New York State Water Resources Institute

Annual Technical Report

FY 1998

Introduction

Research Program

Basic Project Information

Basic Project Information	
Category	**Data**
Title	The Development of a Regionalized Approach to Estimate Low Streamflow Frequency at Ungauged River Sites in the Northeastern United States
Project Number	NY97-C-02
Start Date	08/01/1997
End Date	08/31/1999
Research Category	Climate and Hydrologic Processes
Focus Category #1	Water Quality
Focus Category #2	Water Supply
Focus Category #3	Management and Planning
Lead Institution	Cornell University

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Charles Kroll	Assistant Professor	State University of New York	01
Jeffrey McDonnell	Professor	State University of New York	02

Problem and Research Objectives

Understanding the frequency and duration of low streamflow events is critical to the efficient management of water resources throughout the Northeastern United States. Low streamflow statistics are used to determine waste allocations, plan water supply, irrigation systems, and hydropower, site treatment plants and landfills, and determine interbasin withdrawals and transfers. In addition, low streamflow events are often critical periods for aquatic habitats. Usually low streamflow statistics are required at river sites where no record of past streamflows is present. Using regionalization approaches, the proposed research will investigate estimating low streamflow statistics at such ungauged river sites by comparing four estimation methods: regional regression, baseflow correlation, combined regional regression/baseflow correlation, and an index drought procedure.

Methodology

Methodology and intended results: The thirteen states comprising the Northeastern United States will be divided into five geopolitical study subregions. In each of these subregions the four methods will be developed and compared using a rigorous statistical comparison via a delete-one jackknife resampling procedure. Streamflow records from over 300 gauged river sites throughout the Northeast will be used to perform this analysis. The outcome from this research will be a recommendation for each subregion as to the best available methodology for estimating low streamflow statistics at ungauged river sites. This process will also involve evaluating low streamflow series for the possible impact of changing climate, an important issue that is of concern to many water managers.

Principal Findings and Significance

Progress report:

This work investigated the ability of various probability distributions to describe low streamflow series in various geographical regions, including the Northeastern United States. L-moment diagrams were used in this experiment, where the weighted distance between a LOWESS fit to the data and the L-moment relationship for a specific probability distribution was used as a performance measure. It was found that 2-parameter distributions do not provide an adequate fit, and of the 3-parameter distributions investigated, the 3-Parameter Log-Pearson (LP3) and the Generalized Extreme Value (GEV) provide the best fits.

Interestingly, at sites where some annual minimum low streamflows are reported as zero (i.e. intermittent river sites), a marked shift in the L-moment diagrams were observed. Such sites are said to contain "censored data", since all values below a measurement threshold (usually 0.01 cfs), are reported as zero. A Monte Carlo experiment was performed to investigate this phenomenon. The observed shift appeared more consistent with censoring of a real-spaced probability distribution, as opposed to censoring of log-spaced distribution. This finding may suggest that use of the GEV distribution may be better than using the LP3 distribution, which is the common probability distribution used to model low streamflow frequency in the United States.

A Masters student investigated various regionalization techniques for grouping river sites (Ko, 1999). The largest contribution of this work was how clearly it showed the importance of watershed hydrogeology in describing low streamflow frequency. Both the baseflow recession constant and the baseflow index were used to represent hydrogeology. An investigation of how best to estimate these quantities at ungauged river sites is presently being done.

Investigators associated with the project have developed a GIS approach to estimating various watershed characteristics. This methodology allows us to take advantage of new digital grids of climatic, topographic, and geologic parameters which impact watershed hydrology. A conference paper (forthcoming) analyzed scale issues by comparing output from both a 10 meter and 1 kilometer DEM, using various flow routing techniques. Output was used to model low streamflows in New York State. In this exploratory work, little improvement in these models was obtained when a finer scale grid or a more complex flow routing algorithm was employed.

This project investigated the use of various techniques for performing log-linear regression when the dependent variable is sometimes reported as zero (Kroll and Stedinger, 1999). Techniques included dropping these sites, adding a constant to all at-site quantiles, and the use of an ordinary and weighted Tobit models. A Tobit model was shown to be a much better technique than dropping sites or adding a constant. Use of a weighted Tobit model, which accounts for the heteroscedasticity of the regression model, did not produce much improvement over the use of an ordinary Tobit model.

