Arkansas Water Resources Center

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Arkansas Water Resources Center

Annual Technical Report

FY 2000

Introduction

Statewide Mission. The Arkansas Water Resources Center (AWRC) has a statewide mission to plan and conduct water resource research. AWRC cooperates closely with colleges, universities and other organizations in Arkansas to address the state's water and land-related problems, promote the dissemination and application of research results, and provide for the training of scientists in water resources.

Support Provided. The Center acts as the liaison between funding groups and the scientists, and then coordinates and administers grants once they are funded. Accounting, reporting, and water analyses are major areas of support offered to principal investigators.

AWRC Water Quality Laboratory. The Center maintains a modern water quality laboratory that provides water analyses for researchers and for farmers and other who submit samples through the Cooperative Extension Service and the Department of Housing and Urban Development.

Geographical Information System (GIS) Support. The Center for Advanced Spatial Technology (CAST) and the GIS Laboratory in the Department of Crop, Soil, and Environmental Sciences provide support in developing GIS data for the management and protection of water.

Research Program

Basic Information

Title:	Saline Water Investigations in Eastern Arkansas: Geochemical Tools to Characterize Sources of Saline Water
Project Number:	B-02
Start Date:	3/1/2000
End Date:	2/28/2001
Research Category:	Water Quality
Focus Category:	Hydrogeochemistry, None, None
Descriptors:	Groundwater, Eastern Arkansas, Saline Intrusion, Hydrochemistry
Lead Institute:	University of Arkansas
Principal Investigators:	Ralph K. Davis

Publication

1. Cooper, C.D., R.K. Davis and K.F. Steele, 2001, Spatial Characterization of Hydrochemistry for the Alluvial and Sparta Aquifers of the Grand Prairie Region, Eastern Arkansas. Geological Society of America Abstracts with Programs. v.33, no. 5, p. A16.
2. Cooper, C.D., R.K. Davis and K. F. Steele, 2001, Presentation on Spatial Characterization of Hydrochemistry for the Alluvial and Sparta Aquifers of the Grand Prairie Region, Eastern Arkansas. Arkansas Water Resources Center Annual Water Conference - TMDL and Related Water Quality Issues, April 3 and 4, 2001, University of Arkansas, Fayetteville, Arkansas.

PROBLEM AND RESEARCH OBJECTIVES

Saline groundwater underlies Arkansas at shallow depth. Lateral movement of saline water into fresh water by updip migration resulting from pumping was detected in areas of eastern and southern Arkansas. Both the Alluvial Aquifer and the Sparta Aquifer have been impacted by saline intrusion. Critical ground water areas have been established in east-central Arkansas for the Alluvial and Sparta aquifers, and in southern Arkansas for the Sparta Aquifer as a result of declining water levels in these aquifers. There is also some saline water, especially in the shallower Alluvial Aquifer, that has resulted from oil and gas operations in the area, particularly in south-central Arkansas. Other potential sources of saline water include road de-icing, highway department storage piles, discharge from poultry and hog plants, and leaky landfills, among others. Saline water intrusion and near surface sources of saline water in eastern and south-central Arkansas is an increasing problem and will likely dominate our water quality concerns in Arkansas.

In southern Arkansas, the Sparta Aquifer is used as a primary drinking water source and the Alluvial Aquifer is used for irrigation purposes. Chloride concentrations in the Sparta Aquifer in Union County range from 25 to 150 mg/L. About 30% of the irrigation wells and relifts in Desha County have been reported to have chloride concentrations above 100 mg/L. (Broom et al., 1984; Morris, 1988). These high chloride concentrations can be detrimental to the use of the water. Saline water can decrease crop productivity, and cause corrosion and taste problems with drinking water. As saline water intrusion problems become more prevalent and impact more irrigation and drinking water supplies, the need will arise to be able to clearly differentiate the various sources of contamination. Defining the spatial distribution of saline water in the Alluvial and Sparta aquifers in relation to significant areas of ground-water level decline is a critical need. In addition, Geochemical fingerprinting is a tool that may prove to be beneficial to help differentiate sources of saline water contamination to these aquifers.

