Iowa Water Center
Annual Technical Report
FY 2009

Introduction

The Iowa Water Center is a multi-campus and multi-organizational center focusing on research, teaching and outreach activities. The Center’s goal is to encourage and promote interdisciplinary, inter-institutional water research that can improve Iowa’s water quality and provide adequate water supplies to meet both current and future needs of the state. The Iowa Water Center continues to build statewide linkages between universities and public and private sectors and to promote education, research, and information transfer on water resources and water quality issues in Iowa. The Center also plays a vital role in identifying critical water research needs and providing the funding or impetus needed to initiate research that cannot or is not being conducted through other means. Water quality remains a critical concern in Iowa.

While our understanding of nutrient and sediment movement processes and how these materials affect Iowa's surface and ground water is improving, we do not fully understand a variety of issues linking land management and water quality at multiple scales. This is particularly important because Iowa is repeatedly identified as a major contributor of nutrients and sediment to the Gulf of Mexico where hypoxia research continues. There are numerous research questions that are critical to understanding Iowa's water quality issues and the state's contributions to regional problems. The Iowa Water Center plays a role in addressing these questions through administering the 104B program and garnering additional funds for other research projects.

Research Program Introduction

Our understanding of nutrient and sediment movement processes and how these materials affect Iowa's surface and ground water is improving. However, a variety of issues linking land management and water quality at multiple scales require further study. Identifying the most significant sediment and nutrient sources in our watersheds is a challenge and targeting these sources increases the benefit of conservation practices. This is particularly important because Iowa is repeatedly identified as a major contributor of nutrients and sediment to surface water. If we can improve our ability to trace soil material movement on the landscape and to our water bodies, we can focus our Best Management Practices for better water quality.

Other research questions exist that are critical to understanding Iowa's water quality issues. They include: How can we better trace nutrient movement in overland flow; how can we improve models for prediction of sediment and nutrient movement; can we utilize state-of-the art science and technology, such as LiDAR (Light Detection and Ranging), to improve our estimates of soil loss or nutrient delivery to streams?

Biomass Harvest and Nutrient Management Systems Impacts on Water Quality.

Basic Information

Title:	Biomass Harvest and Nutrient Management Systems Impacts on Water Quality.
Project Number:	2008IA126B
Start Date:	3/1/2008
End Date:	2/28/2010
Funding Source:	104B
Congressional District:	3
Research Category:	Water Quality
Focus Category:	Water Quality, Non Point Pollution, Nutrients
Descriptors:	None
Principal Investigators:	Antonio P. P. Mallarino, Matthew J. Helmers

Publications

There are no publications.

ANNUAL REPORT

Iowa Water Center Project
Biomass Harvest and Nutrient Management Systems Impacts on Water Quality.

May 2010

Prepared by Antonio P. Mallarino, Matt J. Helmers, and Mazhar U. Haq

Problem and Research Objectives

The general goal of this project was to evaluate impacts of selected crop, biomass harvest, and nutrient management systems on loss of N and P from fields with surface runoff and subsurface tile drainage. The two main objectives stated in the original proposal were the following:

1. Determine dissolved reactive P, total dissolved P, algal-available P, total P, and total N concentrations and loads in surface runoff from corn production systems harvested for grain using different tillage and fertilizer or manure P management systems and from continuous corn harvested for grain and cornstalks.

2. Determine loss of nitrate, dissolved reactive P, and total dissolved P through subsurface tile drainage from selected bioenergy production systems managed with fertilizer or manure N-P management systems.

Summary of Methodology

The field work for Objective 1 was conducted as planned for the runoff P study located in the Iowa State University (ISU) Northwest Research and Demonstration Farm. The experiment consisted of five treatments that include an N-based liquid swine manure management system for continuous corn managed with chisel-plow tillage, P-based fertilizer management for corn-soybean rotations managed with no-till or chisel-plow tillage, and P-based liquid swine manure management for corn-soybean rotations managed with no-till or chisel-plow tillage. Table 1 shows the systems evaluated and the abbreviations used in this report. Corn and soybean of Systems 1 through 4 were grown each year on adjacent plots, and crops were rotated each year. The crops of the corn-soybean rotations were harvested for grain, while the continuous corn was harvested for grain and also for cornstalks (baled after harvest). All systems were replicated three times, and there were 27 plots each measuring 20 by 100 feet. The amount of P needed by crops of the corn-soybean rotations was determined by soil testing and estimated P removal with harvest, and was applied only once in the fall before corn and the 2-year P rate averaged 100 lb P_2O_5/acre. Triple superphosphate was broadcast for all fertilizer P treatments, was not incorporated for the no-till systems, and was incorporated in the spring for the tilled systems. Liquid swine manure from an underground pit was injected into the soil in the fall for all plots of the manure-based systems. Fertilizer N (28% UAN solution) was injected in spring as needed for corn after soybean so that the total N applied was at least 150 lb N/acre and equal for all four systems. For System 5 (continuous corn), manure was applied at 200 lb total N/acre each fall. The runoff samples were analyzed for sediment, dissolved reactive P (DRP) in samples filtered at the field using a 0.45 um filter, bioavailable P (BAP) as estimated by the iron oxide-impregnated paper test), total N, and total P (TP). We also measured total dissolved P in filtered runoff samples from selected systems. Soil samples were collected from several soil depths and were analyzed for P by three routine tests (Bray-1, Mehlich-3, and Olsen), total P, and other nutrients.

The field work for Objective 2 was conducted at a site located in the ISU Agronomy and Agricultural Engineering Research Farm in central Iowa. Treatments were eight cropping and nutrient management systems that included three different cropping systems (continuous corn, corn/soybean rotation, and switchgrass) with varying nutrient management and harvest strategies. Table 2 shows the systems evaluated and the abbreviations that will be used in this report. Three systems involved continuous corn systems managed with N-P fertilizers and harvested for grain, partial stover removal, or total aboveground biomass removal. Two systems involved continuous corn systems managed with N-based liquid swine manure harvested for grain or total biomass. There was one corn-soybean rotation system managed with N-based liquid swine manure harvested for grain. There were two switchgrass systems harvested for total aboveground biomass. One was managed with N-P fertilizer and the other was established in plots with a history of large swine manure application rates and received no nutrient application during the study. Plots with corn were chisel-plowed and disked in spring, soybean residue was disked in spring, and both fertilizer and manure were applied in the spring and incorporated into the soil. Monitoring of drainage and collection of flow-weighted water samples was on-going on at least a weekly basis. Unfiltered tile drainage samples were analyzed for nitrate, reactive P (by the Murphy and Riley method), and total P. Soil samples were analyzed for P and other routine tests as described for the other study.