The project has also completed the code to investigate the use of baseflow correlation techniques to estimate low streamflow statistics. Output from this code is presently being compiled. An experiment with Dr. Richard Vogel of Tufts University is examining trends in low streamflows over the last 50 years. This work is crucially important for the investigation of climate change on hydrologic processes.

Descriptors

Water Quality Management, Water Use Efficiency, Decision Models, Pollution Control, Aquatic Protection, Baseflow, Rivers, Optimization, Stochastic Hydrology

Articles in Refereed Scientific Journals

Kroll, C. N., and J. R. Stedinger, 1999, Development of Regional Regression Relationships with Censored Data, Water Resources Research, 35(3), 775-784.

Book Chapters

Dissertations

Ko, Chia-Tsen, 1999, The Development of Regional Regression Models for Low Streamflow Statistics in the Northeastern United States, MS Thesis, SUNY College of Environmental Science and Forestry, Syracuse, NY, pagination unknown.

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Cryptosporidium parvum: fate of oocysts in soil
Project Number	NY97-C-03
Start Date	10/01/1997
End Date	08/31/1999
Research Category	Biological Sciences
Focus Category #1	Ecology
Focus Category #2	Non Point Pollution
Focus Category #3	Water Quality
Lead Institution	Cornell University

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Dwight D. Bowman	Associate Professor	Cornell University	01
William C. Ghiorse	Professor	Cornell University	02
Michael B. Jenkins	Research Associate	Cornell University	03

Problem and Research Objectives

Cryptosporidium parvum is the highest priority contaminant in New York's Source Water Assessment Program (NYS DOH, 1999), reflecting the potential vulnerability of many public water supply systems and potentially severe consequences from infection of humans with weakened immune systems. There remain substantial uncertainties about the relative significance of sources of these organisms in watersheds and the environmental mobility and survival of oocysts. This uncertainty leaves watershed management programs with a weak basis for investing protection resources. Some may overprotect, causing extra costs to wastewater system owners and hardship to rural farm industries. Some may underprotect and leave their populations at risk to waterborne disease outbreaks.

This research project focuses on the basic soil microbiology of the oocyst stage of Cryptosporidium parvum. This is an area that has received little or no attention, although it is probably of the utmost importance in understanding how this transport stage moves through the environment. Our broader research goals are basically two-fold and are directed at providing information on the survival and transport of the oocyst of C. parvum. First, we are physically and chemically characterizing oocysts and the protective oocyst wall relative to their survivability in the field. Second, we are characterizing the survival and transport of oocysts in the environment. Thus, relative to our overall plan, this proposal deals specifically with the highly circumscribed area of survivability of oocysts under different conditions.

Methodology

This project encompasses both laboratory and field portions. The project will run for two years and will consist of parallel projects being run with samples in the laboratory and with samples from the field. There are three specific objectives to the work we will perform. 1. We will determine the survival of oocysts in soils maintained at -4ºC, 10ºC, 20ºC, and 30ºC, with pH being equal to 5, 7, or 8 and with soil water potentials of 0.33 bars (water holding capacity), -5 bars, and -20 bars. There will be six different soils used: sandy loam, clay loam, and silt loam, with two different organic matter contents for each. 2. We will examine how oocysts survive on a farm within the New York Watershed (the David Post Farm in Delaware Co., NY). This farm is one where we have already performed preliminary work with the sentinel system. We will distribute sentinel chambers around the farm and examine the viability of oocysts over the next 12 months. We will also record soil temperature, pH, moisture content (to be calibrated to a soil moisture curve for soil water potential determinations), and ammonia for each site where samples are placed. To validate further the relation between oocyst survival kinetics and the soil parameters maintained in the laboratory, field sites on the Post Farm will be identified whose soils are characterized (by soil scientists from the Natural Resources Conservation Service). These will be a Barbour soil which is well drained and has an organic matter content of 2.7, and an Onteora soil which is poorly drained and has an organic matter content of 7.2%. Oocyst survival in these soils will be compared to the results of the laboratory experiments. 3. We will map the survival of the oocysts in the field relative to the observed data collected at the field sampling sites. This will produce a two dimensional map of the surface of the farm that will allow us to look for correlation's between changes in oocyst viability and various soil characteristics. The results of this analysis will serve as preliminary work for our planned experiments dealing with oocyst transport where the number of samples will be performed at a much greater density on an expanded sampling grid. We expect to produce the following data relative to oocysts in the environment: laboratory data showing how well oocysts survive in soils of different types when under different environmentally feasible conditions; nomographs for oocyst survivability under different conditions; field data that can then be used to determine if the laboratory data is representative of what occurs under field situations and the opportunity to determine whether the devised nomographs have any real-world application; and a surface map on a farm of oocyst survival relative to measured soil characters that will allow us to examine whether there is any relationship between these characters and the survival of oocysts.