METHODOLOGY

The grant from USGS was combined with additional funds from the Arkansas Soil and Water Conservation Commission to provide sufficient funding to collect one hundred twenty six water samples from the Sparta aquifer and the Alluvial aquifer in the Grand Prairie Region of Arkansas during the summer 2000. Forty two samples from the Sparta Aquifer and 84 samples from the Alluvial aquifer including the field duplicates and field blank samples. An additional 24 samples were collected from the Sparta aquifer in Union County in January 2001. One goal of the project was to collect samples at times of significant aquifer stress. For the Grand Prairie region this occurs in late-summer while in Union County the stress is more uniform because the use is primarily industrial and municipal. Samples from the Grand Prairie Region were collected along transects perpendicular and parallel with the axis of significant areas of groundwater level decline within this region. Samples from Union County were also collected from areas of significant groundwater level decline.

Water samples were analyzed for a suite of major inorganic constituents and selected trace elements at the Arkansas Water Resources Center Water Quality Laboratory, University of Arkansas. The spatial distribution of various hydrochemical components was displayed spatially

using ArcView. This provided a mechanism to compare water quality variations within each aquifer and between the aquifers for each of the selected study areas.

PRINCIPLE FINDINGS AND SIGNIFICANCE

Data reduction and interpretation are still ongoing. Preliminary interpretation of spatial data within the Alluvial and Sparta aquifers shows a qualitative correlation between the areas of significant groundwater level decline and areas of elevated chloride concentrations.

Basic Information

Title:	Prediction of Ground Water Vulnerability to Animal Waste/Fertilizers in Karst Topography Using Fuzzy Logic
Project Number:	B-03
Start Date:	3/1/2000
End Date:	2/28/2001
Research Category:	Water Quality
Focus Category:	Water Quantity, None, None
Descriptors:	
Lead Institute:	None
Principal Investigators:	

Publication

1. Dixon, B., H.D. Scott, J.V. Brahana, A. Mauromoustakos, and J.C. Dixon, 2001, Application of Neuro-Fuzzy Techniques to Predict Ground Water Vulnerability in Northwest Arkansas, University of Arkansas, Fayetteville, Arkansas, p. 67.

PROBLEM AND RESEARCH OBJECTIVES

Contamination of ground water has been a major concern in recent years of local, state and federal agencies involved with the management, quality, and quantity of water and their relationships with human health. Delineation of vulnerable areas and selective applications of animal wastes/fertilizer in those areas can minimize contamination of ground water. Assessment of ground water vulnerability or delineation of the vulnerable areas for monitoring purposes is difficult due to inherent uncertainties associated with ground water contamination from numerous and complex interacting parameters. Statistical correlation of the causal factors that potentially contribute to the contamination often does not produce acceptable results. More accurate ground water vulnerability estimates can be delineated from site-specific studies, however, these studies are quite expensive and not feasible at all sites, especially, when the scale of the model is regional. Therefore, there is a need to develop new modeling techniques that assess ground water vulnerability using less extensive site specific data, and at the same time, be robust when data are uncertain and incomplete.

This research addressed these needs by integrating advanced information technologies such as Global Positioning Systems (GPS), Geographic Information systems (GIS), remote sensing, and Neuro-fuzzy techniques. The specific objective of this research was to develop a model using Neuro-fuzzy techniques in a GIS to predict ground water vulnerability in a relatively large watershed in northwest Arkansas.

METHODOLOGY

A Neuro-fuzzy system is a fuzzy system that is trained by a learning algorithm from neural-network (NN) theory. Neuro-fuzzy models were used in the study because they have the inherent capability to deal with uncertainties in the data, tolerate imprecision and can extract information from incomplete and contradictory datasets. The Neuro-fuzzy model was developed in a JAVA platform using the trapezoidal membership function with four fuzzy sets. Four plausible parameters that are critical in transporting contaminants in and through the soil profile including soil hydrologic group, depth of the soil profile, soil structure (pedality points) and landuse were used as input parameters for the model. Soil-hydrogeological data were obtained from STATSGO and SSURGO databases and landuse data were obtained from arial photographs. The nitrate-N contamination data for 44 springs and wells were used to validate the model prediction. Coincidence reports were generated among model inputs, model predictions and well contamination level for nitrate-N.

