Environmental Resources Research Institute
Annual Technical Report
FY 1999

Introduction

Summary Two new projects were initiated in the budget year (3/1/99-2/28/00) State Water Resources Research Base Grants Program (PL. 98-242 Sect. 104) and will continue through a subsequent year. In addition, for the regional competition funded projects, three were completed and two will continue. In a base grant project, “Impact of Stream-Subsurface Exchange on Fine Sediment Dynamics in Streams,” funded through Drexel University, the objectives are to examine and describe the complex interactions between high sediment loadings, downstream transport of suspended sediment, stream-subsurface exchange, and siltation of stream beds. In an information transfer effort “Development of Youth Water Conservation Education Materials for Pennsylvania 4-H Programs” drafts of water conservation educational curriculum booklets are being prepared and reviewed for use in Pennsylvania with 4-H Club members. Results from the completed project “Evaluating Contributions of Atmospheric to Nitrate in Mid-Appalachian Streams by Isotopic Separation” suggest that stream nitrate response to changes in atmospheric nitrogen deposition will be delayed or gradual, rather than quick and direct. In the exercise “An Updated Assessment of Acidic Deposition in Pennsylvania” an Acid Deposition Conference was held and completed. Two volumes of conference proceedings related to forest effects and aquatic effects have been published. In another outreach effort, “Disseminating Information to Individual Water System Managers in Pennsylvania via Satellite,” a safe drinking water program was delivered via satellite and videotape. Copies of the program were sent to all 67 Pennsylvania County Cooperative Extension offices. The data gathering phase for “The Use of Seasonal Oxygen-18 Variations in Modeling Shallow Groundwater Recharge” continued during the budget year. Overall data analysis has been initiated and will conclude when the complete set of oxygen-18 results are completed. In a continuing project “Occurrence of Helicobacter Pylori in Surface, Ground and Finished Water: Implications for Drinking Water Supplies” it has been determined that there is an association between the presence of total coliforms, E. coli and Heliobacter pylori. A newsletter describing Institute research and outreach was also maintained and circulated.

Research Program

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Evaluating Contributions of Atmospheric Deposition to Nitrate in Mid-Appalachian Streams by Isotopic Separation
Project Number	C-01
Start Date	09/01/1997
End Date	08/31/1999
Research Category	Water Quality
Focus Category #1	Nitrate Contamination
Focus Category #2	Surface Water
Focus Category #3	Geomorpological and Geochemical Processes
Lead Institution	Environmental Resources Research Institute

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
William E. Sharpe	Professor	Environmental Resources Research Institute	01
David R. DeWalle	Professor	Environmental Resources Research Institute	01
Karl W. J. Williard	Assistant Professor	Other	01

Problem and Research Objectives

The overall goal of this project was to evaluate the relative contributions of atmospheric nitrate to streams in forested headwater basins in the mid-Appalachian region. Historically, northern temperate forests were thought to be nitrogen limited systems, but recently conditions of nitrogen saturation have been discovered in forested basins receiving relatively high inputs of atmospheric nitrogen for an extended period of time, such as the mid-Appalachians. Nitrogen saturation would imply that stream nitrogen levels could be directly related to atmospheric inputs. This study was designed to determine if atmospheric nitrogen inputs were directly appearing in stream water by using the amount of oxygen-18 in nitrate dissolved in the water as a tracer. The project has been completed and terminated, but publication activity will continue for the next year or two. Early findings were reported last year and a summary report is given below.

Methodology

Water samples were collected for analysis of oxygen-18 levels in nitrate in samples of streamflow, open precipitation, forest throughfall, and leachate from the forest soil litter layer. Nitrate oxygen-18 levels were then used to compute the fraction of stream nitrate due to atmospheric wet deposition versus soil organic matter using a simple two-component mixing model. Streams on 27 relatively undisturbed forest basins in PA, MD and WV were sampled during summer and winter baseflow, a subset of six streams was sampled seasonally, and one WV stream was sampled during stormflow. Precipitation and throughfall were sampled biweekly in WV and PA. Leachate from soil litter layer samples from each of the 27 basins was used to determine nitrate isotope levels in organic matter.