Principal Findings and Significance

The sample collection and analyses have been completed for both sites and the two years of the project. We are still summarizing a major portion of the laboratory results at this time, however. For the surface runoff study these include sediment loss, runoff total dissolved P, runoff total N, and soil samples taken in fall 2009. For the tile drainage study these include both nitrate and P in tile drainage water and soil samples taken in fall 2009. Also, we have not completed statistical analyses for most measurements and sampling dates. Therefore, in this report we show and discuss the most relevant of the available results and cannot have final conclusions.

Highlights of Results for Objective 1 - Runoff Study.

There were a total of 13 runoff events with measurable water or soil loss for most plots of the experiment. We summarize results by showing average annual runoff P concentrations and loads for DRP, BAP), and total P fractions. The DRP fraction is readily available for algae in streams or lakes, the BAP fraction estimates both P readily available and P becoming available over a short period of time (probably weeks), and TP becomes available over a longer period of time depending on water properties and other factors.

Figure 1 shows that average runoff P concentrations were lowest for DRP, intermediate for BAP, and highest for TP. Runoff P was higher for the corn years (soybean residue in corn-soybean rotations) than for the soybean years (corn residue). In the corn years the systems ranked similarly for DRP and BAP, with statistically higher concentrations for the fertilizer-based systems (FP-CH and FP-NT), intermediate for MP-CH, and lowest for the other systems. Total runoff P concentration (which reflects soil loss more than DRP or BAP) was highest for FP-CH and lower with small differences for the other systems. In the soybean years (corn residue), DAP and BAP concentrations were low and did not differ. The concentrations of TP were larger, however, and much higher for the tilled systems than for no-till.

Figure 2 shows the P loads, which integrate treatment effects on runoff (water and soil losses) and runoff P concentrations. In the corn years, DRP and BAP losses were highest for the no-till and fertilizer-based system (FP-NT) and lowest for MP-NT, with small or no differences between the other intermediate systems. The TP losses were highest for FP-CH and MP-CH, lowest for MP-NT, and intermediate with small or no differences for the other two systems. In the soybean years, there were small differences between systems for DRP and BAP, although losses of both fractions seemed highest for MP-CH. The TP loss was much larger with tillage than with no-tillage for fertilizer- or manure-based systems. The P loss data in this figure must be interpreted with care because the corn and soybean crops alternate over time but there is corn every year for the continuous corn. The available results suggest that the P loss over a 2-year period was about similar for the systems managed with tillage, with small or no difference between the P-based and manure-N based systems.

One consistent result was, however, that losses of all runoff P fractions in corn-soybean rotations were much higher for the corn year. This is reasonable because the fertilizer or manure P was applied before corn, and also because runoff was higher since there was less water infiltration where soybean was the previous crop. Another clear result was that DRP and BAP losses were the highest for the no-till and P fertilizer based system in corn years, which probably is explained by broadcast fertilizer application before no-till corn. The differences with the other systems were smaller, however, and this higher loss of DRP and BAP for the no-till and P fertilizer based system was not observed in the soybean years. The total P losses for systems managed with tillage were much higher (two to four times higher) than the DRP and BAP losses but differences were much smaller for the systems managed with no-till, which was an expected result. Overall, there was a much higher total P loss with tillage than with no-till with small or no differences between fertilizer and manure management systems.

Highlights of Results for Objective 2 - Tile Drainage Study.

Monitoring of drainage and collection of flow-weighted tile drainage water samples was at least on a weekly basis from April to November 2008 and then from March to November 2009. Approximately 600 to 700 water samples were collected each year.

Figures 3 and 4 show nitrate-N concentrations for 2008 and those available from 2009. In 2008, the highest nitrate concentrations were for the continuous corn plots fertilized with commercial fertilizer at 200 lb N/acre. Continuous corn plots with manure applied received an average of 211 lb N/acre while the corn-soybean rotation received 159 lb N/acre for corn. A significant spike was observed for the commercial fertilizer plots in June 2008 that continued into July, which likely was due to extreme rain events during these months. Average nitrate-N concentration was lowest for the switchgrass plots receiving commercial fertilizer. Results for 2009 again indicate the highest nitrate-N concentrations for continuous corn treatments receiving commercial fertilizer, particularly for grain and total biomass harvest systems. Continuous corn plots with manure applied received an average of 159 lb N/acre while the corn-soybean rotation received 117 lb N/acre for corn. Similarly to results for 2008, there was a pronounced increase in nitrate-N concentrations in June for systems managed with inorganic fertilizer. Nitrate concentration was lowest for the switchgrass systems. Further interpretation and confirmation of apparent differences will be possible after completing data from 2009 and statistical analyses.

Figures 5 and 6 show tile drainage water reactive P concentrations for 2008 and those for available from 2009. In both years reactive P concentrations for most samples were extremely low, less than 5 ug/L for most treatments and flow events. Spikes in concentration occurred in April or June of each year and in the fall of 2008 (data for fall 2009 were not summarized at this time). These isolated spikes were not clearly related to the treatments applied and may be explained by relatively higher rainfall amounts during those periods.

Data for total P in drainage water for 2008 and 2009 are shown in Figures 7 and 9, respectively. The total

P concentrations were higher than reactive P concentrations for all treatments in both years, and there were no clear or consistent differences between management systems. In 2008, the total P concentrations followed reactive P trends closely, but there was less agreement in 2009. Further analysis and interpretation of these results will be possible after completing analysis of water and soil samples collected in 2009 and corresponding statistical analyses. Data for 2008 in Fig. 9 clearly show the higher total P concentration than for reactive P for all treatments, which on average was two to four times higher. Although in this study we did not analyze the nature of this additional P and drainage water samples were not filtered, the samples seldom had any sediment and previous work with soil extracts suggest that it mainly represents P in labile organic and inorganic compounds that is not measured by the Murphy and Riley colorimetric method.

Significance of Results.

The last portion of data collected during 2009 has not been summarized and no statistical analysis has been conducted. Therefore, no strong conclusions can be drawn at this time. Results for the surface runoff study indicate that, as expected, less P loss with no-till than with tillage for soybean residue, but small and inconsistent tillage effects for corn residue and also inconsistent differences between the fertilizer and swine manure P management systems. Results for the tile drainage study suggest larger nitrate loss for the fertilizer management systems than for the swine manure systems, and lowest loss for the switchgrass systems. These results suggest that swine manure N was less available for leaching through the soil profile than the fertilizer N. There were small differences between the cropping and harvest systems that cannot be interpreted with certainty until more recent samples are analyzed and statistical analysis are completed. Nitrate and P loss among the lowest in the study for switchgass established on plots that had a long history of large swine manure application (where soil-test P was very high) shows the great potential of such a system to remediate soils with high N and P loss. Comparisons of analyses for reactive P and total P in drainage water indicate that the differences between these two P fractions varied across systems and flow events, but on average TDP were two to four times higher than DRP for all management systems. We will continue studying results for both studies, but such a difference is important because dissolved P that is not measured as reactive P can be available for algae growth over a very short period of time.