Principal Findings and Significance

Progress report: Our work has identified a method that determines the survival of oocysts in soil conditions using a sentinel chamber system. This system allows us the ability of examining the persistence of oocysts in the soil environment and the determination of the effects of various environmental conditions. Using this method of examination, we have shown that oocysts in both soil and in manure piles persist much less than would be expected based on work under more reductionistic, bench-top systems where the soil/manure interactions are ignored. Using this system we have shown major effects due to soil water potential and temperature. Results of an experiment where we have looked at the long-term survivability of oocysts in the soil on a farm site are currently in the process of being analyzed. We plan to map the soil survivability over the farmyard. We are also in the process of examining the effects of repeated freeze-thaw cycles on oocysts in soil. We are currently moving into the study of the transport of oocysts where we will begin to examine in depth how they move about within farms on the watershed.

Descriptors

Cryptosporidium, Pathogens, Public Health, Water Quality Control, Soil Microbiology, Surface

Drainage, Land Use, Pollutants, Ecosystems, Dairy Waste Management, Animal Waste, Agriculture, Contaminant Transport

Articles in Refereed Scientific Journals

Jenkins M. B. , D. D. Bowman, and W. C. Ghiorse, 1998, Inactivation of Cryptosporidium parvum oocysts by ammonia, Applied and Environmental Microbiology, 64:784-788.

Barr, S. C., D. D. Bowman, M. F. Frongillo, and S. L. Joseph, 1998, Efficacy of a drug combination, praziquantel, pyrantel pamoate, and febantel against giardiasis in dogs, American Journal of Veterinary Research, 59:1134-1136.

Jenkins M. B., M. J. Walker, D. D. Bowman, L. C. Anthony, and W. C. Ghiorse, 1999. Use of a sentinel system for field measurements of Cryptosporidium parvum oocyst inactivation in soil and animal waste, Applied and Environmental Microbiology, 65:1998-2005.

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Bowman, D. D., M. B. Jenkins, and W. C. Ghiorse, 1997. Excystation of Cryptosporidium parvum sporozoites requires oocyst pretreatment with hydrogen ion and is maximized in the presence of bile salts, 7th International Coccidiosis Conference, Oxford, UK, Abstract No. 106.

Jenkins, M. B., D. D. Bowman, M. J. Walker, and W. C. Ghiorse, 1997. Use of sentinel Cryptosporidium parvum oocysts to measure effects of passive manure storage on oocyst inactivation, 7th International Coccidiosis Conference, Oxford, UK, Abstract No. 107.

Jenkins, M. B., P. L. McDonough, D. D. Bowman, L. C. Anthony, S. C. Kachlany, and W. C. Ghiorse, 1997, Fatty Acid and lipid composition of the oocyst of Cryptosporidium parvum. American Society of Tropical Medicine and Hygiene, Orlando, FL, Abstract No. 469.

Anthony, L. C., D. D. Bowman, M. B. Jenkins, B. S. Eaglesham, S. C. Kachlany, and W. C. Ghiorse, 1998, Chemical Composition and ultrastructure of the oocyst walls of wildtype Cryptosporidium parvum. ASM Annual Meeting, Atlanta, GA

Jenkins, M. B., M. J. Walker, D. D. Bowman, and W. C. Ghiorse, 1998, Use of sentinel Cryptosporidium parvum oocysts for field measurements of oocyst inactivation kinetics in surface soil. ASM Annual Meeting, Atlanta, GA.

Werre, S. R., D. D. Bowman, H. O. Mohammed, M. B. Jenkins, F. W. Quimby, K. M. Horton, and J. P. Dubey, (date not cited), Transmission to guinea pigs of very low doses of Toxoplasma gondii oocysts in drinking water, Americal Society of Protozoologists, Raleigh, NC.