Principal Findings and Significance

Over 85% of stream nitrate was contributed by organic matter decomposition in the 27 streams under base-flow conditions. Less than 15% of stream nitrate could have been directly contributed by atmospheric deposition. Even though the contributions of atmospheric nitrate were greater during high flows, the inputs of atmospheric nitrate never exceeded about 25% and nitrate from organic matter decomposition still dominated. The results suggest that the stream nitrate response to changes in atmospheric nitrogen deposition will be delayed or gradual, rather than quick and direct. Due to rapid assimilation of nitrogen deposition by forest plants and animals, stream nitrogen will respond to a reduction in atmospheric deposition only after the nitrogen stored in forest biomass is gradually diminished. These streams do not appear to be nitrogen saturated. The time required for a natural ecosystem to respond to a nitrogen deposition change is not well understood and is a recommended topic for future research.

Descriptors

Keywords: Nitrogen, Isotopes, Acid Deposition

Articles in Refereed Scientific Journals

Williard, K.W. J., D. R. DeWalle, P. J. Edwards, and W. E. Sharpe. 2000. Assessing atmospheric contributions to stream nitrate by oxygen-18 separation on forested mid-Appalachian basins. Submitted to J. Hydrol.

Book Chapters

Dissertations

Williard, K. W. J. 1999. Factors affecting stream nitrogen concentrations in Mid-Appalachian forested watersheds. Ph. D. Dissertation, Ecology, Graduate School, Pennsylvania State University, 258 p.

Water Resources Research Institute Reports

Conference Proceedings

Williard, K. W. J., D. R. DeWalle, P. J. Sharpe, P. J. Edwards, and M. B. Adams. 1999. Spatial variations in stream nitrate concentrations in a region containing a nitrogen saturated watershed. Chapter 5. Pp. 23-30 In. W. E. Sharpe and J. R. Drohan, eds., Proceedings of the 1998 PA Acidic Deposition Conference, Vol. II, The Effects of Acidic Deposition on Aquatic Ecosystems in Pennsylvania, Pa. State Univ., Environmental Resour. Res. Instit., Univ. Park, PA. 61+ p.

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	1997 PA Water Research Institute Program:colon; An Updated Assessment of Acidic Deposition in Pennsylvania
Project Number	C-02
Start Date	09/01/1997
End Date	08/31/1999
Research Category	Water Quality
Focus Category #1	Acid Deposition
Focus Category #2	Ecology
Focus Category #3	Nutrients
Lead Institution	Environmental Resources Research Institute

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
William E. Sharpe	Professor	Environmental Resources Research Institute	01

Problem and Research Objectives

A considerable amount of new research information has accumulated during the nine years since the last acid deposition conference in Pennsylvania. This information is important to natural resource managers and requires dissemination.

Methodology

Research and Technology Transfer Conference

Principal Findings and Significance

The 1998 Acid Deposition Conference has been completed. The proceedings has been divided into two volumes, one summarizing forest effects and one containing papers on aquatic effects. The proceedings have been published. The costs of publication design, layout and printing for the proceedings greatly exceed funds provided in this grant. Consequently, funds from additional sources have been obtained to support these activities. Other agencies providing funds are the College of Agricultural Sciences (Water Quality Funds), the Chesapeake Bay Program, and the Joint Conservation Committee of the Pennsylvania General Assembly.