PRINCIPAL FINDINGS AND SIGNIFICANCE

The model output showed high coincidence with soil structure parameters (pedality points) and agricultural landuse. About 22% of the watershed was classified as highly vulnerable area and the majority of the highly vulnerable areas coincided with agricultural landuse, moderately deep and deep soils, soil hydrologic group C and high pedality points. Coincidence among model inputs, well nitrate-N contamination data and vulnerability maps indicated that the rule base and classifier for the Neuro-fuzzy model needed to be fine tuned. However,

comparisons between well location (point) and vulnerability categories (spatial) should not be used to determine the usefulness of the Neuro-fuzzy models in an absolute sense.

Application of Neuro-fuzzy techniques to the prediction of ground water vulnerability does not provide exact solutions but provides a map indicating relative vulnerability. The proposed methodology has potential in facilitating modeling ground water vulnerability at a regional scale. This methodology can be used for other regions, however, this approach would require incorporation of appropriate input parameters suitable for the region. This study is the first step toward incorporation of Neuro-fuzzy techniques in a GIS and would require improvements for wider range of application.

Basic Information

Title:	Source Water Assessment of Public Drinking Water Supplies in Arkansas: Phases III, IV, and V
Project Number:	S-01
Start Date:	7/1/1999
End Date:	2/28/2001
Research Category:	Water Quality
Focus Category:	Water Quality, None, None
Descriptors:	
Lead Institute:	University of Arkansas
Principal Investigators:	Ralph K. Davis

Publication

1. Anderson, Paula E.W. and R.K. Davis, 2000, Improvements to Current Source Water Delineation Methods of Wells and Springs Using Examples From Northwest Arkansas Fractured Karst Terrain. Geological Society of America, Abstracts with Programs. v. 32, n. 7, p. A356.
2. Davis, R.K. and P. Anderson, 2000, Arkansas' Source Water Assessment Program: Delineations for Groundwater and Implications for Mantled Karst Aquifers. Geological Society of America, Abstracts with Programs. v. 32, n. 3, p. A47.

PROBLEM AND RESEARCH OBJECTIVES

A major component of this program was development of a management tool for public water utilities in northwest Arkansas to enhance the protection of their source of drinking water. This is a joint effort with the Arkansas Department of Health, the U.S. Geological Survey and two units of the University of Arkansas including the Department of Geosciences and the Center for Advanced Spatial Technologies (CAST). We have identified source water protection areas for public drinking water supplies and have provided assessment of potential sources of contamination within distinctly delineated areas. In four counties in northwest Arkansas, these analyses are being completed for 138 public water supplies which represents about 9% of the public water supplies in the state. These 138 public water supplies provide water for approximately 10% of the state's population. The Center for Advanced Spatial Technologies provided Geographical Information Systems (GIS) data coverage which were used in the delineation and assessment model for each public water supply.

METHODOLOGY

Eight of the public water supplies obtain their supply from surface sources including lakes and rivers. One hundred twenty three of the public water supplies obtain their water from wells completed in Ordovician limestone, dolomite and sandstone aquifers below the Chattanooga Shale, which acts as a regional confining unit. The designated source water assessment and protection area for these wells is a fixed radius of ¼-mile surrounding the wellhead. This arbitrary fixed radius for the protection zone may be sufficient for these areas since it is not anticipated that there will be significant impact to these wells or aquifers from surface anthropogenic sources of contamination. In addition, five springs that discharge from the regolith mantled Boone/St. Joe Aquifer and two wells completed in this shallow karstic aquifer are currently serving as public water supplies in this portion of the state. These wells and springs are considered to be under the direct influence of surface water. An arbitrary fixed radius of ½-mile surrounding the intake has been designated as the source water assessment and protection area for these systems. These sources are extremely susceptible to anthropogenic surface sources. Water-quality analysis over storm hydrographs shows significant impact to this aquifer from applied animal manure. Arkansas is a major producer of poultry, cattle and swine and the manure associated with these animals is used as fertilizer on pasture. Concentrations of fecal coliform bacteria, dominated by *Escherichia Coli*, range from < 100 coliform forming units/100mL (cfu/100mL) at low-flow to over 50,000 cfu/100mL during storm pulses. Other surface sources of contamination, including significant concentrations of nitrate-nitrogen, are impacting this shallow regolith mantled karst aquifer.