Kato, S., D. D. Bowman, and M. B. Jenkins, 1999, The effects of the pretreatment with hydrogen and

potassium ion and bile salts on the excystation of Cryptosporidium parvum sporozoites, American Association of Veterinary Parasitologists, New Orleans, LA.

Jenkins, M. B., D. D. Bowman, E. A. Fogarty, S. R. Werre, S. Kato, and W. C. Ghiorse, 1999, Inactivation of Cryptosporidium parvum oocysts in three soil types at various temperatures and water potentials, American Society of Tropical Medicine and Hygiene, Washington, DC.

Jenkins, M. B., D. D. Bowman, and W. C. Ghiorse, 1999, Inactivation of Cryptosporidium parvum Oocysts in Three Soil Types at Various Temperatures and Water Potentials. Northeast Section of the American Society of Agronomy and Soil Science Society of America, Guelph, Canada.

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Developing comprehensive criteria for dehalorespiratory bioremediation of chlorinated ethenes in a contaminated aquifer
Project Number	NY98-C-04
Start Date	10/01/1998
End Date	06/30/2000
Research Category	Water Quality
Focus Category #1	Ecology
Focus Category #2	Toxic Substances
Focus Category #3	Groundwater
Lead Institution	Cornell University

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Eugene L. Madsen	Assistant Professor	Cornell University	01

Problem and Research Objectives

Chlorinated solvents [e.g., trichloroethene (TCE) and perchloroethene (PCE)] can constitute a significant threat to public health and are among the most widespread groundwater contaminants. In

addition, the elimination of chlorinated solvents from groundwater can be a major financial liability to the many Northeastern regional municipalities and industries responsible for industrial pollution. This proposal seeks to augment an industry-sponsored project designed to document rates of TCE biodegradation in fractured rock beneath an industrial manufacturing plant. This project will advance basic knowledge of dehalorespiration and factors that govern this important detoxification process in field sites.

Dehalorespiration is a recently discovered physiological process carried out by naturally occurring microorganisms. Dehalorespiration links the sequential removal of chlorine atoms from toxic chlorinated solvents to growth of the responsible bacteria. The end product of dehalorespiration is ethene, a non-toxic, biodegradable gas (actually a plant growth hormone). An improved understanding of how naturally- occurring microorganisms spontaneously eliminate groundwater pollutants can provide added technological flexibility and cost savings (supplementing or replacing costly air strapping and other clean-up technologies) for regulatory officials, municipalities, and industrial operations in the Northeastern US.

This NIWR-strengthened project will expand the overall project scope to include stable isotopic, physiological, and field-deployed passive sampler assays that will provide basic knowledge of dehalorespiration that can lead to a broad understanding of how this process can be reliably exploited to supplement or replace costly engineered groundwater clean up technologies.

Methodology

The project will study a contaminated field site 8 km east of Niagara Falls, NY. Three field and laboratory studies will be pursued:

1. Use stable isotopic analyses of the inorganic and organic carbon pools in the contaminated field study site to trace the sources and fates of carbon transformation processes (e.g. respiration, methanogenesis, reductive dechlorination). Characteristic signatures in ^{13}C to ^{12}C ratios will allow *in situ* electron sources and sinks to be identified. The same assays can be applied to laboratory microcosms.

2. Use laboratory incubations of groundwater and rock samples from the field site to assess the impact of competing physiological regimes (electron accepting processes that include methanogenesis, sulfate reduction, iron reduction, manganese reduction, nitrate reduction) on dehaolrespiration. These incubations will also include radiotracer-amended microcosms that document the potential of groundwater microorganisms to mineralize vinyl chloride (the most toxic of chlorinated ethenes daughter products) to CO_2 under iron-reducing and other conditions.

3. Deploy sorbent-containing passive sampling devices in wells that span contaminated and uncontaminated zones of the site. These devices will be periodically retrieved and analyzed for both parent (e.g. TCE) and daughter products (e.g., dichloroethenes, vinyl chloride, and ethene) to assess the efficacy of zones of active dehalorespiration in curtailing contaminant migration.

Principal Findings and Significance

(This project began late in the FY98 reporting period. Its progress will be reported in FY99 and FY2000 reports.)