Descriptors

Acid Deposition, Information Dissemination

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Sharpe, W. E. and J. R. Drohan, eds., Proceedings of the 1998 Pa. Acidic Deposition Conference, Vol. I, The Effects of Acidic Deposition Conference, Vol. I, The Effects of Acidic Deposition on Pennsylvania Forests; Pa. State Univ.; Environmental Resour. Res. Inst., Univ. Park, Pa., 61 pp. Sharpe, W. E. and J. R. Drohan, eds., Proceedings of the 1998 Pa. Acidic Deposition Conference, Vol. II, The Effects of Acidic Deposition on Aquatic Ecosystems in Pennsylvania, Pa. State Univ., Environmental Resour. Res. Inst., Univ. Park, Pa., 266 pp.

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	The Use of Seasonal Oxygen-18 Variations in Modeling Shallow Groundwater Recharge
Project Number	C-03
Start Date	09/01/1998
End Date	08/31/2000
Research Category	Ground-water Flow and Transport
Focus Category #1	Groundwater
Focus Category #2	Geomorpological and Geochemical Processes
Focus Category #3	Hydrology
Lead Institution	Environmental Resources Research Institute

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
William E. Sharpe	Professor	Environmental Resources Research Institute	01
Kevin J. McGuire	Student	Environmental Resources Research Institute	01
David R. DeWalle	Professor	Environmental Resources Research Institute	01

Problem and Research Objectives

The main objective of this research is to investigate ways in which the seasonal variations in oxygen-18 in soil water, stream baseflow and shallow wells can be used to determine the mean residence time of groundwater. Timing of response of water quantity and quality to environmental change will be determined in large measure by the average time for water to move from the surface through the available subsurface flow pathways to the outlet in a stream or well. The well known seasonal variation in oxygen-18 in precipitation in the Mid-Appalachian regions can be modified by recharge patterns and

propagated through the subsurface to create a unique signature in outlet waters over time. A comparison of input and output oxygen-18 signatures or variations permits one to compute the mean residence time of percolating waters using various theoretical models describing the nature of subsurface mixing and movement. The question remains what type of theoretical model best describes the mixing process dominant in a basin. In this study we attempt to show the most appropriate theoretical model for soil water and shallow groundwater movement in the Mid-Appalachian region. Many theoretical models exist, but we have chosen to test the 1) no-mixing or piston flow model, 2) the perfect mixing or exponential model, 3) the partial mixing or dispersion model and 4) the exponential-piston flow model. Models best fit to soil water and stream baseflow data will likely vary with geologic setting. Data will be collected and models derived for three geological settings typical of the region: an Appalachian Plateau sandstone terrain typical of forested regions, Ridge and Valley sandstone ridge to karst valley terrain which is intensively farmed, and Ridge and Valley upland sandstone to valley shale/sandstone terrain which is also highly developed for agriculture. Thus we can see if models and mean residence times of soil and baseflow water vary with geologic settings typical in this area. Previous research in the area suggested that mean residence time of stream baseflow water increased with basin area, with virtually no apparent seasonal signal or residence times greater than 5 yr for a watershed area of about 1,000 ha. In order to determine effects of basin size, we are also sampling streams in a nested watershed design within each geologic setting to look for increasing residence times with increasing basin area.

Methodology

Precipitation/throughfall, soil water and stream baseflow were sampled at three locations in central PA (sandstone, karst and shale) beginning in April 1999. Soil water was sampled biweekly with zero-tension pan and ceramic suction lysimeters at 15, 30 and 90 cm depths in a representative soil pit at each site. Baseflow was grab-sampled biweekly at five nested basin stream sites in each geologic setting. Precipitation/throughfall samples were collected biweekly at each soil pit site using funnels and collection bottles. A software package developed by Maloszweski and Zuber (FLOWPC) was used to model these data and will be used to select the best model fit to experimental data. A partial preliminary data set from two sites with sandstone/shale dominating water movement was available for the prior drought year and formed the basis for Kevin McGuire's M. S. thesis provides preliminary results. The data gathering phase of the larger data set was just concluded in May 2000 due to delays in the start of sampling due to the drought and freeze/thaw damage to soil pits due to lack of snow.

