Calculating a Statewide Nutrient Mass Balance to Guide Strategic Nutrient Management Planning in Maryland

Submitted by:
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SUMMARY

Achieving a nutrient mass balance is the fundamental principle of economically and environmentally sound agricultural nutrient management. The mass balance approach has been used internationally to guide nutrient management planning and policy initiatives at the farm, watershed, state, and regional scale. The University of Delaware recently completed a detailed nutrient mass balance for the Delaware Nutrient Management Commission (DNMC) with recommendations to guide further nutrient management policy in Delaware (available upon request). Recently, the Center for the Inland Bays hosted a conference, *Frontiers in Nutrient Management: Sources and Solutions in the Inland Bays Watershed.* The mass balance report prepared for Delaware was one of the driving forces and the centerpiece of the conference. Fundamentally, the concept of a nutrient mass balance at any spatial scale is relatively simple – the nutrient inputs should match as closely as possible to the nutrient outputs to the area of interest. Nutrient surpluses indicate an increased potential for nutrient losses to the environment, while nutrient deficits suggest that economical optimum nutrient levels are not available for the most efficient crop production. The justification for this approach is best summarized in the report to the DNMC by Sims et al. (2008), where they state:

> *While climatic and management factors contribute to and influence the extent of N and P losses from land to water and air, the root cause in these settings is usually the surplus of nutrients present on the farm. Given this, understanding, and quantifying, the nutrient balance on a farm, and at larger scales such as watersheds, represents the first step in strategic nutrient management planning. This is the highest level of planning for any operation and focuses on the development of long-term goals and the broader strategies needed to achieve these goals.*

OBJECTIVES

1) Therefore, the first objective of this study is to document how individual and statewide efforts to improve nutrient management have affected the nutrient balance in Maryland today and provide recommendations based upon the findings of this study. This will be achieved by calculating statewide, county level agricultural nutrient balances for N and P for each year from 1996 to present. Some of the potential benefits of calculating a statewide nutrient mass balance are as follows:

    a) Assessment of successes or failures of current nutrient management strategies;

    b) Identification of new strategies to reduce the potential impacts of agriculture to water quality;

    c) Provide input into refinement of existing strategies (i.e. enhancement of phosphorus site index).

2) The second objective of this study will be to validate the findings of the statewide, county level nutrient balances that are calculated under Objective 1.

METHODS

Objective1:

Two nutrient budgets should be calculated and compared side-by-side using the same methods as in the DNMC-sponsored study. Full details of methods are presented in the final project report

that was prepared for the DNMC and is available upon request (Sims et al., 2008). In brief the methods are as follows. The first approach is management oriented and quantifies the amount of nitrogen (N) and phosphorus (P) produced or sold and compares this to the N and P recommended by University of Maryland Cooperative Extension for economically optimum crop production. The second approach uses an input-output calculation with estimates of all the N and P produced or sold and added to soils by biological N_2 fixation, compared to the estimated amount of nutrients that left the state or county in harvested crops or by manure relocation. The inputs in both approaches will account for all nutrients that are land applied including biosolids, manures, and inorganic fertilizers.

The balances described above will be calculated on both a statewide and county basis. If funding is available it is strongly recommended that available land-use GIS data layers be combined with the nutrient mass balance in order to present the information in a spatial context allowing extrapolation of the balances to watershed scales.

Objective 2:

It would be prudent to attempt to correlate how changes in statewide nutrient mass balances relate to environmental indicators of agricultural management changes. It has been suggested that soil P concentrations could provide one vehicle to perform such an assessment. However, it would be extremely difficult to assess historic soil P concentrations to correlate to historic nutrient balances. In addition, soil P does not respond in the short term to changes in management. However, such an assessment could provide valuable information. Therefore, we propose the following method to attempt such an assessment of statewide changes in soil P concentrations. Prior to the closing of the Maryland Cooperative Extension Soil Testing Laboratory (MCESTL) in 2003, Dr. Frank Coale collected 665 soil samples representing a range of agricultural soils across the state. These samples were analyzed in the MCESTL and at several commercial laboratories. This dataset represents a unique opportunity to examine soil nutrient changes with time. We will attempt to collect soil samples that represent as closely as possible the locations of the original 665 samples. However, the initial study was not designed to be duplicated so there is some question as to how accurately sampling locations can be replicated. Nonetheless, the large sample size should mitigate some of the error associated with spatial accuracy. These samples will then be analyzed using the same methods as the original 665 and the data will be compared to assess changes in soil P concentrations over that time period.