Student Involvement

One M.S. graduate student participated in the project and received training in all aspects of the study, from treatment application to data management. One postdoctoral associate helped plan and execute the project, and up to three undergraduate students also helped at different times. These undergraduate students helped mainly with field and laboratory work.

Outreach Activities and Publications

Two progress reports with preliminary results of each portion of the project, were prepared in March 2010, and were posted in the web site of the ISU Research Farms (see specific reference below). Preliminary results also were shared at field days or conferences (see below). We will continue sharing results of the project through various ISU Extension outlets in 2010 and beyond. We will begin preparing presentations for scenic national meetings and two articles for scientific journals (one for each portion of the project) once analysis of all data is completed.

Helmers, M., C. Pederson, A. Staudt, R. Christianson, and A.P. Mallarino. 2010. Impacts of crop, biomass harvest systems, and nutrient management on yield and subsurface drainage water quality. Agric.

Eng., Agronomy, and Central Iowa Research Farms. RFR-A9135. ISRF09-16, 30. Iowa State Univ., Ames, IA. http://www.ag.iastate.edu/farms/reports.html.

Mallarino, A.P., A. Andrews, M. Haq, and M. Helmers. 2010. Corn harvest and nutrient management systems impacts on phosphorus loss with surface runoff. Agric. Eng., Agronomy, and Central Iowa Research Farms. RFR-A9133. ISRF09-16, 30. Iowa State Univ., Ames, IA. http://www.ag.iastate.edu/farms/reports.html.

Mallarino, A.P., M.J. Helmers, M.U. Haq, A.A. Andrews, and C.H. Pedersen. 2009. Biomass harvest and nutrient management impacts on nutrient loss from fields. Presentation at the Iowa Water Quality Conference, March 10, 2009, Iowa State University, Ames.

Mallarino, A.P., M.J. Helmers, M.U. Haq, C.H. Pedersen, and A.A. Andrews. 2008. Water quality impacts of biomass production. Presentation at the Bioeconomy Conference, Sep. 7-10, 2008, Iowa State University, Ames.

Mallarino, A.P., M.J. Helmers, and M.U. Haq. 2008. Tillage and nutrent management systems impacts on phosphorus loss with surface runoff. Field day presentation at the Northwest Iowa State Univ. Research and Demonstration Farm. Sep. 2, 2008. Sutherland.

Table 1. Management systems evaluated at the Northwest Iowa runoff study site.

System	Rotation	Tillage	Nutrient Management	Abbreviation		
				Crop	Nutrient	Tillage
1	Corn-Soybean	Chisel plow	Fertilizer P	Cs or Sc	FP	CH
2	Corn-Soybean	No till	Fertilizer P	Cs or Sc	FP	NT
3	Corn-Soybean	Chisel plow	Manure P	Cs or Sc	MP	CH
4	Corn-Soybean	No till	Manure P	Cs or Sc	MP	NT
5	Continuous Corn	Chisel plow	Manure N	CC	MN	CH

Table 2. Management systems evaluated at the Central Iowa tile drainage study site.

System	Crop rotation	Harvest Practice	Nutrient Management	Abbreviation
1	Continuous corn	Grain only	Fertilizer NP	CCGr-F
2	Continuous corn	Grain only	Manure N	CCGr-M
3	Continuous corn	Aboveground biomass	Fertilizer NP	CCTot-F
4	Continuous corn	Aboveground biomass	Manure N	CCTot-M
5	Continuous corn	Grain and stover baling	Fertilizer NP	CCSt-F
6a	Corn before soybean	Grain only	Manure N	CsGr-M
6b	Soybean before corn	Grain only	None	ScGr-M
7	Switchgrass	Aboveground biomass	Fertilizer NP	Sw-F
8	Switchgrass	Aboveground biomass	Manure history	Sw-Mh

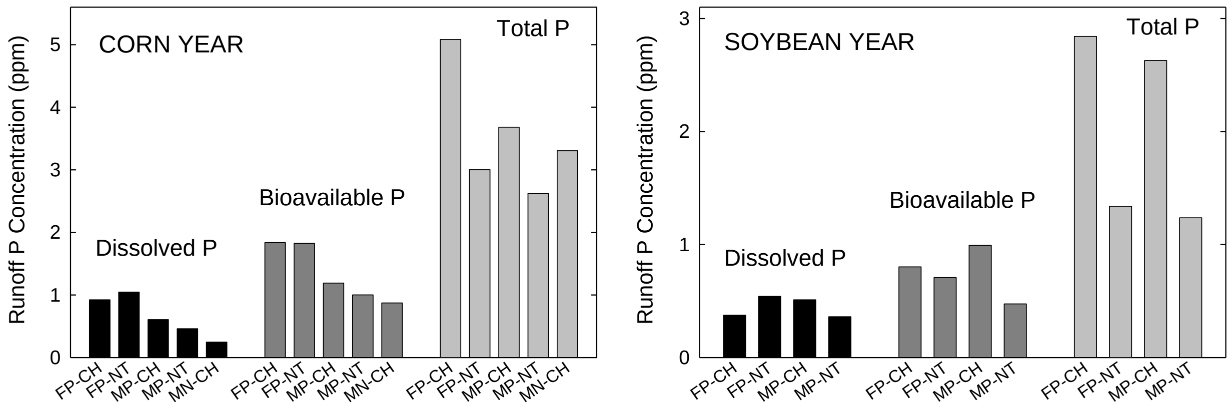

Figure 1. Runoff P concentrations for the corn and soybean years at the Northwest Iowa study (annualized averages).

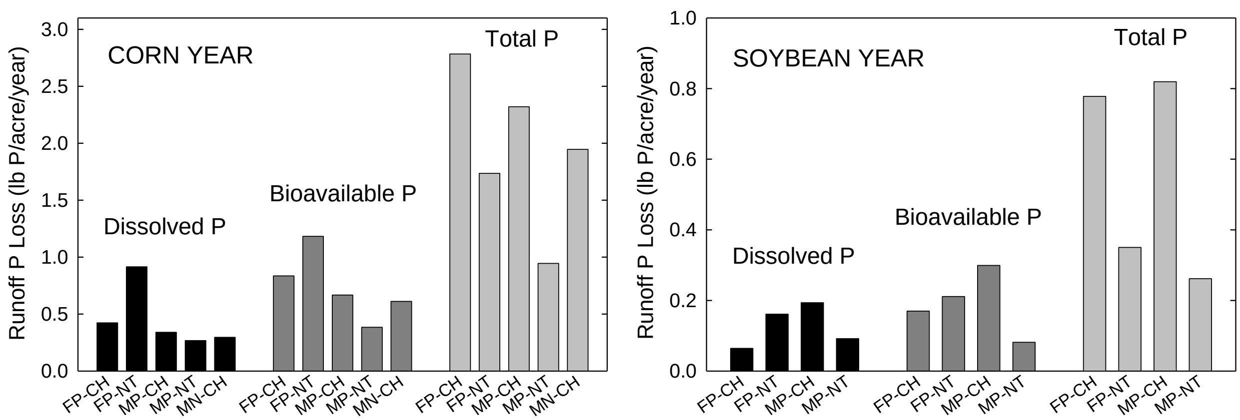

Figure 2. Runoff P loads for the corn and soybean years at the Northwest Iowa study (annualized averages).