Principal Findings and Significance

Preliminary results from McGuire's thesis research collected during a drought period show that either the exponential- piston flow or dispersion flow models gave the best fits to baseflow oxygen-18 seasonal patterns in streams at two sandstone/shale bedrock sites. Both model types showed best fits with the transit time distribution function peaking quickly to a maximum at transit times of about 40-150 days, with gradually declining dispersion or exponential flow thereafter. In the case of the exponential-piston flow model this translated into about 12-25% of water as direct piston flow without mixing combined with the remainder being moved as well-mixed water. Mean residence times for the observed stream baseflow over a one-year drought period was computed to be 8.5 to 10.5 months using these models. Samples of well water from near the ridge of one watershed showed that samples collected near the surface of the well showed an indeterminate, but greater mean residence time than stream baseflow water on the same watershed. This result suggests that shallow flow paths for water moving to the channel were reducing the mean residence time of baseflow water, compared to residence times of water moving vertically through the entire soil profile to the water table in the well. Analysis of soil water oxygen-18 data at the 100-cm depth in soils derived from shale bedrock showed mean residence times of 2.3 to 4.5 months. The partial mixing or dispersion model fit the soil water data best. Zero-tension pan lysimeters showed more rapid response to precipitation oxygen-18 levels than suction lysimeters at both sites, but lysimeter data were too limited due to the drought conditions for intensive analysis. Drought conditions required that recharge factors be used to adjust precipitation data for the

amounts and oxygen-18 levels of water that were actually recharged to the basin. A new, continuously-varying recharge factor equation was derived and calibrated to the times that soil lysimeters gave samples to provide proper weighting. Recharge factors varied continuously from about 5% during most of the summer to about 95% at times of peak lysimeter water collection. Recharge factors used in earlier studies for this type of analysis produced illogical results. Preliminary results clearly show that subsurface movement of groundwater to a stream channel during baseflow represents a combination of : 1) piston flow of water which is rapidly moving to the channel without much mixing, perhaps due to flow through soil macropores and large rock fractures and 2) a very well-mixed flow component which moves relatively slowly through the general soil matrix or small rock fractures. We are currently awaiting complete oxygen-18 results to begin overall data analysis to verify these results and look for differences due to soil depths, basin size and geologic setting.

Descriptors

Keywords: Groundwater Hydrology, Isotopes, Model Studies

Articles in Refereed Scientific Journals

McGuire, K. J., D. R. DeWalle, and W. J. Gburek. 2000. Evaluation of mean residence times in subsurface waters using oxygen-18 fluctuations during drought conditions in the Mid-Appalachians. Submitted to J. Hydrol.

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

McGuire, K. J. 1999. Determining mean residence times of groundwater using oxygen-18 fluctuations in the Mid-Appalachians. M. S. Thesis, Forest Resources, Graduate School, PA. State Univ., Univ. Park. 73 p.

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Occurrence of Helicobacter pylori in Surface, Ground, and Finished Water: Implications for Drinking Water Supplies
Project Number	C-05
Start Date	09/01/1998
End Date	08/31/2000
Research Category	Water Quality
Focus Category #1	Water Quality
Focus Category #2	Water Quantity
Focus Category #3	Water Use
Lead Institution	Environmental Resources Research Institute

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Katherine H. Baker	Assistant Professor	The Pennsylvania State University	01
Diane S. Herson	Associate Professor	Other	01

Problem and Research Objectives

Chronic gastritis is one of the most common diseases in the world. The recognition of Helicobacter pylori as the major causative agent of chronic gastritis, gastric ulcer disease, and stomach cancer has spawned intensive research on the pathophysiology and epidemiology of this organism. In spite of the widespread occurrence of Helicobacter pylori infections, estimated to be as high as 50% of the world's population, little is known about the mode of the transmission and natural history of this organism. Current opinion regarding the mode of transmission of Helicobacter pylori is divided with some epidemiological evidence supporting the hypothesis of direct transmission and other studies implicating a water-borne transmission route. This research examines the possible water-borne transmission of Helicobacter pylori via two primary research objectives: 1. Monitoring of aquatic environments for Helicobacter pylori. 2. Evaluating the effect of common disinfection treatments on the survival of Helicobacter pylori.

