

Report for 2005SD36B: Evaluating Phosphorus Loss on a Watershed Scale

Publications

- Conference Proceedings:
 - Guidry, A.R., F.V. Schindler, D. R. German, R. H. Gelderman, and J.R. Gerwing. 2005. Evaluating Phosphorus Loss Potential of Dominant Agricultural Soils in South Dakota. Annual Meeting of Professional Soil Science Association of South Dakota. Huron, South Dakota. March 11, 2005.
- Other Publications:
 - German, D. 2006. "Soil P and Runoff P Relationships: Implications for Lake and Watershed Management." 18th Annual Environmental and Ground Water Quality Conference Mar 14 –16, 2006. Pierre SD.
 - Nonpoint Source 319(h) Progress report. 2006. South Dakota Department of Environment and Natural Resources.

Report Follows

Final Report

State Water Resources Institute Program (SWRIP) March 2005 to February 2006

PART I.

Title: Evaluating Phosphorus Loss on a Watershed Scale

Investigators: Dr. Ronald H. Gelderman, Plant Science Department
Dr. Frank V. Schindler, Dept. of Chemistry and Biochemistry
Mr. David R. German, Water Resources Institute

The following report discusses the results of the research project titled "Evaluating Phosphorus Loss on a Watershed Scale" during the funding period of March 2005 through February 2006. This project is part of an ongoing phosphorus (P) study to evaluate the P loss potential of South Dakota soils, and has been conducted in cooperation with a project funded, in part, by the South Dakota Department of Environment and Natural Resources (SD DENR). The information gathered from this project provides the SD DENR sound scientific data in which to base their regulations of manure and fertilizer P application to agricultural land.

This project has been funded, in part, by the SD DENR (319 funds) for two years. The USGS-SWRIP contributions were to provide funding not covered by the SD DENR 319 grant, which included costs of a Masters level graduate student, and the analyses and travel costs of a third watershed. By evaluating an additional watershed (for a total of three), we will be better able to statistically assess plot scale versus watershed scale P loss. The third watershed will also double the number of watershed treatment effects that can be analyzed starting in year three when the project begins its paired watershed evaluation phase. The specific objectives of this project were:

Objective 1: Evaluate the relationship that exists between total P loss from micro-plot field areas and total P loss on a watershed scale.

Objective 2: Provide field demonstrations and P loss education to livestock producers, extension educators, water quality experts, state regulators, and various environmental stakeholders.

Methodology and Accomplishments:

Identification and characterization of two areas on university owned land that possess the physical and drainage character of typical watersheds in South Dakota have commenced. Three watershed areas of approximately 5.5 acres in size were located on university owned land. Each watershed possesses the physical and drainage properties of typical South Dakota watershed as defined by NRCS specialists. Each watershed area contains a similar drainage area (Point A in Fig. 1), length, slope, and shape, and are established with similar land cover and use, surface roughness, and soil characteristics. The identification of watershed areas were accomplished through the help of

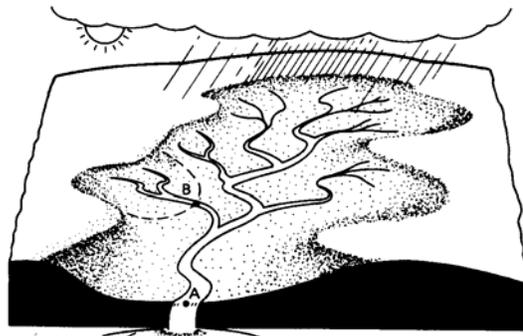


Figure 1. Delineation of a watershed boundary.

NRCS personnel, Water Resources Institute, and SDSU staff having watershed and natural resource expertise.

Watershed identification has been completed. Figure 2 shows the three watersheds as delineated using a Global Positioning Receiver (GPS) and a Handheld Geographical Information System. The red box in Fig. 2 represents the discharge area of the three watersheds and corresponds to point A of Fig. 1.

Figures 3 and 4 show the front view of the flumes for the three watershed areas, and a rear view of the flumes with the wing walls and established burms, respectively. Burms were plowed around the entire watershed area and between individual watershed areas to isolate surface flows.