Descriptors

Biodegradation, Reductive dechlorination, Trichloroethene, Detoxification, Intrinsic Bioremediation, Groundwater, Technology

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Preferential flow and organic enhancement of metals transport to groundwater from land-applied biosolids in the northeastern U. S.
Project Number	NY98-C-05
Start Date	10/01/1998
End Date	08/31/2001
Research Category	Ground-water Flow and Transport
Focus Category #1	Solute Transport
Focus Category #2	Toxic Substances
Focus Category #3	Models
Lead Institution	Cornell University

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Tammo S. Steenhuis	Professor	Cornell University	01
Murray B. McBride	Professor	Cornell University	02

Problem and Research Objectives

Application of municipal wastewater sludges (biosolids) to land is being widely promoted as a cost-effective management alternative. Agricultural land, forest land, and land reclamation sites are increasingly being used for land application. In addition to beneficial components such as organic matter and nutrients, sludges also contain trace metals (such as Cd, Cu, Hg, Ni, Pb and Zn) which in groundwater or agricultural products may present a human toxicity risk. Current USEPA regulations governing sludge application assume little or no mobility of sludge-applied metals to groundwater (USEPA, 1993). We have observed substantial movement of sludge-applied metals via preferential flow paths, facilitated by complexation with soluble organics. Moreover, many field studies are unable to account for a substantial fraction of sludge-applied trace metals when the receiving soil is examined several years after application. Losses from the soil profile via leaching is a potential mechanism for the apparent losses. Relatively few studies report water quality data, and results can be complicated by instrumental detection limits and by the potential for sampler interactions (such as substantial metal adsorption by ceramic cup lysimeters as reported by Wenzel et al. 1997).

Our ongoing experiments have shown heavy metal leaching through soils in experimental and field systems. The presence of preferential flow paths (soil fractures, shrink-swell cracks, worm holes, etc. that exist under field conditions) and soluble humic organics (which complex with metals) both served to greatly increase the leaching of metals in undisturbed soil columns (Camobreco et al.1996). In contrast, conventionally-prepared homogenized soil columns (which are completely unlike field conditions) immobilized all applied metals, whether in water alone or with soluble organics. Preferential flow and facilitated transport factored significantly in metal mobility recently observed in an old sludge application site (Richards et al. 1998). Unfortunately, much of present conventional wisdom about metal immobility is based on homogenized soil columns and is thus overly optimistic about the soil immobilization of sludge-applied metals. Similarly, conventional simulation models (including those used for the USEPA assessment of groundwater contamination risk during Part 503 rule development) do not account for either preferential flow or facilitated transport. These phenomena may increase the risk of leaching of sludge-applied metals to groundwater, especially in the Northeast where soils are relatively shallow and leaching rates are high, and may thus present an unforseen long-term environmental risk. Rates of nutrient mineralization from land-applied sludges are also poorly defined, and overapplication may result in groundwater contamination. A more recent concern with land-applied sludge is the presence of surfactants and metabolites thought to act as endocrine disruptors, and for which there is little field data, especially regarding leaching potential. Emerging national and international water quality standards for these surfactants are on the order of 1 µg/L (Renner 1997) There is a sense among many soil scientists and others that the USEPA Part 503 sludge land-application standards may not be sufficiently protective in the Northeast US, and that cumulative sludge applications in the Northeast US should be lower than the Part 503 standards would allow, at least until more long-term research is available. Some have advised using the Northeast recommendation levels found in Baker et al. (1985) as interim cumulative application limits, equivalent to approximately 10% of the allowable Part 503 metals loadings (e.g. Harrison et al. 1997). Concerns include potential human, animal and crop toxicity. The recent convening of the NEC-100 Northeast regional ad hoc technical committee to review and discuss sludge application issues specific to the Northeast underscores these concerns. The need for reliable field data on the fate of sludge-applied metals in typical Northeastern soils has been identified as a key parameter, especially in view of our findings of potential metal mobility in leachates. There is also little US field data on the presence and impacts of surfactants and their metabolites in land-applied sludges (Rubin, 1998), which may contain these compounds at up to part-per-thousand levels (Giger et al. 1984) but for which no sludge quality standards exist.

The proposed work will allow us to obtain a better understanding of metal movement in the soil. The results of the study will contribute to our understanding of the potential risks to water quality posed by land application of sludges, and will contribute to the base of knowledge needed to define land application practices that are protective of water quality in the Northeast.