Methodology

Water samples were aseptically collected in sterile Whirl-Pak bags and shipped to our laboratory on ice. Samples were analyzed for the presence of Helicobacter pylori using fluorescent-antibody-CTC (FACTC) staining. Total coliforms and E. coli were enumerated on m-Coli Blue broth. In addition, for several of the samples, the presence of Helicobacter pylori was confirmed using a semi-nested PCR amplification of a 203 bp segment of the urease gene. Disinfection studies specifically examined the effects of free chlorine, chloramines and ozone on E. coli, Campylobacter jejuni and Helicobacter pylori. Disinfectant efficiency was determined using viable count reduction in a culture after disinfection.

Principal Findings and Significance

We have expanded the surface and groundwater survey reported on last year. Currently we have evaluated a total of 120 water samples. For 95 of these samples, we have obtained data on the presence of selected indicator organisms (total coliforms and E. coli as well as Helicobacter pylori. With this increased data set we have been able to more completely evaluate the association between the presence of Helicobacter pylori and indicator organisms. This expanded database confirms the association between total coliforms and Helicobacter pylori. In addition, the expanded database reveals an association between Helicobacter pylori and E. coli. This is in contrast to the finding reported last year where no statistically significant association between the two organisms was found. Upon examination of the two data sets the reason for this discrepancy appears to be an oversampling of contaminated sites during the first year of the project. We have continued our studies of factors influencing the persistence of Helicobacter pylori in groundwater. The presence of additional organic matter (synthetic sewage) has been found to enhance persistence of this organism. Surprisingly the addition of phosphate buffer to groundwater also significantly increases persistence. Finally, we have made considerable progress in the development of a cultural method for the detection and isolation of Helicobacter pylori from environmental samples. Using a combined immunomagnetic separation-acid urea method we have been able to recover Helicobacter pylori from surface water samples spiked with low levels of Helicobacter pylori (» 100 Cfu/ml).

Descriptors

Drinking water, Pathogens, Helicobacter pylori, Disinfection, Ulcers

Articles in Refereed Scientific Journals

Hegarty, J. P., M.T. Dowd and K. H. Baker. 1999. Occurrence of Helicobacter pylori in Surface Water in the United States. Journal of Applied Microbiology.

Book Chapters

Dissertations
Water Resources Research Institute Reports
Conference Proceedings
Other Publications

1. Kelley, C. M., C. C. Rodgers, J. P. Hegarty, K. H Baker. Development of a Method for the Culture of Helicobacter pylori from Water Samples. Presented at 100th, General Meeting, American Society for Microbiology. 2. Rodgers, C. C., Y. L. Ma, J. P. Hegarty, K. H. Baker. Inorganic Factors in the Persistence of Culturable Waterborne Helicobacter pylori. Presented at 100th General Meeting, American Society for Microbiology. 3. Baker, Katherine H. July 10-12, 2000. Evidence for a Water-Borne Route of Transmission of Helicobacter pylori: Occurrence and Persistence in Surface and Ground Water. Presented at Summer Conference Campylobacter, Arcobacter and Heliocobacter, Society for Applied Microbiology, Glasgow Scotland. 4. Ma, Y. and K. H. Baker. Persistence of Helicobacter pylori, Campylobacter jejuni and Escherichia coli in the Groundwater. Masters Paper for Environmental Pollution Control Program, Penn State University, Harrisburg, PA. 5. Baker, Katherine H.. Helicobacter pylori in Drinking Water. Annual Meeting PAWWA. 6. Baker, K. H., J. P. Hegarty, B. R. Redman, N. Reed, Y.L. Ma and D. S. Herson. Helicobacter pylori in Drinking Water. Environmental and Clinical Associations, 10 Int. Conf. CHRO. Outstanding Presentation Award.