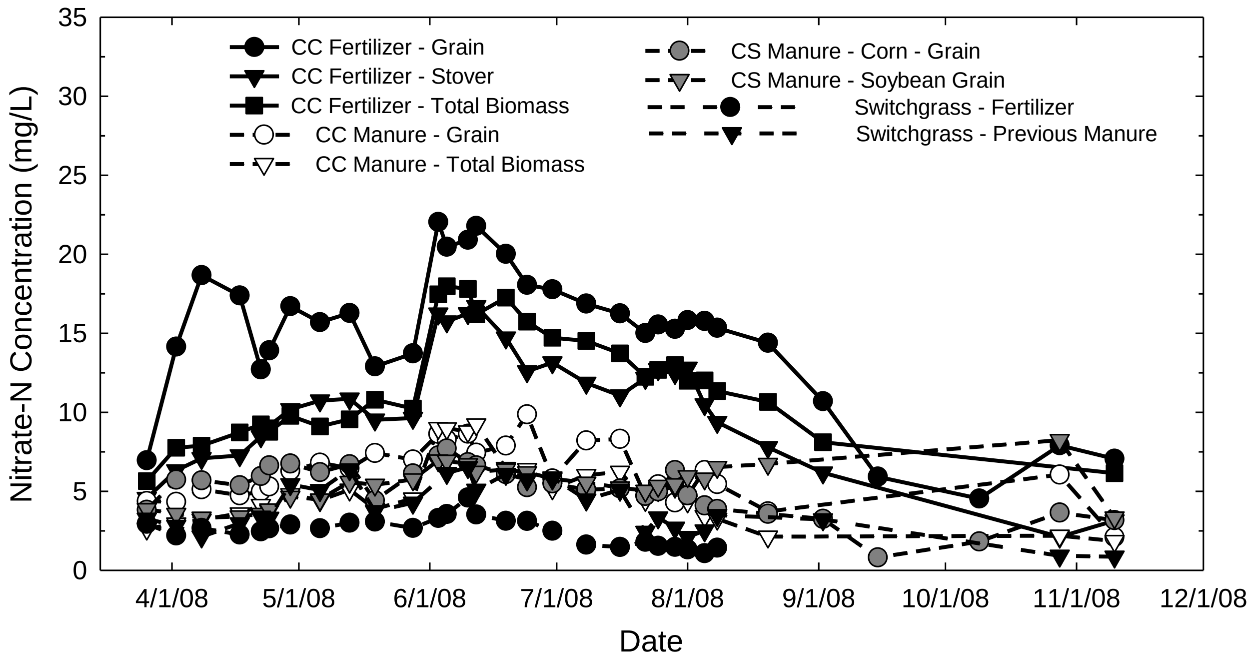

Figure 3. Nitrate-N concentrations in subsurface drainage water during 2008.

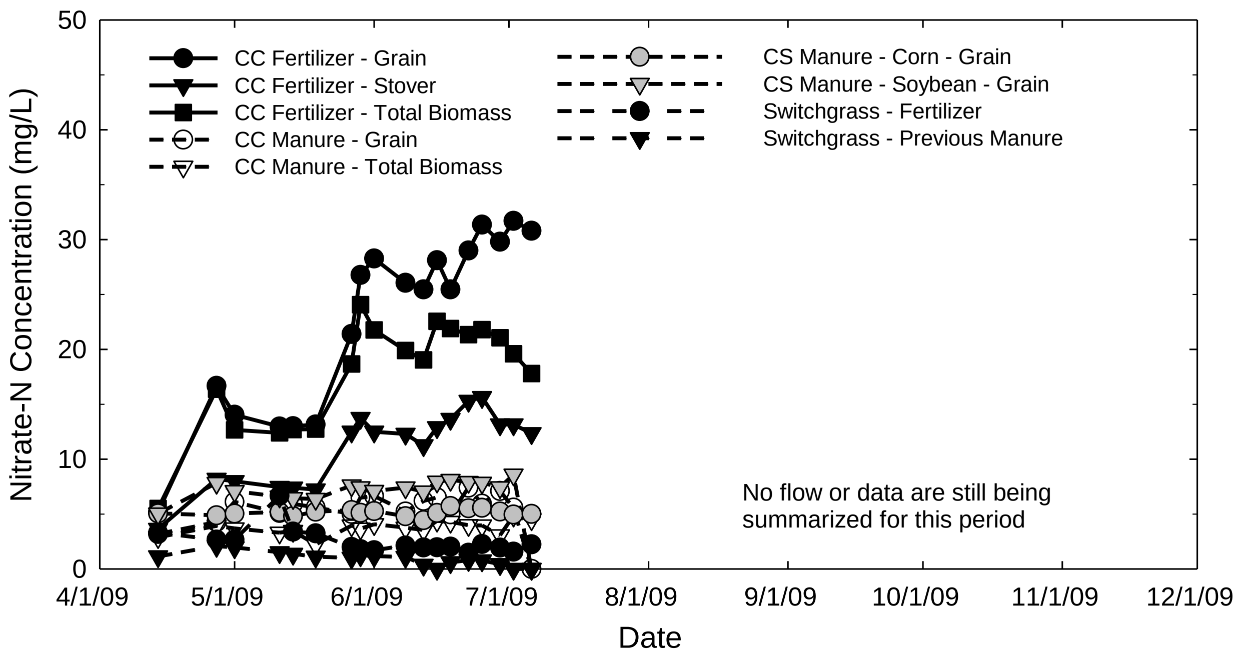

Figure 4. Nitrate-N concentrations in subsurface drainage water during 2009.