Methodology

The concept that metals are moving as organic complexes through preferential flow paths is relatively new and needs further investigation. We will expand and verify our current observations by continuing to examine an extensive existing soil column study for longer-term metal mobility. At well-documented field sites we will examine soil profiles, soil water, tile outflow and/or groundwater to determine if metals and nutrients are leaching. The proposed project will also afford the opportunity to screen sludge, soil, and water samples obtained for the presence, persistence and mobility of surfactants and their metabolites (in this case primarily 4- nonylphenol, which can act as a potent endocrine disrupter). The project's five objectives have associated field, laboratory, and modeling methods:

1. To examine a well-controlled undistrubed soil column system for metal mobility fooolwing recent sludge applications. 78 undisturbed soil columns have been established to cover 2 soils X 2 initial pH levels X 6 different sludge products X 3 replicates, plus six untreated controls. Each column has a sludge product applied over time to represent normal agronomic practice.
2. To examine a well-defined sludge application site for evidence of long-term metal losses and current mobility. A site at the University of Guelph in Guelph, Ontario, CA had sludge applied from 1973 to 1980. Soil at 18 sites within this location (2 rates X 3 sludge products X 3 replicates) will be sampled.
3. To observe current percolate and gorundwater metal calculations at large-scale agricultural sludge application sites. Soil horizions, wick samplers, tile outflow, and /or groundwater wells at farms where sludge has been applied will be sampled.
4. To use measured mobility results to refine and calibrate a preferential flow solute mobility model. Observed data from work under objectives 1-3 would be used to refine an existing preferential flow solute leaching model.
5. To screen soil and water samples for surfactants and metabolites. Sludge products and selected environmental and laboratory samples collected under objectives 1-3 will be analyzed for surfactant and related metabolite contents, emphasizing 4-nonylphenols. Extractions and determinations are done using methods of Giger or later.(reference: Giger, W., P. H. Brunner, and C. Schaffner. 1984. 4-Nonylphenol in sewage sludge: accumulation of toxic metabolites from nonionic surfactants. Science, 225:623-625.)

Principal Findings and Significance

(This project began late in the FY98 reporting period. Its progress will be reported in FY99 and FY2000 reports.)

Descriptors

Contaminant transport, sludge, biosolids, heavy metals, leaching, phosphorus, surfactants, nonylphenols, pollutants, preferential flow, facilitated transport groundwater, water quality, modeling

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Information Transfer Program

(Note: Base funding for this activity comes from the New York State College of Agriculture and Life Sciences, including Cornell Cooperative Extension. This section describes NYS WRI's general information transfer approach.) As in most previous years, the Institute gave priority to information transfer activities during the Federal FY98 period, supported primarily by Cornell University. The transfer process works in both directions: scientific information is disseminated to government agencies, professionals, and the general public and the needs and opinions of these individuals and organizations strongly influence the content and form of most NYS WRI activities.

Subject matter and problems:

Some of the issues NYS WRI staff and cooperating faculty have addressed through education and training activities during recent years are:

- protecting watersheds and well catchments of water supplies;
- managing the impact of new land development on water quality;
- protecting groundwater and surface water from pesticides;
- assessing nonpoint source impacts on lakes, streams, and groundwater;
- assessing urban water demand;
- managing agricultural manure for nutrient and pathogen control.

Most of these issues are identified through the constant interaction of NYS WRI staff with the public, business, and governmental entities.

Target audiences and related strategies:

NYS WRI considers everyone in New York to be potential members of one of its audiences. NYS WRI staff and cooperating faculty normally pursue the following activities with the following groupings of people:

- local government staff: technical assistance projects;
- agricultural industry: technical assistance projects for agricultural chemical companies;
- water supply industry: technical and educational assistance projects related to source water quality protection;
- County Extension staff: periodic Statewide training courses including teleconferences; regional training activities; telephone consultation;
- County Soil and Water Conservation District staff: Statewide and regional training activities, collaborative demonstration projects, new program development;
- private citizens concerned about their own or local water problems: telephone advice and referral;

development of general leaflets and bulletins about water and contaminants.

