USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

TITLE: A FRAMEWORK FOR EVALUATING BMP EFFECTS ON N AND P DISCHARGES FROM WATERSHEDS

DURATION: Two years

FEDERAL FUNDS REQUESTED: $70,000 ($35,000/yr for two years)

NON-FEDERAL: $141, 172 (1st Year- $70,951; 2nd Year-$70,221)

PRINCIPAL INVESTIGATORS:

S. Mostaghimi, R. B. Reneau, D. Bosch, J. A. Burger, and S. Shukla, Departments of Biological Systems Engineering, Crop and Soil Environmental Sciences, Agricultural and Applied Economics, and Forestry, respectively, at Virgi nia Tech, Blacksburg, VA.

CONGRESSIONAL DISTRICT: Ninth

STATEMENT OF CRITICAL REGIONAL AND STATE PROBLEMS:

Nitrogen (N) and phosphorus (P) are two important contaminants affecting the health of the Chesapeake Bay. In 1985, Virginia, Pennsylvania, Maryland, and District of Columbia, signed an agreement to achieve a 40% reduction in nutrient l oadings to the Chesapeake Bay by year 2000. However, according to the National Research Council (NRC, 1993a), current efforts will not be adequate for meeting this goal. In order to fulfill the 40% reduction goal, various B MPs were adopted by different s tates. To monitor the changes in the N and P discharges from the watersheds resulting from B MP adoption, several watershed studies, such as the Nomini Creek watershed study in Virginia's Coastal Plain, were initiated in the Chesapeake Bay drainage basin. However, evaluation of the BMPs impact on water quality has been faced with different levels of uncertainty, depending on the site specific characteristics and type of water bodies targeted (surface water or groundwater) (Clausen, 1992; USEPA, 1993). Dif ficulty in evaluating the BMP effects on N and P contamination of surface and groundwater at watershed scale stems from: a) interconnection between the surface and groundwater, b) inherent variability in soil-air-water processes that affect the movement a nd attenuation of N and P; c) natural sources of N as well as P in the environment; d) the lag time between the B MP implementation and their effect on the water quality; e) significant variability in atmospheric N and P loadings; and f) insufficient BMP implementation level.

Current approaches of evaluating the B MP impact assessment are mostly limited to comparing the pre-BMP and post-BMP water quality data (USEPA, 1993). However, such an approach can be flawed due to: a) inability to determine the lag tim e which results in inaccurate comparison of the pre-BMP and post-BMP data; b) inability to take into account the entire N and P cycling, including

the variations in atmospheric deposition sources; and c) over reliance on statistical methods as opposed to the mechanistic approaches that take into account the different N and P fluxes, sources and sinks in the watershed. A factor usu ally ignored in the watershed-scale BMP impact studies, is the economic impacts of BMP adoption on farmer's net return. Magbley (1992) noted that economic assessment of the BMP implementation can greatly increase the economic efficiency of the BMP monitor ing programs and thus facilitate selection of cost-effective BMPs for achieving water quality improvements.

State and federal agencies critically need a holistic approach for evaluating the BMPs effectiveness at the watershed scale. Such an approach should consider important N and P fluxes and the spatial and temporal changes in the N and P s inks and sources in the watershed to evaluate the long-term impacts of BMPs. Long term N and P watershed mass balances are essential for understanding the transport of these nutrients to the Chesapeake Bay (NRC, 1993a). Despite their increasing importance , the mass balance and flux of N species in many types of watersheds, including those in the Chesapeake Bay region, have not been well characterized (Bohlke and Denver, 1995). The long-term watershed scale N mass balances, fluxes of N species, and retenti on of the atmospheric N in the forested and mixed landuse watersheds, have not been investigated in the Chesapeake Bay regions. Lack of adequate knowledge regarding the BMP impact at the watershed-scale, and the scarcity of information regarding the water shed mass balances of the N and P, demonstrate the need for development of a framework for evaluating watershed-scale BMP impacts. Moreover, the N and P mass balances also need to be characterized to assist the federal and state agencies in achieving the 40% nutrient reduction goal of the Chesapeake Bay.

STATEMENT OF RESULTS AND BENEFITS:

In the proposed research, we plan to study the impact of B MPs in a Virginia Coastal Plain watershed by employing the mass balance modeling approach. We will construct and analyze the watershed level N and P mass balances for crop seaso n, annual, and crop rotation time scales, using the ten year (1986-1996) monitoring data collected at the Nomini Creek watershed in the Virginia Coastal Plain. The lessons learned from this study will be utilized to develop a framework for evaluating the watershed-scale BMP impacts. The results of this study could answer the following questions concerning effects of BMPs at the watershed scale and the role of atmospheric deposition as a nonpoint source of N and P, in the Chesapeake Bay drainage basin' a) were the BMPs sufficient to cause the change in surface and groundwater quality or did the response to BMPs occurred due to variability in precipitation and atmospheric N and P loadings; b) what is the lag time for surface and groundwater response to BMPs ; c) what improvements can be made in future studies aimed at evaluating BMP responses at watershed scale using the framework developed in this study; d) what is the economic impact of BMP implementation on farmer's net returns; e) what is the relative co ntribution of atmospheric deposition as a source of N and P in forested and mixed landuse watersheds; and f) what is the extent of the temporal variability in the atmospheric and agricultural sources of N and P.

The proposed research will be the first of its kind in the Mid-Atlantic Coastal Plain to study the long-term N and P cycling at watershed scale. The results of this study could be used to evaluate the long-term impact of BMPs on the N a nd P discharges from the Chesapeake Bay watersheds and the impact of these discharges on the Bay health. This information is critical in designing effective nonpoint source pollution programs for reducing the N and P loadings to the Chesapeake Bay (NRC, 1 993a).