PRINCIPLE FINDINGS AND SIGNIFICANCE

The ½-mile radius source water protection area prescribed by the program is an arbitrary assignment that is not based on hydrogeology. Delineating capture zones in this flow system is difficult because of the significant surface water-ground water interaction which is characterized by flow via caves, enlarged fractures, bedding planes, conduits, sinkholes, and sinking streams. To adequately provide source water assessment and protection, capture zones for these seven public water supplies must be based on a more complete delineation of the recharge area for each

well and spring. Standard methods of capture zone analysis have been developed primarily for flow in alluvial aquifers or aquifers where matrix flow dominates. Flow in the Boone/St. Joe Aquifer is dominated by secondary porosity associated with karst features. Each flow domain is unique and will require a separate and detailed hydrogeologic investigation to adequately delineate the recharge and capture zone for these systems.

Basic Information

Title:	Source Water Assessment of Public Drinking Water Supplies in Arkansas: Phase II - GIS Portion
Project Number:	S-02
Start Date:	9/1/1998
End Date:	6/30/2000
Research Category:	Water Quality
Focus Category:	Water Supply, None, None
Descriptors:	Source Water Assessment, Northwest Arkansas, Karst
Lead Institute:	University of Arkansas
Principal Investigators:	W. Fred Limp, R. Brian Culpepper

Publication

1. White, P. and R.K. Davis, 1999, Hydrology Portion of the Project: Subtantiating the Need to Base Delineation of Source Water Assessment and Protection Areas on Hydrogeology in Mantled Karst Aquifers, "in" Association of Groundwater Scientists and Engineers, Technical Program, National.
2. Limp, W.F., 2000, Presentation on Source Water Protection Methodologies in Arkansas, Research Seminar of King Faisal University, Department of Soil and Water, Hofuf, Saudi Arabia.

PROBLEM AND RESEARCH OBJECTIVES

The purpose for the proposed work was to obtain information on the location of all public water intakes in the state of Arkansas and the location and characteristics of Potential Sources of Contamination (PSOC) that are within their immediate vicinity (either one-quarter or one-half mile – for wells). The purpose of this work was to develop base data to be used by the U.S. Geological Survey (USGS) to assess the potential for contamination for the state's public water intakes. PSOC data needed for assessment of public surface water sources (impoundments, rivers, etc.) will be provided to the USGS. The individual assessments performed by USGS will be provided to the Arkansas Department of Health as part of the Environmental Protection Agency (EPA) required program on source water assessment (EPA 816-R-97-009 "State source water assessment and protection program guidance").

Hydrology Portion of the Project: Develop a management tool for public water utilities to enhance the protection of their source of drinking water via identification of source water assessment areas of drinking water supplies and identification of potential sources of contamination within distinct delineated areas.

METHODOLOGY

Due to the large number of public water intakes and potential PSOCs it would be enormously expensive and almost impossible to field map all these data using traditional methods, therefore the use of Geographic Information Systems (GIS) technologies enables such a large project to be completed in a timely manner. The goal of this data collection task is to develop a GIS data set that can serve as a useful basis for assessing the potential for contamination for every public water system within Arkansas. The final mapping script continued to be tested, evaluated and reviewed by the entire project team during this quarter and it was estimated that approximately 90% of this task had been completed at the conclusion of this quarter. The PSOC test report format and output script also matured during this quarter and approximately 90% of this task was completed by the end of the quarter. Additionally, another 15% of the GIS data layers that had been developed for this project had been documented with official FGDC metadata at the conclusion of this quarter. Completed Tasks as of 2/28/00:

TASK 1 - Convert key base map GIS data into common digital format/projection
TASK 2 - Convert key PSOC data to digital format
TASK 3 - Geo-code PSOC databases
TASK 4 – Seamless Data Base Assembly
TASK 5 - Macro Development
TASK 6 - Draft Map production
TASK 7 – Edit PSOC locations/attributes from field maps
TASK 8 - Calculate the elevation of each PSOC collected.
TASK 9 - Construct and Deliver Access Database to project team.
TASK 10 - Determine PSOC Distance Weighting
TASK 11 - Prepare Final Map Prototypes and GIS Scripts (90% Complete)
TASK 12 - Prepare Final PSOC location text reports (90% Complete)
TASK 13 - Convert Oil and Gas Well Data into GIS Coverage

TASK 14 - Develop FGDC Compliant metadata (40% Complete)

Hydrology Portion of the Project

Delineate and assess the area of approximately 140 public drinking water sources in four counties in northwest Arkansas. The delineation and assessment are conducted in accordance with procedures described in " Source Water Assessment Program" Arkansas Department of Health.