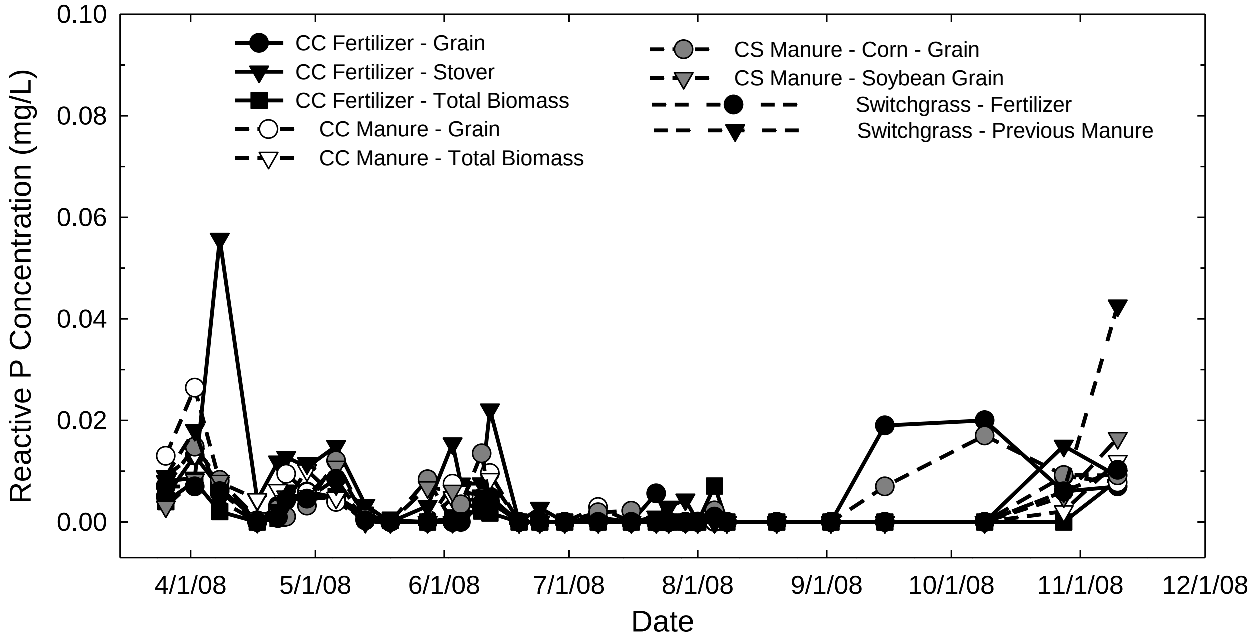

Figure 5. Reactive P concentrations in subsurface drainage water during 2008.

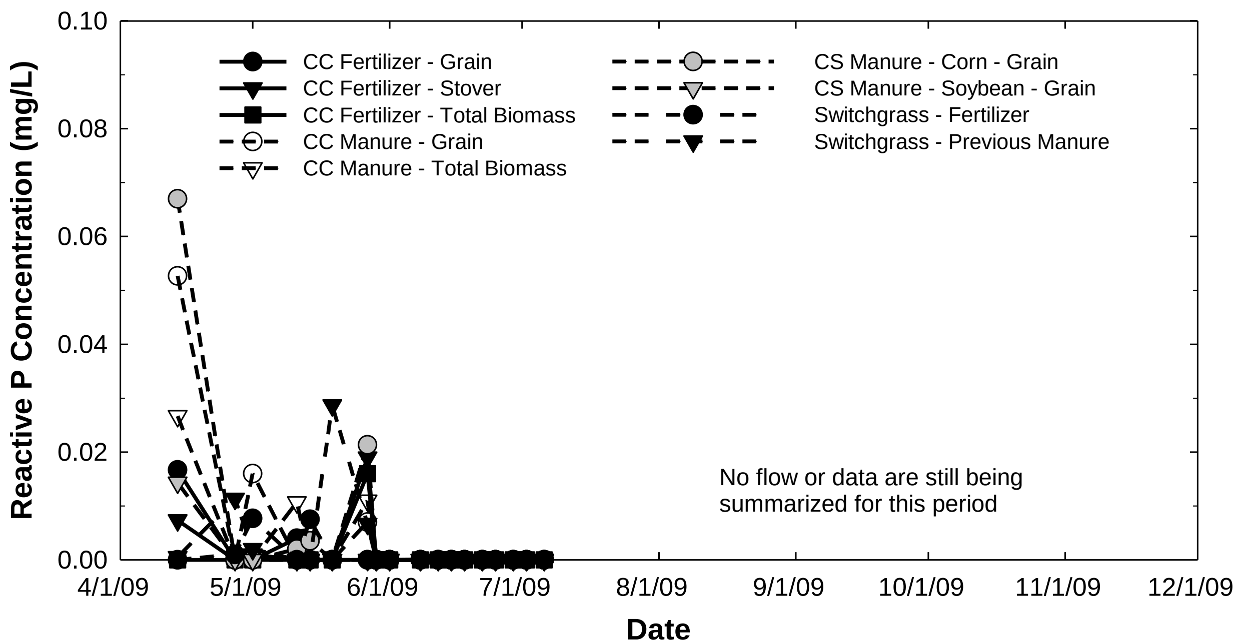

Figure 6. Reactive P concentrations in subsurface drainage water during 2009.

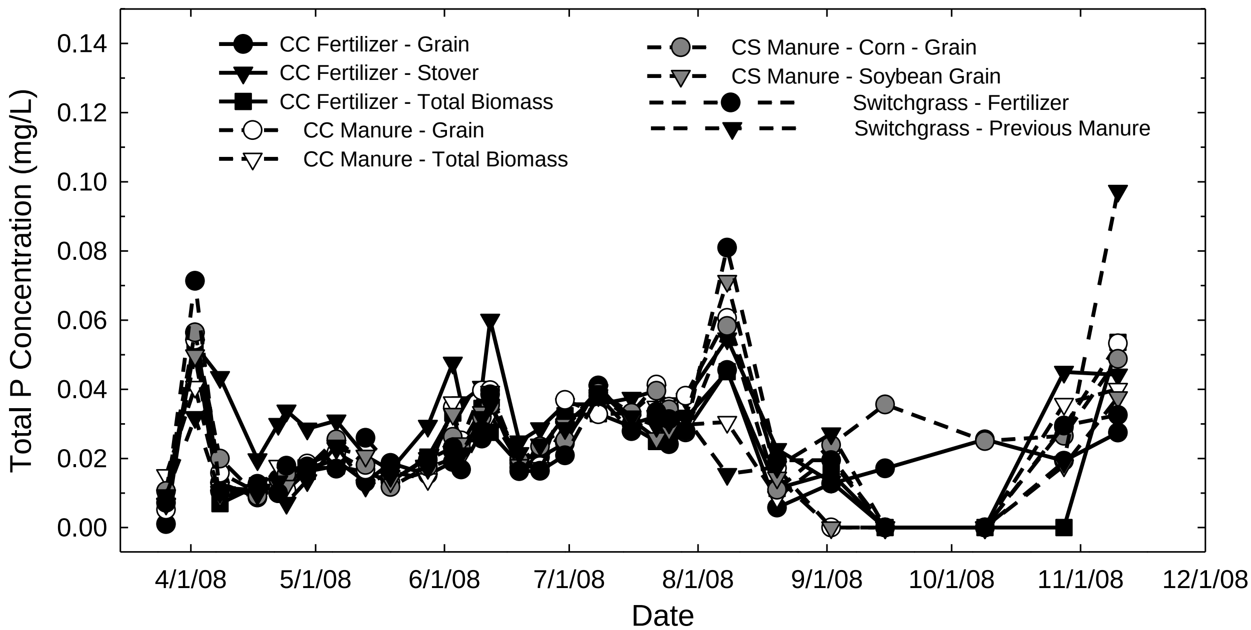

Figure 7. Total P concentrations in subsurface drainage water during 2008.