TIMELINE

The entire project will take two years to complete after initiation as described below. In the first year data will be collected and refined by working in close cooperation with state agencies including MDA and MDE in order to obtain the most accurate and up-to-date information. A preliminary report will be submitted one year after the data collection research assistant is hired. Half-way through the first year a GIS specialist will be hired and they will begin working to tabulate the nutrient inputs and outputs within a spatial context.

During the first year of the study a second research assistant will be hired to sample and analyze the 665 soil samples proposed under Objective 2. It is anticipated that sampling, analysis, and data interpretation will take approximately 18 months after the hiring of the research assistant. This person will then work with the other team members in completion of final project reports over the last 6 months of the project.

In the second year the final report will be prepared, again working closely with state agencies to generate a publication that can be used to evaluate the effect of activities over the past 12 years and to guide nutrient management activities the future.

BUDGET JUSTIFICATION

The tables below provide a detailed budget for the proposed project. Salary fringe benefits were calculated at 35% of salary. No capital equipment is to be purchased (>$5,000). None of the requested salaries, labor, equipment, or supplies are previously covered by any other public or private funding source. A research assistant will be hired to complete data collection and report preparation under Objective1. A second research assistant will be hired to complete Objective 2. Travel funds will be used to cover anticipated travel for data collection, soil sample collection, and meetings. The GIS specialist will be hired after data collection has begun. They will be employed for one year to prepare a detailed nutrient mass balance within a spatial context based on data collected for the standard nutrient mass balance. Information technology and publication costs will cover generation of final reports and telecommunication costs and equipment. Soil analysis costs were estimated based on 665 samples analyzed in duplicate at a rate of $10 per sample.

OUTREACH

As described above, the project will culminate in the production of a final report detailing the effect of nutrient management over the past 10 years on the State's nutrient mass balance. Information will be disseminated at public meetings through the University of Maryland Cooperative Extension Service by the Soil Fertility and Nutrient Management Specialist. One example of how this could be used is the recent conference (mentioned above) hosted by the Center for the Inland Bays. The Delaware Nutrient Mass Balance was the centerpiece of the conference and the Center intends to host three technical sessions throughout the year to develop policy going forward in Delaware (http://www.inlandbays.org/). Hopefully, upon completion, Maryland's Nutrient Mass Balance could encourage a similar initiative.

YEAR 1 BUDGET						
Budget Item and Description		**HRHCAE Requested Amount**		**Match and Source**		**Total Project Amount**
Salaries						
Research Assistant (Data collection)	$	45,000	$	-	$	45,000
Research Assistant (GIS Specialist)	$	30,000	$	-	$	30,000
Research Assistant (Objective 2)	$	45,000	$	-	$	45,000
Fringe Benefits						
RA Fringe (35%)	$	15,750	$	-	$	15,750
RA Fringe (35%)	$	10,500			$	10,500
RA Fringe (35%)	$	15,750			$	15,750
Subtotal Salaries & Benefits	**$**	**162,000**	**$**	**-**	**$**	**162,000**
Travel						
Travel	$	5,000	$	-	$	5,000
Subtotal Travel	**$**	**5,000**	**$**	**-**	**$**	**5,000**
Other						
IT and Publications	$	4,000	$	-	$	4,000
Soil Anaylsis	$	13,300	$	-	$	13,300
Subtotal Other	**$**	**17,300**	**$**	**-**	**$**	**17,300**
TOTAL	**$**	**184,300**	**$**	**-**	**$**	**184,300**