Phase II involves compilation of existing data primarily for surface water systems and selected springs and wells that are considered to be directly influenced by surface sources (Groundwater Under the Direct Influence of Surface Water).

PRINCIPAL FINDINGS AND SIGNIFICANCE

For the estimated 1500 public water intakes at the time of this project, approximately 3 to 5 individual map layout formats and reports were customized by CAST. These changes came about via extensive testing and evaluation by the entire project team, as well as, the SWAP projects Technical and Citizens Advisory Committees, which met in Little Rock at a public meeting. Another 15% of the GIS data layers that had been developed for this project had been documented with official FGDC metadata at the conclusion of this quarter. Compiled GIS Data Layers:

1. Geology (1:500k) vector
2. Soils (STATSGO 1:250k) vector
3. Poultry/Swine houses
4. Land Cover reclass of GAP (30m raster)
5. Canals and Ditches (1:100k TIGER/DLG)
6. Irrigation Wells (ASWCC)
7. NPDES and TRI (EPA)
8. Highways by classification, railroads, airports, bridges (AHTD)
9. Pipelines (TIGER 1:100k)
10. RCRA
11. ERNS
12. Cemeteries (AHTD/GNIS)
13. Schools (AHTD/GNIS)
14. Septic Systems (AHTD)
15. Mines (GNIS)
16. Elevation (30m where available; else 80m)
17. Streams/Rivers (DLG 1:100k)
18. Dairies (Ark. Dept. of Health) Potential Sources of Contamination (PSOC): As identified the USGS and Arkansas Department of Health
    1. Above ground storage tanks
    2. Under ground storage tanks
    3. Leaking storage tanks
    4. Agri Industry

5. Pesticides applied per acre
6. Airports
7. Repair Shops
8. Cemeteries
9. Chemical Storage
10. Dry cleaners
11. Electric substation
12. Golf Courses
13. Gravel Pits (& PC&E Streaming Mining)
14. Highways
15. Manufacturing facilities (non-specific)
16. Pipelines
17. Oil and gas wells
18. Salvage yards
19. Sewage treatment plants (NPDES facilities)
20. Septic tanks
21. Landfills
22. Water wells
23. Confined animal operations
24. Aqua-culture
25. Land application of Solid Waste (PC&E)
26. Waste water lagoon (Discharge data)
27. In-steam gravel removal (PC&E Permits)
28. RCRA
29. CERCLA (Superfund)
30. Marinas
31. Mining Hydrology Portion of the Project: All public water supplies were visited in the four county study area. GPS locations for each well were collected as well as a wellhead inspection during site visits. A summary report detailing the condition of the wellhead and noting any wellhead deficiencies was prepared and is being incorporated into the source water assessment for each public water supply. The University of Arkansas Center for Advanced Spatial Technologies has prepared an extensive data set as their component of this project. These data sets are now being incorporated into the overall assessment process.

Basic Information

Title:	Fiscal Year 2000 Arkansas State Water Resources Research Program
Project Number:	B-01
Start Date:	3/1/2000
End Date:	2/28/2001
Research Category:	Water Quality
Focus Category:	Non Point Pollution, Education, Water Quality
Descriptors:	Management, Information Dissemination
Lead Institute:	University of Arkansas
Principal Investigators:	Kenneth F. Steele