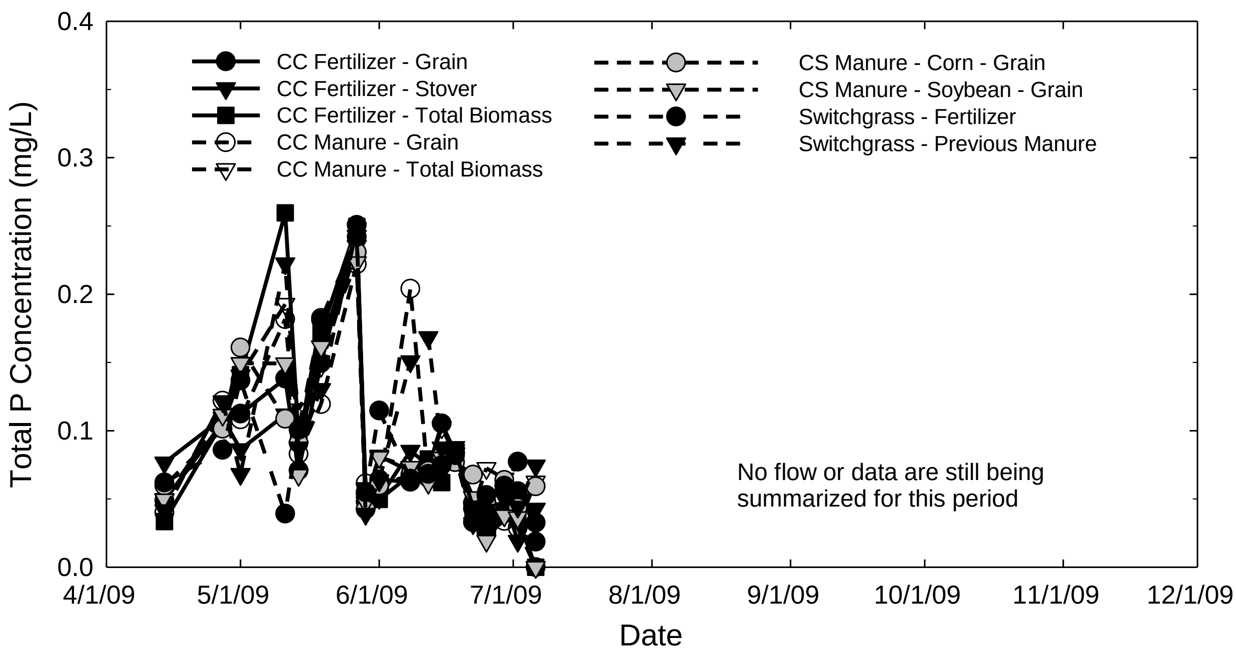

Figure 8. Total P concentrations in subsurface drainage water during 2009.

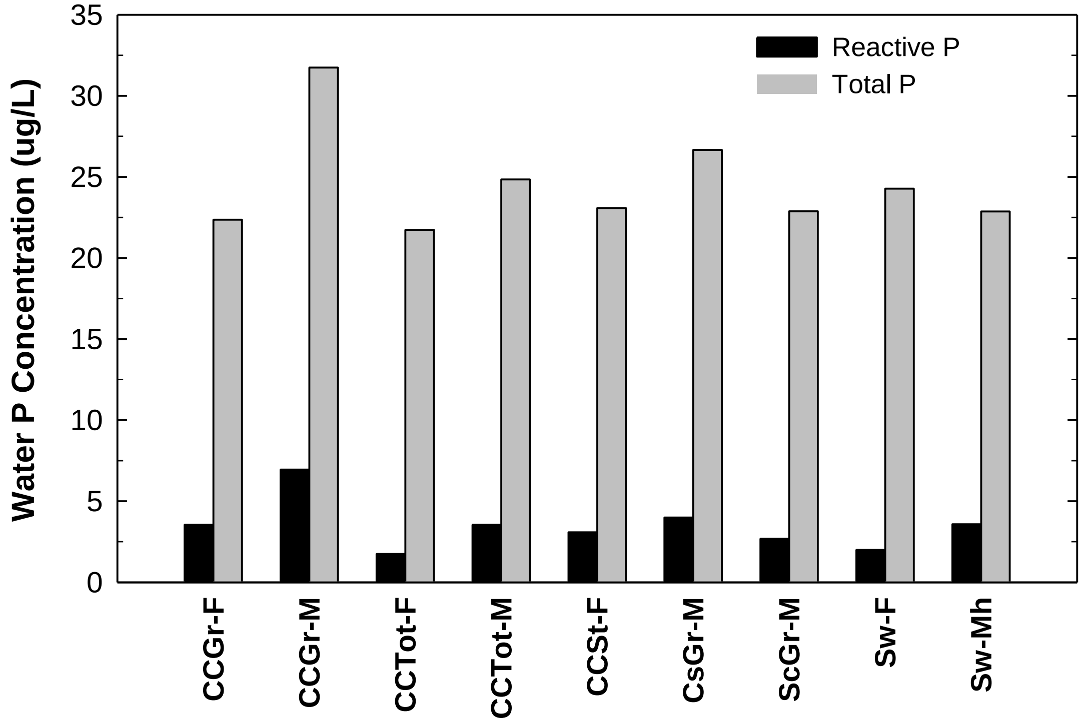

Figure 9. Comparison of reactive P and total P in tile drainage water for samples collected in 2008.

Award No. 08HQGR0147 Development of Techniques for Measuring and Mapping Flow Velocities in Rivers Using ADCPs

Basic Information

Title:	Award No. 08HQGR0147 Development of Techniques for Measuring and Mapping Flow Velocities in Rivers Using ADCPs
Project Number:	2008IA148S
Start Date:	9/1/2008
End Date:	5/31/2009
Funding Source:	Supplemental
Congressional District:	
Research Category:	Not Applicable
Focus Category:	None, None, None
Descriptors:	
Principal Investigators:	Marian V.I. Muste

Publications

There are no publications.

IWC Final Report
Development of Techniques for Measuring and Mapping Flow Velocities in Rivers using ADCPs

PI: Marian Muste

June 2009 (for report period December 1 2008—June 1, 2009)

Problem and Research Objectives

The overall goal of USGS-IIHR collaborative development is to systematically review, evaluate, and develop methods and practical processing tools capable of measuring and mapping flow velocities in rivers using ADCPs. A set of operation guidelines for acquiring mean velocities using fixed and moving vessel procedures and map velocity fields and the reach scale will be formulated. This information is critical for a wide range of river-related investigations, from purely hydrologic to ecological. Currently there is not a software program that uses raw data files collected in the field and provide tools to quality assurance and mapping of data in project drawings. The research objective is to develop an efficient process for quality assuring and mapping prototype velocity vectors for display and comparison with physical and numerical model results

Methodology

Ancillary software is developed and used to ease post-processing by incorporating the best found algorithms and procedures are also delivered for processing ADCP data for velocity mapping and model verification project. The software should allow all files being processed to be selected as a group and then provide a means for statistical graphical quality assurance on the files and a group and/or individually as appropriate. The software is built using Object Oriented Programming (OOP) techniques in conjunction with Borland C++ Builder (version 6). The analysis results are displayed in numerical and graphical formats. In this initial stage, VMS handles ASCII file format provided by Teledyne RD Instruments Acoustic Doppler Current Profilers (ADCP).