Cooperators:

Some NYS WRI staff (including the Director) have appointments with Cornell Cooperative Extension and participate in Extension activities on a statewide and regional basis. WRI’s sponsored projects generally involve the appropriate County Extension Association if they have any interest in the issue. Besides Cooperative Extension entities in counties, some of NYS WRI's recent, more frequent partners in information transfer activities include:

- County Soil and Water Conservation Districts;
- New York City Watershed Agricultural Council, Inc.;
- New York City Department of Environmental Protection;
- Within the New York City watershed program, Cornell’s Department of Soil, Crop, and Atmospheric Sciences (agricultural nutrient assessment and management), Department of Agricultural Management and Resource Economics (local government, farm business management), Department of Agricultural and Biological Engineering (hydrology and farm nutrient and pathogen transport), Section of Microbiology (farm pathogen viability and analysis), Department of Animal Science (nutrient and pathogen management through dairy nutrition and health), Department of Veterinary Clinical Sciences (pathogen risk assessment); Veterinary Diagnostic Laboratory (pathogens and animal health), Department of Rural Sociology (rural community watershed management);
- Upper Susquehanna Coalition (Conservation Districts and other county entities in thirteen counties in New York and Pennsylvania);
- NYS Dept. of Environmental Conservation (NYS DEC) and NYS Department of Health (NYS DOH) program development activities.

Since early 1997, NYS WRI has been participating in an Environmental Community Assistance Consortium, whose current academic members are units from Cornell University, Syracuse University, the State University of New York at Buffalo, the State University of New York at Stony Brook, and the Rensselaer Polytechnic Institute. The Consortium specializes in technical and educational assistance to local government. Its first official project assisted Genesee County, NY, in constructing a water supply infrastructure plan.

USGS Internship Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	11	5	0	0	16
Masters	1	6	0	0	7
Ph.D.	0	1	0	0	1
Post-Doc.	0	0	0	0	0
Total	12	12	0	0	24

Awards & Achievements

A focal area dominating NYS WRI's activity in the 1990's has been the development of programs based on

watersheds. Most effort since 1992 has been devoted in the New York City Watershed. NYS WRI has been acting as an intermediary between New York City and elements of the agribusiness sector and wider community in the watersheds as they strive to develop alternatives to the "police power" approach, alternatives that retain more local sovereignty. The most mature component program operates under the banner of "Whole Farm Planning" (WFP). This program has been carrying out Phase II of a long-term, $35M program since 1994. The program has attracted national attention due to its unusual blend of balanced environmental and economic goals, local farmer governance, a promising voluntary participation rate, multilevel governmental cooperation, diverse scientific input, and significant funding transfer between the water supplier and farmers. During the Federal FY98 period, NYS WRI began to organize a new work area: phosphorus management in the Cannonsville Reservoir basin (West Branch of the Delaware River). The Cannonsville Reservoir is somewhat eutrophic. New York City has imposed strict controls on additional wastewater phosphorus discharges in its basin, a policy that the watershed communities feel is hampering economic development. The area is economically disadvantaged relative to the rest of the state, making economic restrictions especially troubling.

NYS WRI has assisted Delaware County in obtaining over $800,000 of State and Federal seed funding (Federal Water Resources Development Act, Federal Safe Drinking Water Act) to develop its own scientifically credible local program that will reduce phosphorus loadings to the reservoir without unduly constraining economic development.

Publications from Prior Projects

Articles in Refereed Scientific Journals

Wagenet, L. P., M. J. Pfeffer, H. D. Sutphin & J. M. Stycos, 1999, Adult Education and Watershed Knowledge in Upstate New York, Journal of the American Water Resources Association, 35(3), 609-621.

Stycos, J. M., and M. J. Pfeffer, 1998, Does Demographic Knowledge Matter? Results of a Poll in the New York City Watershed, Population Policy Review, 17 (4), 389-402.

Poe, G., N. Bills, B. Bellows, P. Crosscombe, R. Koelsch, and P. Wright, 1998, Documenting the Status of Manure Management in New York Current Practices and Willingness to Participate in Voluntary Programs, Abstract in the Agricultural and Resource Economics Review, 27(2), 298.

Carlsen, W. S., 1997, Never ask a question if you don't know the answer: The tension in teaching between modeling scientific argument and maintaining law and order, Journal of Classroom Interaction, 32(2), 14-23.

Carlsen, W. S., 1998, Engineering design in the classroom: Is it good science education or is it revolting?, Research in Science Education, 28(1), 51-63.

Book Chapters

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