
Conservation Practices Applied Estimates [Buffers, Conservation Tillage, Erosion Control, Irrigation Management, Nutrient Management, Pest Management, Prescribed Grazing, Tree & Shrub, Waste Management, Wetland, Wildlife Habitat]
Pesticide Use Estimates
Soil Erosion Estimates

Inventory Phase: Because natural resource management requires spatial considerations within, and beyond, county boundaries, the usefulness of county level agricultural data remains limited. During this phase of the process, county level agricultural data, collected in the database development phase, is spatially allocated to the appropriate 10-digit watershed within each county. To accomplish this task a number of geo-spatial techniques using the following GIS related tools are employed [Table 1]:

Table 1. Spatial Database Tools Utilized and Their Source

Spatial Database	Source
1993 NRCS ag. data by watershed	NRCS
1993 Digital Ortho-photography	USGS
1994 MRLC Land Cover Data [Draft]	EPA
1997 Georgia County Boundaries	DOT
1997 USDA-NRCS-NRI Data-Ga.	NRCS
2000 Ga.Hydrologic Unit Boundaries	GHIUG

Once county level agricultural data is spatially allocated to an appropriate 10-digit watershed, field interviews with local county agricultural professionals will be conducted for each county in the state. NRCS-District Conservationists, UGA–County Extension Agents, and FSA–County Executive Directors and their staff are the primary interviewees. Additional interviews with local producers and producer organizations are conducted as appropriate.

During the local interview process, the accuracy of spatially allocated data is determined using two techniques. First, preliminary data generated via the database development phase of this project and the preliminary data generated through geo-spatial analysis described above is presented to local agricultural professionals. They then have an opportunity to provide input into the spatial allocation of county data process. Second, site visits to 10-digit watersheds for the purpose of ground truthing spatially allocated county data is conducted as time permits. Adjustments are made to the repository database as needed.

In addition to determining the accuracy of spatially allocated data, local interviews provide insight into farm management activities [i.e. conservation adoption rates]. Local agricultural professionals have a tremendous knowledge base of farm management activities within their jurisdiction, which is not recorded elsewhere. Some of this information includes an understanding of producers who have a strong conservation ethic, and the types of conservation strategies they employ. This information, concerning conservation adoption activities, is collected for the purpose of estimating conservation adoption rates

Analysis Phase:

There are many dynamic variables associated with natural resource management on agricultural lands. Describing the inter-relationship between these variables including vegetative cover, nutrient demand, conservation adoption rates, BMP effectiveness, soil erosion, and nutrient supply, etc. is challenging. During the analysis phase of this process, published research and empirical data is applied to results of the inventory phase. In order to maximize consistency across 1,962 watersheds, a few "Major Analysis Tools" are utilized initially [Table2]:

Table 2. Partial Listing of Technical Resources Utilized and Purpose

Analysis Tool	Purpose
Erosion models	Erosion Rates
NRCS-Waste Mgt. Handbook	Nutrient Demand
USDA-EPA Waste Utilization	Nutrient Demand
NCSU's "Manure Database".	Waste Production
NCSU's "Manure Database".	Waste Management

Unfortunately, published literature does not contain all the data that is needed to complete an agricultural watershed assessment. Therefore, certain calculations, required for land application of potential pollutants and mass balancing equations, will be based on "best professional judgement". When this occurs, assumptions, and calculation examples, are explicitly stated. One example of such an assumption might include the following:

> "Producers who following their CNMP will apply waste at appropriate agronomic rates, whereas producers without a CNMP will apply waste at rate that is consistent with published literature which assumes adequate vegetation."

Relational databases are developed using Microsoft's Excel Software and ESRI's ArcView, ArcView-Spatial Analyst, and ArcInfo Software. Key fields to relate spatial and non-spatial databases include 10-digit watershed number and Excel is used to develop unique polygon identifiers resulting from geo-processing techniques. Specific parameters to be included in the final database are listed below in Table 3.

Table 3. Parameters Estimated for Each 10-Digit Watershed

Parameter:	Format
Cropland	Acres
Pasture	Acres
Animal Units by Type	1000 Lb. Equivalents
PPR by Type by Pollutant	Per 1000 Lb. Per Day
Animal Waste Generated	Tons/Year
Pollutants Generated	Tons/Year
Farm Management Coefficient	Unitless
Land Applied Pollutants	Tons/Year
Commercial Fertilizer Applied	Tons/Year
Nutrient Demand [TN-TP]	Tons/Year
Nutrient Supply [TN-TP]	Tons/Year
Mass Balance [Over/Short]	Tons/Year

Table 3. Parameters Estimated for Each 10-Digit Watershed [Cont'd]

Fecal Coliform [fc]	col/100 ml/ac/day
Total Nitrogen [TN]	Tons/Year
Total Kjeldahl Nitrogen [TKN]	Tons/Year
Nitrate-Nitrogen [NO_3]	Tons/Year
Ammonium-Nitrogen [NH_4]	Tons/Year
Total Phosphorus [TP]	Tons/Year
Phosphate [P_2O_5]	Tons/Year
Orthophosphate [PO^4]	Tons/Year
Biological Oxygen Demand	Tons/Year
Chemical Oxygen Demand	Tons/Year
Sediment	Erosion - T/A/Y

LITERATURE CITED

Bramblett, Jimmy R. 1999. *TMDL Development and Georgia Agriculture.* Proceedings of the Georgia Water Resources Conference March 29-31, 1999 Athens, Georgia.

United States Department of Agriculture. 1990. *Georgia Agricultural Facts – 1990 Edition.* United States Department of Agriculture, National Agricultural Statistical Service. Athens, Georgia.

United States Department of Agriculture. 1999. *Georgia Agricultural Facts – 1999 Edition.* United States Department of Agriculture, National Agricultural Statistical Service. Athens, Georgia.

United States Department of Agriculture. 1993. *Georgia Watershed Agricultural Nonpoint Source Pollution Assessment.* United States Department of Agriculture, Soil Conservation Service. Athens, Georgia.

United States Department of Agriculture. 2000. National Resources Inventory – 1997 – Unpublished Data. United States Department of Agriculture, Soil Conservation Service. Athens, Georgia.

United States Environmental Protection Agency. 1998. *Clean Water Action Plan.* United States Environmental Protection Agency.