Principal Findings and Significance

We finished development of the software named 'VMS' for the given period of time. During the user workshop jointly held with USGS and US Army Corps, where about 20 participants tested the software, the VMS was proved to successfully provide efficient and smooth work flows for processing groups of ADCP transects especially focusing on quality assurance and spatial averaging of velocity. Many of existing algorithms regarding the postprocessing of ADCP data, which have been separately developed and used in diverse user environments, were integrated into the VMS. It means that the VMS will be able to take a role of a centralized software platform for additional implementations required by the ADCP communities. Moreover, the VMS supports reading existing vector-based GIS file as a background of ADCP files and exporting the processed ADCP files into GIS files. Any vector formats of shape file (point, line, and polygon) are applicable. Integrating ADCP information in conjunction with GIS data is expected to extend potential applicability of ADCP data with the well established GIS functionalities.

The software is a first bold step in extending the capabilities of ADCP – the most capable non-intrusive river instrumentation for river hydrodynamic characteristics – from its traditional use, which is the estimation of discharge, to other quantities relevant to other water sciences and monitoring goals. Among them is the characterization of ecohabitat regions in the streams, the potential for scour and deposition in rivers, investigation of the bank stability, the long-term monitoring of the hydraulic structures. The software development is in its initial stage, and it is expected to lead to new requests for both intensive (new features) as well extensive (other ADCP manufacturers) developments.

The basic change brought by this research is that the high-resolution velocity data, that is currently a by-product of standard stream-gaging practice, will become main focus for the ADCP measurement campaigns. Use of such obtained velocity fields in conjunction with data from other instruments will collectively change the field of river science and engineering by enabling rapid acquisition of high resolution accurate data related to river morphology and hydrodynamics. Besides providing data that were available through conventional methods, these new datasets are providing fine scale datasets critically important for calibration and validation of numerical simulations and for investigating research issues that were only possible through laboratory experiments in the past. It is expected that the developed software will enable improved understanding of river dynamics and processes over a wide range of scales.

Time-Series Modeling of Reservoir Effects on River Nitrate Concentrations

Basic Information

Title:	Time-Series Modeling of Reservoir Effects on River Nitrate Concentrations
Project Number:	2009IA144B
Start Date:	3/1/2009
End Date:	2/28/2010
Funding Source:	104B
Congressional District:	2
Research Category:	Water Quality
Focus Category:	Hydrology, Nitrate Contamination, Solute Transport
Descriptors:	None
Principal Investigators:	Keith Schilling, Kung-Sik Chan

Publication

1. Schoch, A.L.; Schilling, K.E.; Chan, K.S. 2009. Time-series modeling of reservoir effects on river nitrate concentrations. Adv. Wat. Resourc., 32, 1197-1205.

Final Report to the Iowa Water Center

Time-Series Modeling of Reservoir Effects on River Nitrate Concentrations

PI: Kung-Sik Chan[1], Keith E. Schilling[2]

June 2010 (March 1 2009—February 28, 2010 reporting period)

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Problem and Research Objectives

The overall goal of the project was to improve understanding of the reservoir effects on river nitrate concentrations, using Saylorville reservoir as a case study. Surface water from the Des Moines River is impaired by nitrate-nitrogen for drinking water use. Saylorville Reservoir is a 24.1 km^2 impoundment of the Des Moines River located approximately 10 km north of the City of Des Moines. Monthly mean nitrate concentration data collected upstream and downstream of the reservoir for a 30-year period (1977-2006) were analyzed in this study. We hypothesized that monthly water quality downstream of the reservoir depends on the current monthly upstream water quality and its past lags. The dynamic relation was studied via a transfer function model that is shaped by reservoir characteristics such as surface area, volume, and discharge. Research results may be used to better manage Saylorville Reservoir to mitigate nitrate concentrations in downstream receiving waters and forecast potential impairment to the Des Moines Water Works.

Methodology

Monthly nitrate concentration data from 1977 to 2006 were analyzed with the GNU software R that is available free from the internet (http://www.r-project.org/). The R package TSA (time-series analysis) was used for the analysis. Our hypothesis was tested by constructing a time-series model. Let Y_t and X_t be the (square-root transformed) nitrate concentration downstream and upstream of the reservoir in the t^{th} month. The transfer function model specifies that

$$Y_t = f(X_t, X_{t-1}, \ldots X_{t-q}) + \varepsilon_t, \qquad (1)$$

where f is generally a linear function that may involve the current and all past X's, and $\{\varepsilon_t\}$ is a zero-mean possibly temporally correlated error process. We first considered the case that f is a linear function dependent on X_{t-j}, for $j=0,1,2,\ldots,q$ where q is a fixed integer known as the transfer function order to be estimated from the data, and that $\{\varepsilon_t\}$ is an autoregressive-moving-average (ARMA) process. Such a linear model allows us to assess whether or not nitrogen-nitrate was reduced by the reservoir and, if so, quantify the reduction.

Next, we explored the nonlinear case that f is a piecewise linear function dependent on a threshold variable so that f switches between two linear functions as the threshold variable crosses a certain threshold value; c.f. the threshold model (Chapter 15 of Cryer and Chan, 2008). Such a piecewise linear formulation furnishes new insights on the nonlinearity in the nitrate reduction by the reservoir and may suggest new approaches to reduce nitrate in river water by manipulating the threshold variable.

Principal Findings and Significance

Results obtained by Schoch, Schilling and Chan (2009) indicated that downstream nitrate can be effectively modeled using a transfer function approach, i.e. Eqn. (1) with f being a linear function of the inflow concentrations during the current and previous month as input variables. Inflow concentrations were modeled using an autoregressive AR(20) model, with the higher order model consistent with temporal correlation noted by others. The transfer function model suggested that the reservoir is reducing nitrate concentrations by 22 ± 6%, a reduction that greatly exceeds previous estimates. Monthly nitrate forecasted with the model were nearly all within a 95% prediction interval of their actual measured values and did not appear greatly affected by flow variations.