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Impact of stream-subsurface exchange on fine sediment dynamics in streams
Project Number	B-01
Start Date	03/01/1999
End Date	02/28/2001
Research Category	Water Quality
Focus Category #1	Sediments
Focus Category #2	Geomorpological and Geochemical Processes
Focus Category #3	Water Quality
Lead Institution	Environmental Resources Research Institute

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Aaron I. Packman	Assistant Professor	Other	01

Problem and Research Objectives

High concentrations of fine sediments adversely impact stream ecosystems by decreasing light penetration through the water column and filling pore spaces in the stream bed. Further, the mobility of fine sediments controls the fate and transport of some aqueous contaminants, including metals, PCBs, and arsenic. In Southeastern Pennsylvania, reservoirs of contaminated sediments exist in many areas, and significant quantities of fine sediments may be mobilized by extensive ongoing construction and development. In spite of these issues, relatively little is known about how fine sediments progress through a watershed. Thus this project seeks to examine and describe the complex interactions between high sediment loadings, downstream transport of suspended sediment, stream-subsurface exchange, and siltation of stream beds. Four key questions are to be answered in this work: 1. What is the rate of uptake of suspended sediment by the stream bed? 2. How does the accumulation of fine sediment affect

the hydraulic conductivity, porosity, and other physical characteristics of the bed? 3. How do these changes in the stream bed affect stream-subsurface exchange? That is, what feedback is there between the fine sediment accumulation in the bed and the rate of uptake? 4. What is the net effect on suspended sediment transport in the stream?

Methodology

Methods and results:

In the first year of the project, we utilized stream-side flumes to examine the deposition of suspended sediments in a gravel bed. This work was conducted at Stroud Water Research Center in collaboration with Denis Newbold. The beds of these flumes were composed of river gravels representative of nearby streams, and the water and suspended sediments used in the experiments were taken directly from the adjacent stream. Thus, these flumes essentially reproduced actual stream conditions, but had controlled flow rates. We observed suspended sediment deposition in the stream-side flumes for over three months, and measured solute-exchange and particle deposition on a weekly basis.

Two flumes were utilized in this study, with different sizes of stream gravels. In their initial state, these gravels had been somewhat plugged by the natural suspended sediments. To assess exchange with the beds, a salt solution was injected as a pulse at the upstream end of the flumes and then the resulting output was measured. To assess particle deposition, suspended sediments which had been concentrated from the creek water were also injected as a pulse and their output measured over time at the flume outlets. Exchange and particle deposition were measured with the pre-existing bed condition, and then the flumes were cleaned to remove the accumulated silts from the gravel beds. Solute and particle releases were then repeated in order to assess the difference in exchange and deposition between the clean and clogged beds. Following cleaning, stream water was pumped through the flumes continuously for almost 3½ months, so that suspended sediments were continuously delivered to the flumes at the same concentration as in the nearby stream. Solute exchange and particle deposition rates were measured approximately weekly over the course of the experiment.

We observed that the stream bed readily silted up over time, and that this hindered subsequent deposition (Figure 1). In addition, we also observed that leaf input into the stream (from natural leaf fall in this wooded area) had a significant effect on suspended sediment transport through the flumes. Siltation of the stream bed greatly altered the porosity and permeability of the bed, as can be seen from our time-series of data on stream-subsurface exchange (Figure 2).

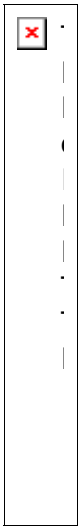

Figure 1: Change in suspended sediment transport over time. Four distinct trends can be seen as indicated on the graph by arrows with boxed numbers. (1) Deposition increased (and particle throughput decreased) initially after the beds were cleaned. (2) Additional particle throughput occurred as the bed became plugged with deposited silts. (3) Throughput decreased as leaves accumulated in the channels. (4) Throughput increased again following manual removal of the accumulated leaves.