Publication

1. Steele, K.F. (editor), 2000, Environmental Hydrology, Arkansas Water Resources Center, University of Arkansas, Fayetteville, Arkansas, p. 33.
2. Steele, K.F., March 19, 2000, Presentation on Orientation for National Institutes for Water Resources Directors, (Invited), National Institutes of Water Resources.
3. Nelson, M.A., Optimum Sampling Intervals for Calculating Pollutant Loads in Streams, Proceedings of the Arkansas Water Resources Center Annual Conference: Environmental Hydrology, held April 4 and 5, 2000.
4. Soerens, Thomas, M. Nelson, and J. Spooner, Optimum Sampling for Determining Pollution Loads in Streams, in Water Resources into the New Millennium: Past Accomplishments and New Challenges, Proceedings of 1999 International Water Resources Engineering Conference, ASCE Specialty Conference, August 8-12, 1999, Seattle, Washington. EWRI/ASCE, 2000.
5. Steele, K.F., M.A. Nelson, P.F. Vendrell, 2000, Pastureland and Storm Impacts on Water Quality of Six Small Streams in the White River Basin, Arkansas, in White River Forum II Abstracts, Arkansas Water Resources Center, University of Arkansas, Fayetteville, Arkansas, p. 9 (presented by K.F. Steele).
6. Steele, K.F., May, 2000, Presentation on Pastureland and storm impacts on stream water quality, Ozark Region, Water Resources in Extreme Environments, American Water Resources Association, Anchorage, Alaska.
7. Steele, K.F., M.A. Nelson, P.F. Vendrell, R.G. Roggio, 2000, Presentation on Pastureland and Storm Impacts on Water Quality of Six Small Streams in the White River Basin, Mountain Home, Arkansas, November 2, 2000 (presented by K.F. Steele).
8. Nelson, M.A., 2000, Presentation on Optimum Sampling Intervals for Calculating Pollutant Loads In Streams, Proceedings of the Arkansas Water Resources Center Annual Conference, April 4 and 5, 2000.
9. Nelson, M.A., 2000, Presentation on Optimum Sampling Intervals for Calculating Pollutant Loads In Streams, Arkansas-Oklahoma Arkansas River Compact Commission, October 2000,
10. Nelson, M.A. 2000, Presentation on Optimum Sampling Intervals for Calculating Pollutant Loads in Streams, Arkansas Department of Environmental Quality, Arkansas Department of Environmental Quality, June 2000.
11. Soerens, T.S., 2000, Presentation on Pollutant-Specific Stream Sampling Protocol, 2000 AGU

Spring Meeting, Washington DC, May 30-June 3, 2000, published abstract: EOS, Vol. 81, No. 19, May 9, 2000, p S232.

12. Nelson, M.A., T.S. Soerens, 2000, Presentation on Illinois River Arkansas-Oklahoma Transboundary Load Determination Issues, 2000 AGU Spring Meeting, Washington DC, May 30 - June 3, 2000, published abstract: EOS, Vol. 81, No. 19, May 9, 2000, p. S193-194.

PROBLEM AND RESEARCH OBJECTIVES

Arkansas Water Resources Center (AWRC) Technical Advisory Committee has established the following priority research categories that are addressed by fifty-seven (57) projects administered and/or funded by the Center in 2000.

- non-point source contamination (nutrients and pesticides)
- development of methods for determination of total maximum daily loads (TMDLs)
- declining ground water levels, especially in eastern Arkansas and associated salt water contamination
- wetlands and flooding
- development of efficient septic systems

Twenty-nine (29) projects, the majority of the Center's projects focused on water quality issues related to nutrients and suspended sediments from pastureland. Because of the importance of large-scale animal production to the State's economy, especially in western Arkansas, methods to reduce contamination from animal waste and erosion of pastureland are critical.

AWRC plays a major role in development and demonstration of effective best management practices to minimize contamination. This role of the Center's research is reflected in the fact that almost twelve (12) of the water quality projects are related to development and demonstration of best management practices. Runoff from pastures can result in excess nutrients and sediments being delivered to streams and lakes and thus are very important in terms of water quality and TMDLs. "Prediction of Ground Water Vulnerability to Animal Waste/Fertilizers in Karst Topography Using Fuzzy Logic" was a 104b modeling project that had impact on best management practices regarding non-point source pollution from animal wastes.

Three (3) Water Resources Research Institute Program projects focus on source water protection of public water supplies, which includes protection from non-point and point source pollution. These projects are being conducted in conjunction with the U.S. Geological Survey, Little Rock District, the Arkansas Health Department, and the University of Arkansas Center for Advanced Spatial Technology. The objective of these projects is the assessment of pollution potential for Arkansas' approximately 1,400 public source water systems. Geographical Information Systems (GIS) and hydrologic information are being used to assess each system.