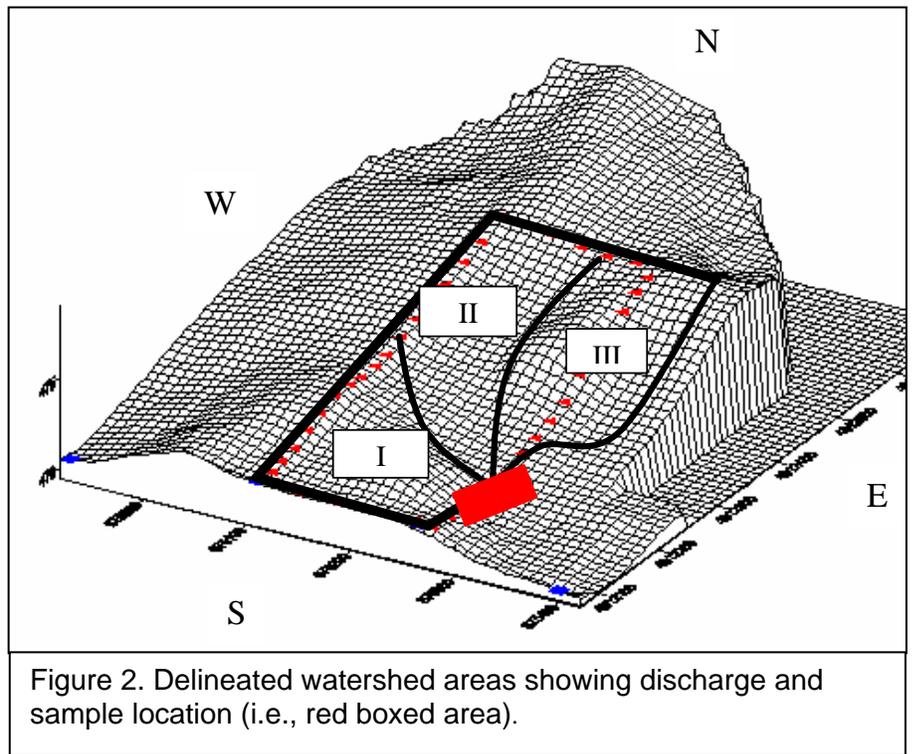


Figure 3. Front view of watershed flumes at the runoff discharge site.



Figure 4. Rear view of flumes showing wing walls and burms.

Samples will be collected from 0-2 and 0-6 inch depth intervals in April 2006 to establish initial characteristics. A composite soil sample at each depth increment will be obtained through an intensive grid sampling scheme. This will be used to establish the average soil P-value of the watershed. During the grid sampling, 10 discrete soil samples at each depth increment will be obtained and used to determine the degree of watershed heterogeneity, and also used for composite value comparisons. These samples will be analyzed by SDSU Soil and Plant Testing Laboratory and will include values for pH, Olsen extractable P, nitrate-N, potassium, organic matter, and soluble salts.

P loss in surface water runoff at the microplot scale will be evaluated. To facilitate microplot assessments and minimize plot and watershed disturbance, two additional rainfall simulators were obtained from the University of Illinois. Microplot establishment and rainfall simulator set-ups will occur immediately following spring 2006 planting, and all runoff evaluations will be conducted according to the protocol for the National Research Project for Simulated Rainfall-Surface Runoff Studies (NPRP, 2001).

Assessment of runoff volumes and total P loss from watershed areas began in March 2006. Two light rainfall events in March 2006 that generated flow at the flume discharge sites. Runoff samples and flow measurements were taken manually. Automatic flow recorders and samplers are going to be installed once a protective housing is build over the flumes. The automation will allow remote access to all flow data. The sampling automation includes and SIC dataloggers, solar power kit, telephone surge and lightening protection, and tipping bucket rain gage. NexSens iChart Software was purchased with USGS-SWRRRI funds that will be used to interface all samples and flow meters. A computer/electronics expert from the Agricultural Engineering Dept, will help install and hard wire all electronic recording devices. All materials needed to build the protective housing over the flumes have been acquired, and building is scheduled to begin on April 11, 2006. Total runoff and P loss data collection will be completed by 10/06 and 8/07 for the first and second year of the overall project, respectively.