Figure 2, Left Panel: Curves of solute concentration vs. time measured at downstream end of flume following pulse inputs at the upstream end, before and after cleaning of the gravel bed. Additional tailing of the pulse shows that removal of silts from the bed increased stream-subsurface exchange. Right Panel: Following cleaning of the bed, exchange decreased considerably due to ongoing siltation. Stream-subsurface exchange results are ambiguous after leaf-fall, but generally agree with sedimentation data.

We are currently planning a second set of experiments in the stream-side flumes in order to better understand the rapid changes that occur in a clean stream bed at the onset of siltation. In our first set of experiments, significant siltation of the bed occurred much more rapidly than we expected. We theorize that this could be related to rapid growth of benthic biofilms over the first few weeks of deposition into a clean bed. To test this theory, we will monitor the composition of the stream bed and periphyton growth in the flume over time. We will also conduct solute and particle injections as we did in the first set of field experiments, but we will increase the frequency of these injections in the early part of the experiment.

We have also been setting up equipment to conduct similar experiments in laboratory flumes, which allow much better control over the stream conditions, composition and concentration of sediments, etc. These experiments will allow us to examine both the deposition and release of

suspended sediments, whereas the stream-side flumes only allow observation of deposition.

Principal Findings and Significance

Significance: Our work to date has clearly demonstrated that stream-subsurface exchange delivers suspended sediments to the stream bed, that this fine material accumulates in the stream bed under normal flow conditions, and that this accumulation plugs the bed surface and greatly reduces stream-subsurface exchange fluxes. The implication is that high sediment loads can readily degrade benthic habitats and thereby adversely affect stream biota. We have further demonstrated that clean gravel beds may become plugged rather rapidly, so that stream-subsurface exchange can vary significantly over a period of a few weeks. This clearly indicates that stream-subsurface exchange rates can have a high degree of temporal variability, and that exchange rates measured from isolated solute injections are not necessarily characteristic of the watershed, or even of the stream reach. More work will be required to understand the long-term dynamics of fine sediment transport through watersheds, and the implications for the fate of sediment-associated contaminants. Students Supported: Graduate student: Jeffrey MacKay Undergraduate student: Douglas Jerolmack (beginning 7/00)

Descriptors

Keywords: sediment transport, fine suspended sediments, soil erosion, streams, geomorphology, contaminant transport

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Packman, A. I., J. S. MacKay, and J.D. Newbold. Aug. 2000. “Variations in organic particle deposition rate and stream-subsurface exchange due to silt accumulation in a gravel bed,” ASCE Water Resources Engineering Conference, Minneapolis, accepted for presentation and publication in the proceedings.

Other Publications

MacKay, J. S., A. I. Packman, and J. D. Newbold. Dec. 13-17, 1999. “Interplay of stream-subsurface exchange, benthic delivery of particulate organic carbon, and stream bed siltation,” AGU Fall Meeting, San Francisco. We are also preparing a comprehensive paper for a leading journal such as Water Resources Research, which will present our observations of stream-subsurface exchange and particle deposition, and discuss the larger implications of this work.

Information Transfer Program

The Institute maintains an ongoing information dissemination program using matching and state funds for direct requests for technical assistance on a broad spectrum of subjects including assessments of water pollution potential; water testing; training programs for state personnel; community assistance involving the Cooperative Extension Service.

