Effectiveness and Optimization of BMPs in Improving Water Quality from an Agricultural Watershed

Indrajeet Chaubey, Ed Gbur, Berni Kurz, Marc Nelson, Jennie Popp, Michele Steele, Katie Teague

University of Arkansas, Fayetteville, AR 72701

Objective 1

nthesize historic watershed BMP, land use, and water quality data in a GIS-linked database to quantify ationship between BMPs and their influence on water quality

- **Flow and water quality data have been collected at various sites since 1991 (Fig. 1, Tables 1, 2).**
- **Stream nutrient dynamics, limiting nutrient, and sediment-nutrient interactions have been quantified for 2002-2004 (Fig. 2, 3).**
- **A Soil and Water Assessment Tool (SWAT) model has been calibrated and validated for flow and TP (Fig. 4, Chaubey et al., 2004, Cotter et al., 2003). Minimum GIS input data resolution for SWAT modeling has been determined (Cotter et al., 2003).**
- **BMP information has been collected by interviewing 10 agricultural producers in the watershed (Fig. 5). A comprehensive BMP survey will be performed during this project.**
- **New watershed and water quality data needed for statistical and watershed modeling will be developed (e.g., Fig. 6).**

Table 1. Historical water quality data for Moores Creek

Parameter	Base Flow (mg/l)	Storm Flow (mg/l)	Total Flow (mg/l)
1991 - 1995 (Edwards et al., 1995)			
NO_3-N	0.93	1.02	1
TP	0.15	0.38	0.32
NH_4-N	0.19	0.14	0.15
TKN	2.13	2.02	2.09
PO_4-P	0.06	0.18	0.15
TSS	11.99	64.33	52.3
1995 - 1998 (Vendrell et al., 1998)			
NO_3-N	1.2	0.75	1.15
TP	0.17	0.42	0.29
NH_4-N	0.05	0.07	0.07
TKN	0.67	1.2	0.96
TOC	6.52	4.92	7.17
TSS	26.7	155	80

Table 2. Flow (x 10^6 m^3) and water quality (mg/l) data for the Upper Moores Creek monitoring site (Nelson et al., 2003)

Parameter	2000	2001	2002	2003
NO_3-N	2	2.13	1.53	1.17
TP	0.66	0.53	0.38	0.44
NH_4-N	0.1	0.1	0.09	0.46
TKN	1.44	1.15	0.96	1.08
PO_4-P	0.28	0.25	0.18	0.33
TSS	209	137	113	199
Flow	2.2	2.7	3.3	2.5

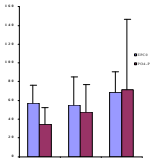

Figure 2. A comparison of sediment EPC_0 and water column PO_4-P concentration in Moores Creek.

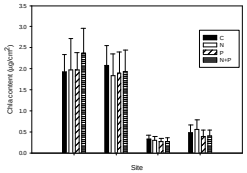

Figure 3. Results from passive diffusion periphytometers showing that light was limiting algal production in Moores Creek

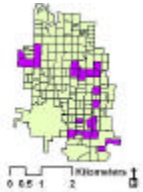

Figure 5. Location of BMPs installed in the watershed

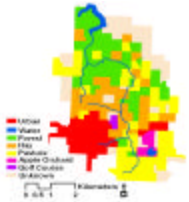

Figure 6. Detailed land use data for the Moores Creek watershed developed using Landsat Imagery and ground truting

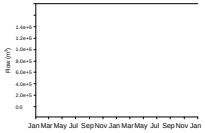

Figure 4. SWAT model calibration results for flow and TP

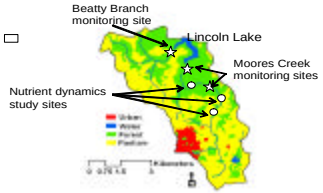

Figure 1. Location and land use of Lincoln Lake Watershed in Arkansas

Project Summary

- **The project will be performed in Lincoln Lake watershed located in the Ozark Highlands of northwest Arkansas (Fig. 1). Nonpoint source (NPS) transport of nutrients, sediment, and pathogens from agricultural activities is a major concern in this area (Edwards and Daniel, 1992; Edwards et al., 1997). Rolling hills in this region are home to thousands of poultry farms and pastures that produce abundant forage for numerous beef and dairy cattle. There is a growing concern that excess land application of animal manure can lead to surface and ground water pollution due to increased runoff losses of nutrients such as nitrogen (N) and phosphorus (P), sediment and pathogens (Edwards et al., 1996).**
- **Overall goal of this project is to quantify relations between water quality, and selection, timing, and distribution of BMPs within a watershed impacted by land-application of animal manure.**
- **The project will integrate a GIS ecosystem model, statistical analyses of historic watershed and water quality data, with a stakeholder-driven nutrient management and BMP decision process, using economic and water quality data for validation.**
- **The project is funded by USDA-CSREES under CEAP Program.**

Objective 2

Quantify linkages among nutrient management, land use, BMP implementation, and water quality at watershed scale

- **Perform statistical analyses of historical data (Fig. 7).**
- **Model water quality impacts of various BMPs to water quality improvements at the watershed scale.**
- **Example BMPs include grazing and pasture management, riparian and buffer zones, poultry litter and commercial fertilizer applications.**
- **Collect stakeholder feedback on modeling scenarios.**

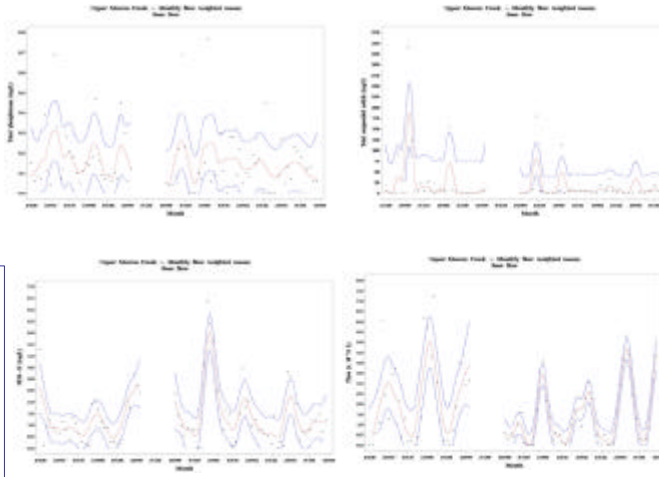

Figure 7. Preliminary results of LOWESS fit based on AIC criteria for flow and nutrients during base flow conditio Red lines indicate fitted curve and blue lines indicate 95% confidence interval.

Objective 3

Develop a comprehensive cost benefit analyses of the water quality management practices t optimize economic returns to agricultural production and improve watershed scale water qua

Objective 4

Develop education/demonstration programs to educate stakeholders on linkages among farm level activities and watershed scale water quality response.

References

- Chaubey, I. Cotter, A.S., T.A. Costello, and T. Soerens. 2004. J. Hydrologic Processes 19:621-628.
- Cotter, A.S., I. Chaubey, T.A. Costello, T.S. Soerens, and M.A. Nelson. J. Amer. Water Resour. Assoc. 39:977-986.
- Edwards, D.R. and T.C. Daniel. 1992. J. Environ. Qual. 22:361-365.
- Edwards, D.R., T.C. Daniel, H.D. Scott, J.F. Murdoch, M.J. Habiger, and H.M. Burks. 1996. Water Resour. Bulletin 32:499-509.
- Edwards, D.R. T.C. Daniel, H.D. Scott, J.F. murdoch, P.F. Vendrell. 1997. Trans. ASAE 40:1311-1319.