YEAR 2 BUDGET					
Budget Item and Description		**HRHCAE Requested Amount**	**Match and Source**		**Total Project Amount**
Salaries					
Research Assistant (Data collection)	$	46,350	$ -	$	46,350
Research Assistant (GIS Specialist)	$	30,900	$ -	$	30,900
Research Assistant (Objective 2)	$	46,350	$ -	$	46,350
Fringe Benefits					
RA Fringe (35%)	$	16,223	$ -	$	16,223
RA Fringe (35%)	$	10,815		$	10,815
RA Fringe (35%)	$	16,223		$	16,223
Subtotal Salaries & Benefits	**$**	**166,860**	**$ -**	**$**	**166,860**
Travel					
Travel	$	5,000	$ -	$	5,000
Subtotal Travel	**$**	**5,000**	**$ -**	**$**	**5,000**
Other					
IT and Publications	$	4,000	$ -	$	4,000
Subtotal Other	**$**	**4,000**	**$ -**	**$**	**4,000**
TOTAL	**$**	**175,860**	**$ -**	**$**	**175,860**

TOTAL BUDGET (TWO YEARS)					
Budget Item and Description		**HRHCAE Requested Amount**	**Match and Source**		**Total Project Amount**
Salaries					
Research Assistant (Data collection)	$	91,350	$	-	$ 91,350
Research Assistant (GIS Specialist)	$	60,900	$	-	$ 60,900
Research Assistant (GIS Specialist)	$	91,350	$	-	$ 91,350
Fringe Benefits					
RA Fringe (35%)	$	31,973	$	-	$ 31,973
RA Fringe (35%)	$	21,315			$ 21,315
RA Fringe (35%)	$	31,973			$ 31,973
Subtotal Salaries & Benefits	**$**	**296,888**	**$**	**-**	**$ 296,888**
Travel					
Travel	$	10,000	$	-	$ 10,000
Subtotal Travel	**$**	**10,000**	**$**	**-**	**$ 10,000**
Other					
IT and Publications	$	8,000	$	-	$ 8,000
Soil Analysis	$	13,300	$	-	$ 13,300
Subtotal Other	**$**	**21,300**	**$**	**-**	**$ 21,300**
TOTAL	**$**	**328,188**	**$**	**-**	**$ 328,188**

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Soil Fertility and Nutrient Management Specialist
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EDUCATION

Ph.D. Soil Science, Dept. of Plant and Soil Sciences, University of Delaware, May 2004.
B.A. Environmental Earth Sciences, Dept. of Earth and Planetary Sciences, Johns Hopkins University, May 1997.

EMPLOYMENT

Assistant Professor of Soil Fertility and Nutrient Management (July 2006 – present), Dept. of Environmental Science and Technology, University of Maryland, College Park, MD.
Research Assistant (April 2006 – July 2006), College of Agriculture and Natural Resources, University of Delaware, Newark, DE.
Post-doctoral Researcher (April 2004 – April 2006), Virginia Polytechnic Institute and State University, Blacksburg, VA.
Graduate Research Assistant (January 1999 – April 2004), Dept. of Plant and Soil Sciences, University of Delaware, Newark, DE.
Research Technician (March 1998 – April 1999), Chesapeake Farms, Dupont Co., Chestertown, MD.
Environmental Scientist (November 1997 – May 1998), Stephens Environmental Consulting, Rising Sun, MD.

PUBLICATIONS

Refereed Research Journal Publications: 4
Technical Reports: 3
Extension Bulletins: 1

PROFESSIONAL PRESENTATIONS

Technical Presentations and Published Abstracts: 23
Farmer/Grower/Manager/Citizen Educational Programs: >50

GRANTS AND CONTRACTS

Total Grants and Contracts Managed = $1.9 Million

PROFESSIONAL ACTIVITIES

Soil Science Society of America and American Society of Agronomy (1999 – Present)
Service to the societies includes:
Early Carreer Members Committee (2007 – present)
Emil Troug Soil Science Award Committee (2004 – 2006), Chair 2006
Training and Continuing Education for Soil Scientists Committee (2004 – 2007)
Volunteer reviewer for society journals
Philadelphia Society for Promoting Agriculture (January 2004 – Present)