Objective two of the study was to provide field demonstrations and P loss education to livestock producers, extension educators, water quality experts, state regulators, and various environmental stakeholders. Educational brochures, fact sheets, and handouts are all types of media that will be used to explain the field results produced and will be distributed to the appropriate end users. Information in these educational media will explain the total runoff and potential P loading to water resources as related to field plot and watershed scales. Since little data has been collected at this point, no informational media has been devised. Also, information dissemination will coincide with the Soil Extension Specialist's annual manure training seminars, workshops, and fertility update meetings across South Dakota, which are typically conducted in the late fall and winter months

Preparation of P manure management project reports describing runoff volumes, water quality, and total P loss relationship between the micro-plot and watershed scales will be accomplished as part of the established milestones for the SD DENR. Semi-annual reports will continue in April 2006, 2007, and annual reports will be prepared in September 2006, & 2007. Ten copies of a final report will be submitted to the SD DENR by December 31, 2007. A manuscript will be prepared and submitted for publication in a refereed, scientific journal.

Principal Findings and Significance:

Olsen-P values for the gridded watershed areas ranged from 27 to 163 mg P kg⁻¹. The nitrate-N and potassium ranged from 2 to 83, 213 to 6581 mg kg⁻¹, respectively, and the pH and soluble salts ranged from 7.0 to 8.3 and from 0.3 to 2.0 mmoh cm⁻¹, respectively. Three watershed areas have been established, and flumes at each discharge area have been installed. Several runoff events have been recorded and the associated samples collected. Enough runoff data should amass by the early summer months to begin developing educational brochures. All milestones to date have been adequately met, and project remains on schedule.

All runoff collection and monitoring will be conducted electronically and data from the three watershed flumes will be accessed remotely. A student is currently setting up all electronics necessary to remotely access data generated from depth gauges, Isco autosamplers, discrete flow measurements from a Montedoro Whitney Model PVM-2A flowmeter, and a tipping bucket recording rain gauge. Runoff samples will be collected by use of

automatic samplers at each watershed and analyzed for their total phosphorus and total dissolved phosphorus levels have remote access. Limited runoff data has been generated to date.

References:

National Phosphorus Research Project, 2001. National research project for simulated rainfall surface runoff studies protocol [Online]. Available at http://www.sera17.ext.vt.edu/Documents/National_P_protocol.pdf (verified March 17, 2006). North Carolina State University, Raleigh.

PART II:

Information Transfer Program: Information transfer will begin when sufficient runoff data has been collected and summarized. This is expected to begin during the summer months 2006. Mr. Jim Gerwing, South Dakota Soil Extension Specialist, will present the P runoff information generated from this project at his annual manure training and meetings/workshops. Meetings conducted include soil testing workshops for ag consultants and fertilizer dealers, manure application training workshops for people applying for state CAFO permits, and Certified Crop Advisor CEU workshops.

Field demonstrations within the watershed area may coincide with the SDSU Plant Science Agronomy tours (field days) scheduled in June 2006

Student Support: This project was originally budgeted to fund a graduate student. Because a qualified student was not found, and since no runoff was generated during the March 2005 to February 2006 time frame, the budget needed to be revised to insure efficient use of funds. We requested that the remaining funds from this project be used for student labor, professional salaries, and equipment. Dr. Van Kelley approved the revised budget. This project will be completed using EPA 319 funds.

Publications/presentations:

German, D. 2006. "Soil P and Runoff P Relationships: Implications for Lake and Watershed Management." 18th Annual Environmental and Ground Water Quality Conference Mar 14 –16, 2006. Pierre SD.

Nonpoint Source 319(h) Progress report. 2006. South Dakota Department of Environment and Natural Resources.

Due to limited data to date, no manuscripts have been written.