Six (6) projects were directly related to development of stream monitoring protocol to find the most effective method of determining stream loads of nutrients and suspended sediments. The results of these projects have been extremely useful to Arkansas and Oklahoma in terms of pollution of the Illinois River and Lake Tenkiller. The Kings River and the west fork of the White River are being monitored using these protocols.

One (1) water quality project in eastern Arkansas is evaluating pesticide contamination of ground water. The results from this project indicate that only a small number of wells are contaminated with pesticides and that in general the contamination is very low and transient in nature.

Declining water levels, especially in eastern Arkansas, are the result of agricultural, industrial, and municipal over pumpage of aquifers. This has led to the legal designation of areas in eastern Arkansas as "critical ground water areas." Both the Alluvial and Sparta aquifers now have such designation. Models for management of these aquifers are available but could be refined. Two projects are focusing on saline water issues. One project is investigating the relationship between the declining water levels and salinity of the ground water. "Saline Water Investigation in Eastern Arkansas: Geochemical Tools to Characterize Sources of Saline Waters" is a USGS 104b project that also investigated salinity issues in the Arkansas Delta Region. Results from this project will be important in determining the source of saline contamination.

One project investigated an innovative method of determining the decline of water levels using soil wetness features. Declining ground water levels in eastern Arkansas are a major concern for Arkansas industries, municipalities and farmers. One of the Center's projects assessed the economic factors of using on-farm reservoirs to distribute surface water to areas with depleted ground water. The information from this project will be extremely beneficial to Arkansas farmers and managers.

Wetlands are an significant issue nationally and the Center has recognized the importance of these areas. The Center currently is involved in one constructed wetland study. This project is investigating the remediation of wastewater at a swine rearing facility.

Determination of the amount of water inundation of stream floodplains is important in terms of planning, especially for farmers in eastern Arkansas. A pilot study in the Black River basin shows a strong and predictable relationship between stream gage readings and the amount of land under water during flood events. Satellite imagery was used to determine the extent of inundation.

Work has continued on the development of efficient septic tank design for problem areas of Arkansas, e.g., those areas with shallow soils or high ground water tables. The project is funded by the state through the University of Arkansas. The principle investigators work closely with the Arkansas Department of Health in development of projects and technical information transfer.

METHODOLOGY

AWRC has a Technical Advisory Committee composed of representatives of all of the state/federal water resources agencies, academia, industry, and private groups that selects proposals for Regional Competition and that provides general advice for the Center's operation. The Center also assists agencies and other groups in forming research teams to address water resource issues. In addition, the Center helps academic researchers in presenting their ideas for research to the correct agency and agency representative. The Center acts as the liaison between funding groups and the scientists, and then coordinates and administers grants once they are funded. Accounting, reporting, and water analyses (through the AWRC Water Quality Laboratory) are major areas of support offered to principal investigators. The Center's training and information dissemination programs are intricately involved with the research projects.

Many students are trained through participation in research projects and also at the Water Quality Laboratory. The Information Dissemination Program consists of the publication of journal articles and other reports, presentation at professional meetings, and organization of conferences and short courses related to the research program.

PRINCIPAL FINDINGS AND SIGNIFICANCE

Expansion of the Center's research support and capabilities continues to be one of the major goals of the Center. The Cooperative Extension Service and the Housing and Urban Development Agency cooperate with the Arkansas Water Resources Center Water Quality Laboratory in a water quality program for farmers and rural residents. The Laboratory is certified for drinking water by the Louisiana Health Department and for wastewater by the Arkansas Department of Environmental Quality. This facility provides services to researchers and, through its cooperators, to citizens and state and federal agencies. The Center's program includes significant effort in information dissemination. In addition to the publication of reports, journal articles, and books, the Center sponsors and co-sponsors conferences for dissemination of information. This past year the Center sponsored a conference on "Environmental Hydrology" that was held jointly with the South-central Section Meeting of the Geological Society of America. AWRC also sponsored a short course titled "Hydrogeology and Geochemistry of Salt Water Contamination", by Charles Kreitler." Although the Center has strong cooperative research programs with state and federal agencies, these can be expanded and strengthened. Cooperative efforts with environmental and industrial organizations can be strengthened. The research priorities of the Center were reviewed and re-authorized at the January 7, 1999 Technical Advisory Committee meeting and were as follows:

1. Investigate the physical, chemical, and biological characteristics of streams, reservoirs, etc. (storm events, substrate/water interactions, identification of new resources, reference systems, etc.).
2. Quantify and qualify the trophic levels and associated parameters in lentil and lotic ecosystems (modeling, energy transfer, production, etc.).
3. Determine the impact of natural and synthetic chemicals on surface water quality (point and non-point sources, toxic material, pesticides, industrial and mining waste, etc.
4. Develop analytical techniques and protocols for assessing water quality (quality control, quality assurance, microbiological, indicator species, etc.).
5. Develop mechanisms for improving quality and quantity of water supplies for surface applications and the impact of the applications (water treatments, irrigation, return flow, leaching, etc.).

Regional Research Priorities

In addition to the state priorities the Southeastern and Islands Region of the National Institutes of Water Resources have the following priorities:

1. Water Quality – Research needs in the water quality area involve information, information management, and the protection of surface and ground water from

degradation. It includes industrial and municipal wastewater treatment and subsurface disposal of hazardous/toxic wastes. In addition, problems from non-point sources of both municipal and agricultural sources, including soil erosion, agricultural runoff, and pesticides, pertain to this area. The development and improvement of monitoring techniques and analysis are also important, as well as water quality problems associated with eutrophication and weed control.

2. Water Management – Research needs in the area of water management include legal, institutional, and financial arrangements. Specific items such as basin planning, water use control, transfers and/or diversions of water, flood control, and drought planning are all priority issues. It also includes construction of facilities, financing and pricing, and water conservation and reuse. Management includes quality protection studies, upgrading of supplies, and state and/or federal and interstate interactions or compacts.
3. Water Quantity – Research needs in the water quantity area include studies of the basin water cycle for an understanding of prediction. It also includes items of surface water flow, basin planning, low flow predictions (7Q10), flood control, water use, and water allocation. Included also are studies of ground water availability and the locations, movement, and volume of ground water. Also of importance are use and user impacts and surface and ground water interaction.
4. Aquatic and Environmental Protection - Research needs in this area include studies of wetlands, swamps and marshes, fish and other biota, and the quality of life. It also includes studies of ecological balance, protection of endangered species, and studies of dredging and filling.
5. Emerging Problems – Studies not included in other priority areas, but which are dedicated to management officials in the region, are included in this category. During the next year, these research priorities will be reviewed with the Technical Advisory Committee. Although no major changes in the priorities are anticipated, more focus will probably be placed on current specific problems, e.g., non-point source contamination, wetlands, and ground water quantity. This focus should allow the Center and the state/federal agencies to continue to cooperate effectively in solving water resource problems in Arkansas. The Arkansas Water Resources Center, in conjunction with state and federal agencies, is addressing many of the issues described under Water Problems and Issues of Arkansas.

Information Transfer Program

USGS Summer Intern Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	1	0	0	0	0
Masters	2	0	0	0	0
Ph.D.	1	0	0	0	0
Post-Doc.	0	0	0	0	0
Total	0	0	0	0	0

Notable Awards and Achievements

None

Publications from Prior Projects

1. Hamilton, Sherri, R.K. Davis and P.F. Vendrell, 2000, Survival of Escherichia Coli in a Mantled Karst Terrane. Geological Society of America, Abstracts with Programs, v. 32, n. 3, p. A13.
2. McCollum-Roden, M., 2001, Water Quality of a Portion of the Mississippi Alluvial Plain of Eastern Arkansas. M.S. Thesis, University of Arkansas-Fayetteville.
3. Hamilton, S.L. and R.K. Davis, 2000, Survival of Escherichia Coli in Stream and Spring Environments of Northwest Arkansas. Geological Society of America, Abstracts with Programs. V. 32, n. 7, p A432.
4. Hamilton, S.K., 2001, A Survival Study of Escherichia Coli in Sediment in a Spring and Stream in the Mantled Karst of Northwest Arkansas, Savoy Expiremental Watershed. M.S. Thesis, University of Arkansas-Fayetteville.