Next, we (Wu, Schilling and Chan, under preparation) fitted a (two-regime) threshold dynamic regression (TDR) model to account for the nonlinear relationship between the upstream and downstream nitrate concentration series, with the residence time effecting the change in the regression relationship. Specifically, we fitted the threshold dynamic regression model:

$$Y_t = \sum_{i=1}^{3} \gamma_i O_{i,t} + \begin{cases} \beta_{1,0} + \beta_{1,1} X_t + \beta_{1,2} X_{t-1} + \sigma_1 \varepsilon_t, & if\ Z_t \le r \\ \beta_{2,0} + \beta_{2,1} X_t + \beta_{2,2} X_{t-1} + \beta_{2,3} X_{t-2} + \beta_{2,4} X_{t-3} + \sigma_2 \varepsilon_t, & if\ Z_t > r \end{cases}$$

$$\varepsilon_t = \phi \varepsilon_{t-1} + a_t$$

where Z_t is the water residence time in the reservoir, $O_{i,t}$ are the dummy variables of the outliers each of which equals 1 on the month the outlier occurred and zero otherwise, $\{a_t\}$ are zero-mean IID normal process whose variance is constrained to make $\{\varepsilon_t\}$ to be of unit variance. This model suggested that when the residence time is long, more nitrogen nitrate is removed by the reservoir (16.7%) than when the residence time is short (8.5%). By implementing a simple control scheme by altering discharge so as to lengthen the residence time to push the dyanmics into the upper regime ($Z_t > r$), model results suggested that nitrate concentrations during vulnerable periods could be reduced by 1.24 mg/l and drinking water violations could be reduced by nearly 26%.

Information Transfer Program Introduction

While the Iowa Water Center maintains a strong research component, disseminating information to water resource professionals, policy-makers and the public is a priority. With a renewed emphasis on information-transfer and outreach, the Center is developing itself as a clearinghouse for research information.

“Reducing runoff: The agricultural and urban link to watershed improvement” was the theme for the 2009 Iowa Water Conference hosted by the Iowa Water Center. The conference featured the Iowa Stormwater Conference and the Iowa Agriculture and Environment Conference. This was the first time these two events have joined forces to advance urban and agricultural water issues through sustainable watershed management. The goal was to offer a conference that provides networking and collaboration opportunities for major water initiatives in Iowa and to provide an opportunity for water professionals and the public to communicate. It received very positive remarks from the nearly 300 attendees.

On April 18th, water center staff demonstrated a rainfall simulator at an annual university celebration to roughly 150 people. This demonstration illustrates rainfall impacts on soils with varying residue amounts and the water quality that results. Staff also presented the simulator in August at a festival in Des Moines. In addition, we presented the groundwater flow model to nearly 100 fifth graders on May 14th at the Iowa Children’s Water Festival. The model demonstrates the link between ground and surface water and implications of pollutant movement.

Students from the Iowa State University Chapter of the Soil and Water Conservation Society and Center staff published a 30 page document titled, “Getting Into Soil and Water.” It addresses issues facing Iowa's soil and water resources. The articles were written by a wide variety of authors from across the state. The publication has been distributed to Iowa High Schools, selected administrative offices on campus, Iowa USDA-Natural Resources Conservation Service offices, the National Council for Science and the Environment and the Sustainable Agriculture and Research Education offices.

A new addition this year was the increased collaboration between the Center and the Iowa Learning Farm (ILF), a statewide initiative involving farmers and agency partners. The ILF hosts numerous field demonstrations throughout the year and across the state where producers learn about the importance of conservation practices from each other. Center staff presented at five field days throughout the state about water quality and agriculture. On January 13, 2010 the Center co-hosted a day-long event with ILF targeting conservation practice professionals. The objective of the forum was to improve communications between conservation technical service providers, such as the USDA-Natural Resources Conservation Service (NRCS), and landowners to increase conservation practice adoption.

Center staff is in the process of creating a how-to DVD on implementing agricultural conservation practices, specifically waterways. This resource will educate producers on the importance of waterways to remove sediment from runoff. Additionally, the Center is leading an effort to develop training modules addressing environmental trading for the NRCS.

We believe that participating in events and developing pertinent publications such as these will increase awareness of Iowa citizens about the importance of water quality and their role in the improvement of natural resources in the state.

Information Transfer Project

Basic Information

Title:	Information Transfer Project
Project Number:	2009IA145B
Start Date:	3/1/2009
End Date:	2/28/2010
Funding Source:	104B
Congressional District:	2
Research Category:	Not Applicable
Focus Category:	None, None, None
Descriptors:	None
Principal Investigators:	Richard Cruse

Publication

1. Cruse, Richard, Hillary Olson, John Laflen. 2010. How Did the Floods Affect Farmland? in Cornelia F. Mutel(ed). A Watershed Year: Anatomy of the Iowa Floods of 2008. Iowa City, Iowa. University of Iowa Press. p 147-154.

2009 Iowa Water Center Administrative Information Transfer Project

The focus of the 2009 Information Transfer Project will be on organizing conferences, symposia, meetings, field days and workshops to promote awareness of water quality and quantity issues facing the State of Iowa. These events will increase recognition of the Iowa Water Center. Our annual Iowa Water conference will be held in conjunction with the Iowa Storm Water Conference for the first time. The Storm Water conference is led by the Iowa Storm Water Education Program. This shared event will serve to promote a partnership between urban and rural audiences and natural resources staff with scientists and professionals across the state. We will be holding a poster display and sponsor/vendor session concurrently with the conference to promote awareness of research and/or outreach activities between individuals and organizations. A field day will be held at Iowa State University to highlight their water quality and natural resource projects. If there is adequate interest, a poster symposium will also be held. This is similar to the format of the 2008 field day/poster symposium held at the University of Northern Iowa. The Center may also host a day-long research presentation event to promote discussion between faculty and researchers working on water quality issues at Iowa State University.

A new addition this year will be the increased collaboration between the Center and the Iowa Learning Farm (ILF), a statewide initiative involving farmers and agency partners. The ILF hosts numerous field demonstrations throughout the year and across the state where producers learn about the importance of conservation practices from each other.

The Center is also involved with the Iowa State University student Chapter of the Soil and Water Conservation Society's first annual publication. This booklet will focus on water research throughout the state, challenges our water resources face and efforts to improve water quality.

The Center will be participating in Project AWARE (A Watershed Awareness River Expedition), which is a weeklong canoe program that promotes conservation and water quality awareness while volunteers remove trash from Iowa rivers and stream banks. In addition to this event, the P & S employee will also be volunteering at the Conservation District of Iowa's Annual Envirothon, a natural resource competition for high school students. The Center will also be participating in the Conservation Districts of Iowa annual legislative day in January. We believe that participating in events such as these will increase outreach with high school and community college students and faculty. We hope to encourage students to pursue water quality and/or natural resource related courses of study.

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	3	0	0	0	3
Masters	1	0	0	0	1
Ph.D.	3	0	0	0	3
Post-Doc.	1	0	0	0	1
Total	8	0	0	0	8

Notable Awards and Achievements

Publications from Prior Years