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Disseminating Information to Individual Water System Managers in Pennsylvania
Description	C-04
Start Date	09/01/1998
End Date	08/31/1999
Type	Audio-Visual Productions
Lead Institution	Environmental Resources Research Institute

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
William E. Sharpe	Professor	Environmental Resources Research Institute	01

Problem and Research Objectives

Millions of rural homeowners rely on individual rather than community water systems for their drinking water. Surveys of individual water supplies in Pennsylvania and throughout the United States have repeatedly shown that these wells, springs, ponds, and cisterns often deliver unsafe or aesthetically unappealing water. Many individual water wells have never been tested and their owners are generally uninformed about necessary water tests or locations of water testing laboratories. These uninformed water system owners may eventually fall prey to scare tactics and gimmicks used by unethical vendors of water treatment equipment, water testing laboratories, or well drillers. Information dissemination programs are needed to educate individual water system owners about the proper management of their water supplies. Traditional speaker-based programs have been used successfully in Pennsylvania over the past 13 years to educate individual water system owners. However, due to the size and fragmented nature of the target audience and funding limitations, these programs have been limited in their ability to reach a large proportion of the individual water system owners in Pennsylvania. The proposed satellite information dissemination program would educate individual water system owners throughout Pennsylvania on the proper management of their water supplies. The overall objective of the proposed information dissemination program is to improve the safety of drinking water being supplied by individual water supply systems throughout Pennsylvania by educating the owners/managers of these systems on proper maintenance techniques. This objective will be accomplished by improving the efficiency of dissemination of individual water system educational materials to the owner/managers of such systems utilizing an existing agricultural communications network in each Pennsylvania county.

Methodology

Dissemination of information to owners of individual water systems will be accomplished by utilizing the Safe Drinking Water Clinic format; a highly successful model developed in part by the principal investigator. This program has been delivered over 120 times by the principal investigator, Mr. Bryan Swistock (Research Support Assistant, Penn State University), and other Penn State specialists. The content of the program will include three basic sections. The first section will introduce water quality standards, common groundwater pollutants, effects of various land-uses on groundwater quality, water testing recommendations, and water test interpretation. The second section will include a 20-minute video on well construction in Pennsylvania including locating wells and proper well construction standards. The final section will discuss common water treatment options for individual water systems. Water treatment techniques will be explained and the advantages, disadvantages, and approximate cost of each method will be discussed. The program will close with a 30-minute question and answer session via toll-free telephone, fax, and email connections with the county audiences. The satellite program will be delivered from Penn State to the county down-link sites via the ADEC network; a consortium of land-grant universities with access to more than 2,000 down-link sites, nationally. The existing distance education system of Pennsylvania Cooperative Extension at Penn State University will be used to produce and transmit the program to the down-link sites. Resident staff in the Agricultural Information Services Department at Penn State have extensive experience in producing and transmitting satellite programs.

Principal Findings and Significance

The Safe Drinking Water program was delivered via satellite on May 12,1999 from 7:00 to 9:30 p.m. Videotape copies of the program were sent to all 67 county Cooperative Extension offices. County offices are now able to use the videotape for future water programs or for assisting clients with individual water system problems. An evaluation of the program has been completed. A summary of this evaluation was submitted to the Journal of Extension.

Articles in Refereed Scientific Journals

Swistock, Bryan R., William E. Sharpe and John Dickison. 2000. Educating rural private water system owners in Pennsylvania using satellite versus traditional programs. Journal of Extension (submitted).

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Development of Youth Water Conservation Education Materials for Pennsylvania 4-H Programs
Description	Project Number: B-02
Start Date	03/01/1999
End Date	02/28/2001
Type	Publications
Lead Institution	Environmental Resources Research Institute

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
William E. Sharpe	Professor	Environmental Resources Research Institute	01

Problem and Research Objectives

Adapt existing water conservation educational materials for use in Pennsylvania with 4-H Club members.

Methodology

4-H curriculum booklets for leaders and members

Principal Findings and Significance

Drafts of the member and leader curriculum booklets are being reviewed by Penn State's 4-H Natural Resources Curriculum Committee. The final publications should be completed by the end of the grant period.

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

USGS Internship Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	1	N/A	N/A	N/A	1
Masters	2	4	N/A	N/A	6
Ph.D.	N/A	1	N/A	N/A	1
Post-Doc.	N/A	N/A	N/A	N/A	0
Total	3	5	N/A	N/A	8

Awards & Achievements

None

Publications from Prior Projects

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications