

**SUMMARY AND ANALYSIS OF WATER-USE DATA COLLECTION  
IN EASTERN ARKANSAS**

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**U.S. GEOLOGICAL SURVEY**

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## CONVERSION FACTORS

For use of readers who prefer to use metric (International System) units, rather than the inch-pound units used in this report, the following conversion factors may be used:

<u>Multiply inch-pound unit</u>	<u>By</u>	<u>To obtain metric unit</u>
acre	4,047	square meter (m <sup>2</sup> )
acre-foot (acre-ft)	1,233	cubic meter (m <sup>3</sup> )
foot (ft)	0.3048	meter (m)
inch (in.)	25.4	millimeter (mm)
million gallons per day (Mgal/d)	3,785	cubic meter per day (m <sup>3</sup> /d)

# **SUMMARY AND ANALYSIS OF WATER-USE DATA COLLECTION IN EASTERN ARKANSAS**

By Nancy T. Baker

## **ABSTRACT**

The collection of water-use data has been an integral part of water resources investigations in eastern Arkansas for many years. Although water-use data reports are published periodically, there has been little documentation of how water-use data were collected in the past, how data currently are collected, the types of data collected, or the quality of the data collected. This report provides such documentation and evaluates the reliability of current water-use data for making management decisions.

From 1960 to 1985, aggregated estimates of water use were collected and compiled by the U.S. Geological Survey. Because the aggregated estimates were not sufficiently detailed to be useful in many hydrologic investigations, State legislators enacted legislation requiring the reporting of ground- and surface-water withdrawals. Since 1985, this site-specific water-use data has been collected by the Arkansas Soil and Water Conservation Commission and compiled and stored in a computerized data base managed by the U.S. Geological Survey as part of a cooperative water-use program between these agencies.

Site-specific water-use data reported to the Arkansas Soil and Water Conservation Commission were compared with U.S. Geological Survey aggregated estimates to evaluate the completeness and plausibility of the reported site-specific data. Although total water-use amounts reported to the Arkansas Soil and Water Conservation Commission and U.S. Geological Survey aggregated estimates for irrigation for 1988 are in good agreement, significant differences occur for some counties. Crittenden, Drew, Greene, and Independence Counties reported water-use amounts more than 50 percent less than the aggregated estimates; indicating probable incomplete reporting in those counties. Several counties reported water-use amounts greater than the aggregated estimates. Most of the variation between water-use amounts reported to the Arkansas Soil and Water Conservation Commission and U.S. Geological Survey aggregated estimates is due to differences in reported and Arkansas Agricultural Statistics Service estimated crop acreages.

High quality site-specific data provide an accurate and representative estimate of water use. Site-specific data are needed to understand current water demands and evaluate trends in water use, to establish a dynamic "baseline" for allocation purposes, and to improve aggregated water-use estimates over current estimates based on statistical sampling or regional calculations.

## **INTRODUCTION**

Water supply is an important constraint in local and regional planning in Arkansas. Planners not only need to know the total amount of water available at a site, but also the seasonal timing of water availability. In the past, managers often have relied on statistical sampling and gross regional estimations of water use to make management decisions. Site-specific water-use data can help planners and managers of the State's resources to define the rate of depletion (or recharge) of existing water supplies, to anticipate and avoid potential problems concerning future water needs, and to make sound water resources management decisions. Site-specific data can provide an accurate and representative estimate of water use so that resulting management decisions are more equitable. The Arkansas Soil and Water Conservation Commission (ASWCC) works cooperatively with the U.S. Geological Survey to collect, compile, store, and manage water-use data for the State.

### **Purpose and Scope**

This report summarizes past and present water-use data collection procedures in eastern Arkansas in terms of aggregated and site-specific data, and provides a comparison between the two types of data. Water-use data have been important elements in many water resources management decisions made in Arkansas. Upon assessment of several critical water issues, State legislators as well as State and Federal agencies have recognized the need for accurate water-use data. Although water-use data reports are published periodically in Arkansas, there has been little documentation of how water-use data were collected in the past, how data currently are collected, the types (aggregated or site-specific) of data collected, or the quality of the data collected. Such documentation is essential for evaluating the reliability of current water-use data for making management decisions.

This report is intended to familiarize the reader with past (1960-85) and present procedures in water-use data collection, the type and quality of data collected, and to emphasize the benefits of high quality water-use data in Arkansas. The comparison of aggregated with site-specific data is provided to aid in evaluating the completeness and plausibility of the reported site-specific data. The comparison is not intended to be an evaluation of the accuracy of either the aggregated or site-specific data. Because aggregated data have been collected since 1960 and the process of collecting these data has been refined, the aggregated data represent an accurate enough measure of water withdrawals to be used as a guideline for evaluating the completeness of the site-specific data.

The study area includes 26 counties in eastern Arkansas (fig. 1). Because water resources in this important agricultural area are critical for the economic prosperity of eastern Arkansas, the area has been the focus of numerous hydrologic investigations. Water-use data are essential for many of these investigations.

### **Description of Study Area**

The entire study area lies within the Mississippi Alluvial Plain, and is rich in soil and water resources. The economy of the area is based almost exclusively on agriculture. Rice, soybeans, cotton, and sorghum are the predominate crops. Arkansas produced 40.6 percent of the rice produced in the United States in 1988 and had more acreage devoted to the production of

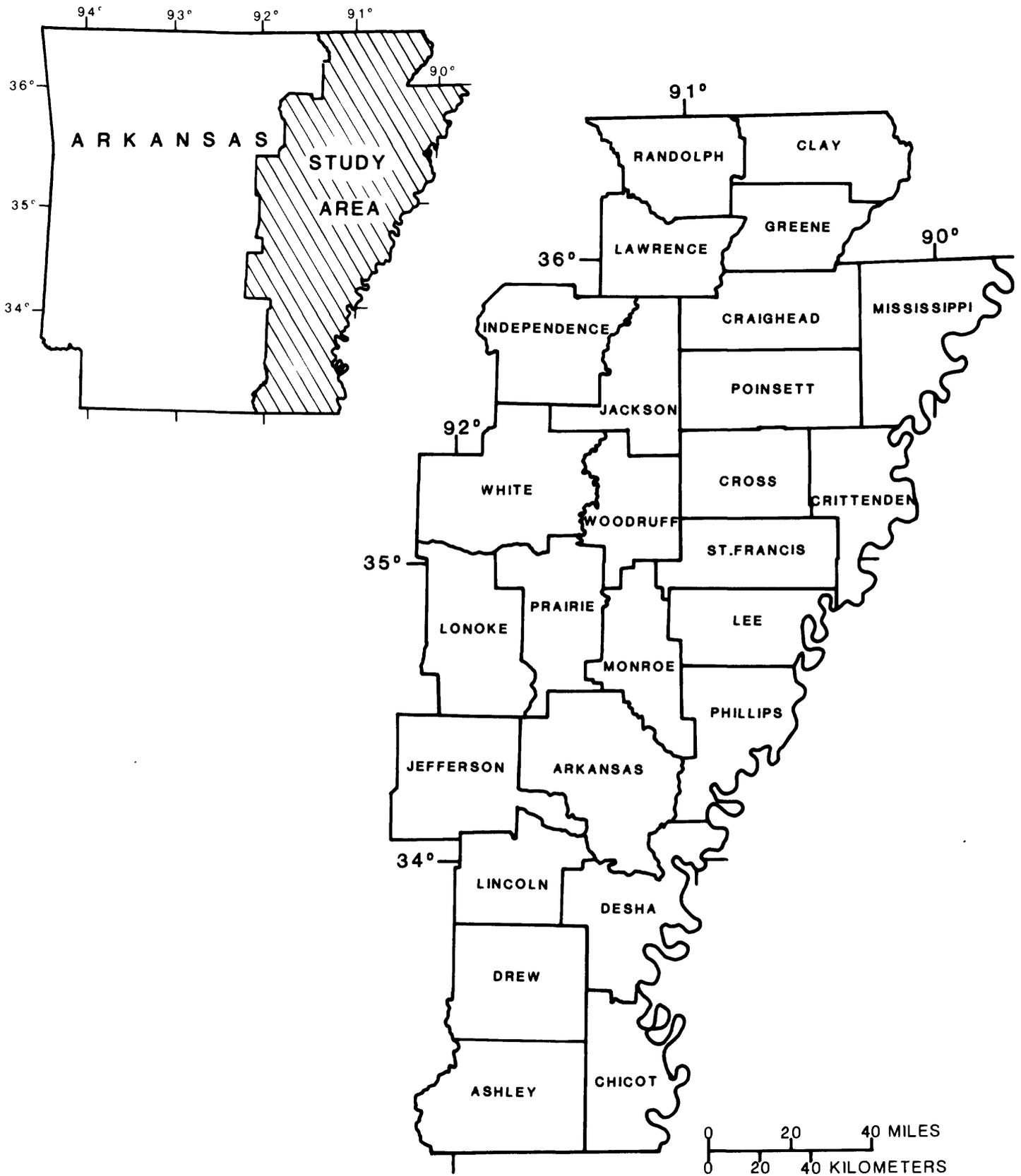


Figure 1.--Location of study area.

rice (1.21 million acres) than any other State (Arkansas Agricultural Statistics Service, 1989, p. 3). Of the 1.21 million acres devoted to rice production in Arkansas, 97 percent was in the 26 counties in eastern Arkansas that constitute the study area. Other agricultural acreages in this area include 3 million acres of soybeans, 0.7 million acres of cotton, and 0.3 million acres of sorghum (Arkansas Agricultural Statistics Service, 1989, pp. 23-27). The agricultural economy of the area depends heavily on water for irrigation. In 1985, about 80 percent of the 4,760 Mgal/d (million gallons per day) of water withdrawn in Arkansas was used for irrigation (excluding that withdrawn for hydroelectric and thermoelectric power) (Holland, 1987).

Fortunately, water normally is plentiful in eastern Arkansas. Average annual precipitation (1951-80) ranges from about 47 inches near Clay County to about 54 inches in Ashley County (Freiwald, 1985). Average annual runoff (1951-80) ranges from about 16 inches in the northern and southern counties to 22 inches in the central counties (Freiwald, 1985). Surface-water sources include the Lower Mississippi-St. Francis River system draining the area to the north, and the Boeuf-Tensas River system draining the area to the south (fig. 2). The most productive ground-water source, is the shallow alluvial aquifer underlying the entire area (fig. 2). More than 90 percent of ground water withdrawn for irrigation is from the alluvial aquifer (Holland, 1987, p. 24). The Sparta and Wilcox aquifers are also important ground-water sources, especially for public, industrial, and commercial supplies (fig. 2).

## **HISTORICAL DATA-COLLECTION PROCEDURES**

Aggregated water-use data for Arkansas have been collected and compiled every 5 years since 1960 (Stephens and Halberg, 1961; Halberg and Stephens, 1966; Halberg, 1972; Halberg, 1977; Holland and Ludwig, 1981; and Holland, 1987). Little changed in the way data were collected from 1960 to 1985. Although water-use estimates were derived from the highest quality data obtainable with existing resources (people, time, money, and equipment), the data collected often were not sufficient for defining and solving the State's water-use problems. Site-specific data were collected for surface-water irrigation beginning in 1969, and a site-specific inventory of public water supplies was completed in 1985. Site-specific water-use data were not routinely collected in Arkansas until 1985 when the State passed legislation requiring the reporting of ground-water withdrawals to the ASWCC.

### **Aggregated Data**

Aggregated water-use data as used in this report refer to data for a group of sites or category of uses. Water-use data can be aggregated by county, hydrologic unit, water-use category, or any other useful grouping. Aggregated data can be composed of site-specific data that have been grouped and summed, or can be indirectly derived from estimations or calculations based on general information (population, total crop acreages, and water-application rates). Estimations and calculations based on general information often are used when existing resources are limited, as was the case in past data collection efforts in Arkansas, or when a high degree of accuracy is not critical.

From 1960 to 1985 water-use information for Arkansas was collected by the U.S. Geological Survey (USGS) in cooperation with the ASWCC and the Arkansas Geological Commission (AGC). Water-use data were collected for eight categories of use: public supply, domestic, commercial, industrial, mining, agriculture, irrigation, and thermoelectric energy. Public-supply information was obtained from the Arkansas Department of Health records of water use for every permitted facility in the State. Domestic water use was estimated from U.S. Bureau of

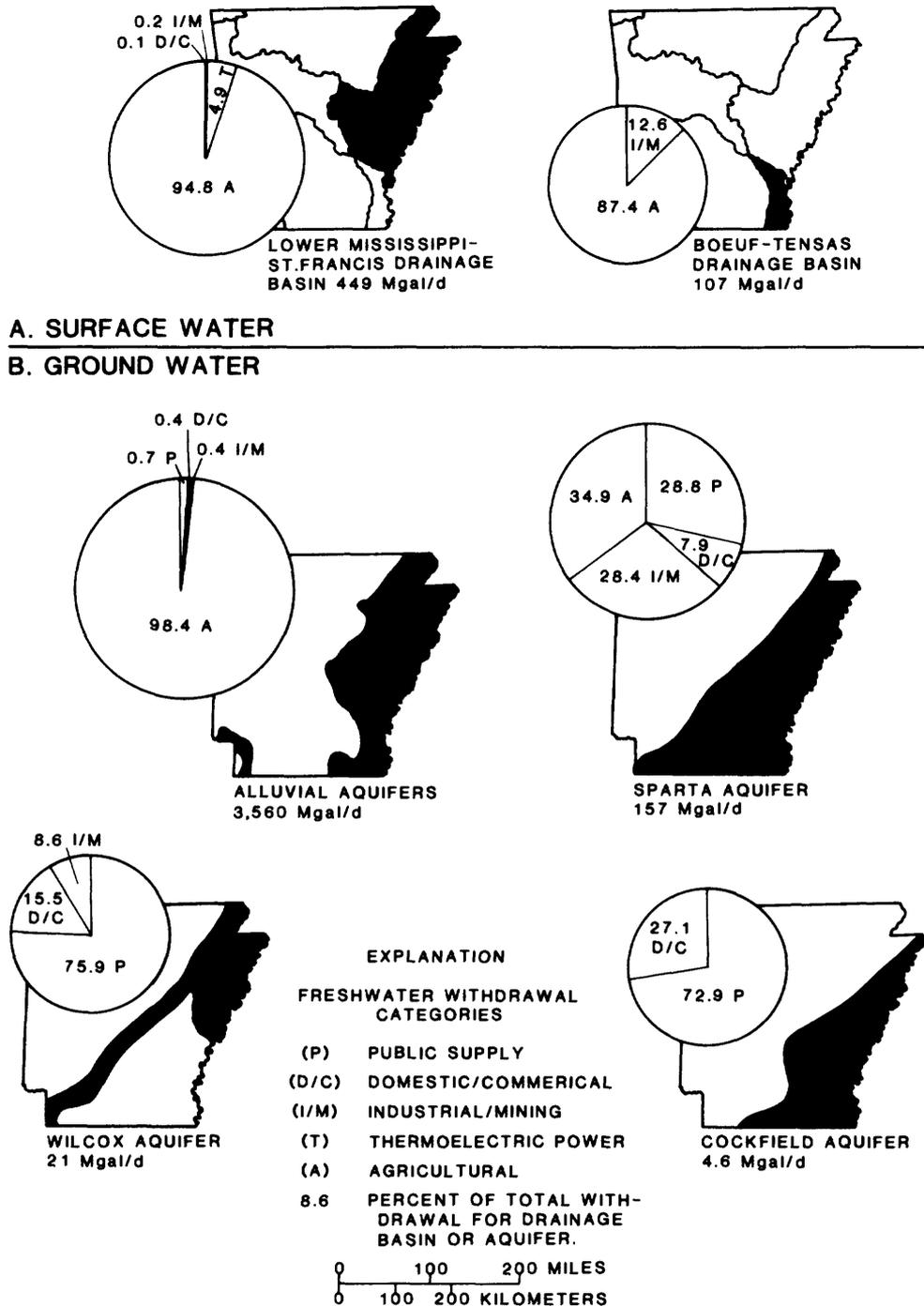


Figure 2.--Water withdrawals by category of use for eastern Arkansas, 1985. A. Surface-water withdrawals by principal drainage basin. B. Ground-water withdrawals by principal aquifer. Abbreviation: Mgal/d is million gallons per day. (From Baker and others, 1990).

Census records of rural population and an estimated per capita water consumption. Self-supplied commercial (hotels, schools, parks, recreation areas, government facilities) water use was estimated from records of the number of people visiting the facility and an estimate of per capita water consumption. Industrial water use was obtained directly from major industrial users. Mining water use was estimated from production data (obtained from the AGC) and a coefficient of water use for each mined product. Agricultural and irrigation water use was estimated from livestock and crop production values and the appropriate water consumption or application rate. Thermoelectric water use was estimated from the electric power produced and coefficients of water use based on rates reported by major thermoelectric power plants.

Several problems are often associated with compiling aggregated estimates of water use. Aggregated estimates may be compiled from a number of sources. Each agency or source contributing information may have a different method of calculating the supplied information resulting in variability of data. Aggregated water-use amounts are often estimates of estimates (for example: human and livestock population estimates, crop acreage estimates, production estimates, per capita consumption estimates, crop water-application estimates, and water consumption estimates per unit production). Per capita consumption, water-application rates, and consumption per unit production estimates are often based on some standard value and may not reflect local variability.

Although aggregated sums of water use may be reasonably accurate and are sufficient for some regional water resources evaluations, the information is not sufficiently detailed to be useful in many hydrologic investigations. The location of water withdrawal points, and the source and amount of water withdrawn from specific points cannot be determined from the aggregated data. Detailed site-specific data are needed for many water-management decisions.

### **Site-Specific Data**

Site-specific water-use data refer to information obtained about an individual withdrawal, transfer, delivery, or release point. Site-specific data generally are composed of measured values, or calculations based on specific information about the site (pump capacity, duration of pumping, and amount of water withdrawn), and are used when accuracy is important. Site-specific data usually require substantial resources to collect and maintain; however, the data are essential for many hydrologic investigations. For example, site-specific data are necessary for determining ground- and surface-water rates of depletion and recharge, and for predicting the availability of future water supplies.

To accurately define the limitations of the water resources of the State and to make sound management decisions regarding those limitations, planners and managers need high quality, site-specific water-use data. The enactment of legislation requiring the reporting of ground- and surface-water withdrawals was an important first step in achieving a high quality, site-specific water-use data base.

Site-specific data were collected by the ASWCC beginning in 1969 (for surface-water users only) as a result of legislation requiring the reporting of surface-water withdrawals. The intent of the legislation was to provide a means of equitably allocating water during periods of shortage. Initially, site-specific surface water-use data were stored on index cards in file drawers. Beginning in about 1982 the ASWCC stored water-use data on a computer system. After the passage of additional legislation in 1985 requiring the reporting of ground-water

withdrawals, the ASWCC entered into a cooperative agreement with the USGS to provide a computerized data base for storing and managing site-specific water-use data.

Data collected in 1985 represent the first "large-scale" water-use data collection effort in Arkansas. Data for about 18,000 withdrawal sites were collected in 1985. That number increased to about 25,000 in 1986 and to more than 30,000 in 1987.

## **SUMMARY AND ANALYSIS OF CURRENT SITE-SPECIFIC DATA**

Currently, water-use data are reported annually to the ASWCC for more than 40,000 withdrawal sites. The State has passed legislation enforcing the water-use reporting requirement with a penalty for not reporting. This legislation and an increasing awareness in the water user community that good water-use data are necessary to help ensure a stable water supply, provide incentives for timely and accurate water-use reporting. The USGS computerized Site-Specific Water-Use Data System (SSWUDS) is being used to store and manage the data.

The following discussion reviews how site-specific data are collected, stored and managed, and the types of data collected. In addition, site-specific data collection, management, and storage procedures are analyzed to evaluate which aspects of the process need emphasis or improvement.

### **Data-Collection and Management Procedures**

Site-specific and aggregated data are collected for the same categories of water use. Users of water for public supply, commercial, and industrial uses, mining, and power generation register their water use by filling out registration forms and mailing them directly to the ASWCC. Agricultural and irrigation water users register their water use by filling out similar registration forms at their local Conservation District offices. Different kinds of information are requested by the ASWCC from different types of water users. Users of water for public supply, commercial and industrial uses, mining, and power generation register their use on standard forms which request basic information such as name and location of the facility, the amount of water withdrawn, and the location of each withdrawal site (fig. 3). Public suppliers also are requested to provide information on the amount of water delivered to domestic, commercial, industrial, mining, agricultural and irrigation water users, and the amount of water purchased from or sold to other public suppliers. Agricultural and irrigation water users register their water use by providing ASWCC with information on the amount of water used, the kinds of crops grown, the number of acres irrigated, and ancillary pump data (fig. 4).

Data are stored and managed using SSWUDS. SSWUDS provides the mechanism to store data about various types of water users, facilities, and measurement points, as well as tracking routes of conveyance in water-use networks. During 1988, site-specific information was stored in the SSWUDS data base for 34,357 ground-water and 6,647 surface-water withdrawal points. SSWUDS data can be retrieved in various formats including aggregated totals of site-specific data, tables for analysis and presentation purposes, and formats suitable for input to hydrologic models.

Currently, quality-assurance measures that have been initiated for the site-specific data, consist of ensuring that reported monthly water use equals the reported annual amount, and that the reported information on the registration form is entered correctly into the data base.

**WATER-USE REGISTRATION FORM**

1. Name of Facility \_\_\_\_\_

2. Water-user Id. # \_\_\_\_\_

3. Use of water: (check one)

WS - Public Supply Use _____	PF - Fossil Fuel Power _____
CO - Commercial Use _____	PG - Geothermal Power _____
IN - Industrial Use _____	PN - Nuclear Energy Power _____
MI - Mining _____	PH - Hydroelectric Power _____

4. SIC Code (1) \_\_\_\_\_ (2) \_\_\_\_\_ (3) \_\_\_\_\_

5. Permit# or PWS# \_\_\_\_\_ 6. Telephone Number (\_\_\_\_) \_\_\_\_\_

7. Location of Facility: Latitude \_\_\_\_\_ Longitude \_\_\_\_\_

8. Hydrologic Unit Code \_\_\_\_\_

9. Address \_\_\_\_\_

10. City \_\_\_\_\_ 11. ZIP Code \_\_\_\_\_

**\*\*\*\*\* COMPLETE 12-18 FOR PUBLIC WATER SUPPLY FACILITIES ONLY \*\*\*\*\***

12. Total Ground & Surface Water withdrawals(MILLION GALS.) \_\_\_\_\_

13. Water Purchased From Other Facilities (Amount in MILLION GALS.):

Facility Name _____	Amount: _____
Facility Name _____	Amount: _____

14. Water Sold To Other Facilities (Amount in MILLION GALS.):

Facility Name _____	Amount: _____
Facility Name _____	Amount: _____

15. Water Used For Facility Maintenance (backflushing, plant operations, losses due to seepage and leaks - MILLION GALS.) \_\_\_\_\_

16. Domestic Population Served \_\_\_\_\_

17. Deliveries to Users (Do not include water sold to other facilities):

<u>Water Furnished To:</u>	<u>Total Water Delivered</u>	<u>Number of Connections</u>
Domestic Households _____	_____	_____
Commercial _____	_____	_____
Industrial _____	_____	_____
Mining _____	_____	_____
Agriculture _____	_____	_____
Irrigation _____	_____	_____

18. Current Rate Structure:  
 \_\_\_\_\_

\_\_\_\_\_  
 (Name of Plant Manager)      (Date)      (County of Diversion)

**Figure 3.--Standard water-use registration form for Arkansas site-specific data collection.**

**FILL OUT A SEPARATE PAGE FOR EACH WELL OR SURFACE WATER DIVERSION POINT**

19. Measurement Point ID \_\_\_\_\_

20. Local Descriptive ID \_\_\_\_\_

\*\*\* If CENTROID, amount of water withdrawn (#29-30) represents the sum \*\*\*  
\*\*\* of water withdrawn from all withdrawal points for this facility. \*\*\*

21. Action Code \_\_\_\_\_ (If Action Code is DL skip to #29)

22. Source of Water (Ground, Surface, or Transfer) \_\_\_\_\_

23. If Surface Water withdrawal:

A. Name of Lake or Stream: \_\_\_\_\_

24. If Ground Water withdrawal:

A. Name of Aquifer: \_\_\_\_\_

B. Depth of Well \_\_\_\_\_

C. Name of Driller \_\_\_\_\_

25. Pump Information:

A. Pump Capacity (Horsepower) \_\_\_\_\_

B. Type of Power (check one): Electric \_\_\_\_\_ LPGas \_\_\_\_\_  
Diesel \_\_\_\_\_ Other \_\_\_\_\_

C. Type of Pump (check one): Stationary \_\_\_\_\_ Portable \_\_\_\_\_  
Gravity \_\_\_\_\_ Other \_\_\_\_\_

D. Diameter of Well or Intake Pipe: \_\_\_\_\_

26. Location of Well or Withdrawal Point (Well or Intake Structure):

Latitude \_\_\_\_\_ Longitude \_\_\_\_\_

27. Hydrologic Unit Code \_\_\_\_\_

28. Withdrawal Amounts Obtained From (check one):

Billing Records \_\_\_\_\_ Pump Capacity + Hours Operation \_\_\_\_\_  
Meter Readings \_\_\_\_\_ Other (list) \_\_\_\_\_

\*\*\*\* For questions 29-30, withdrawal values reported in (check one):\*\*\*\*

Gallons \_\_\_\_\_ Thousand Gallons \_\_\_\_\_ Million Gallons \_\_\_\_\_

29. Total Water Withdrawn From This Withdrawal Point ( nn): \_\_\_\_\_

30. Amount of Water Withdrawn From This Withdrawal Point ( nn):

nn	nn	nn
JAN _____	FEB _____	MAR _____
APR _____	MAY _____	JUN _____
JUL _____	AUG _____	SEP _____
OCT _____	NOV _____	DEC _____

**Figure 3.--Standard water-use registration form for Arkansas site-specific data collection (continued).**



Conservation District offices have been provided topographic quadrangle maps and templates to determine latitude and longitude locations for each measurement point. Information for the industrial, commercial, and public supply water users is obtained separately from that for the agricultural and irrigation water users.

### Analysis of Data

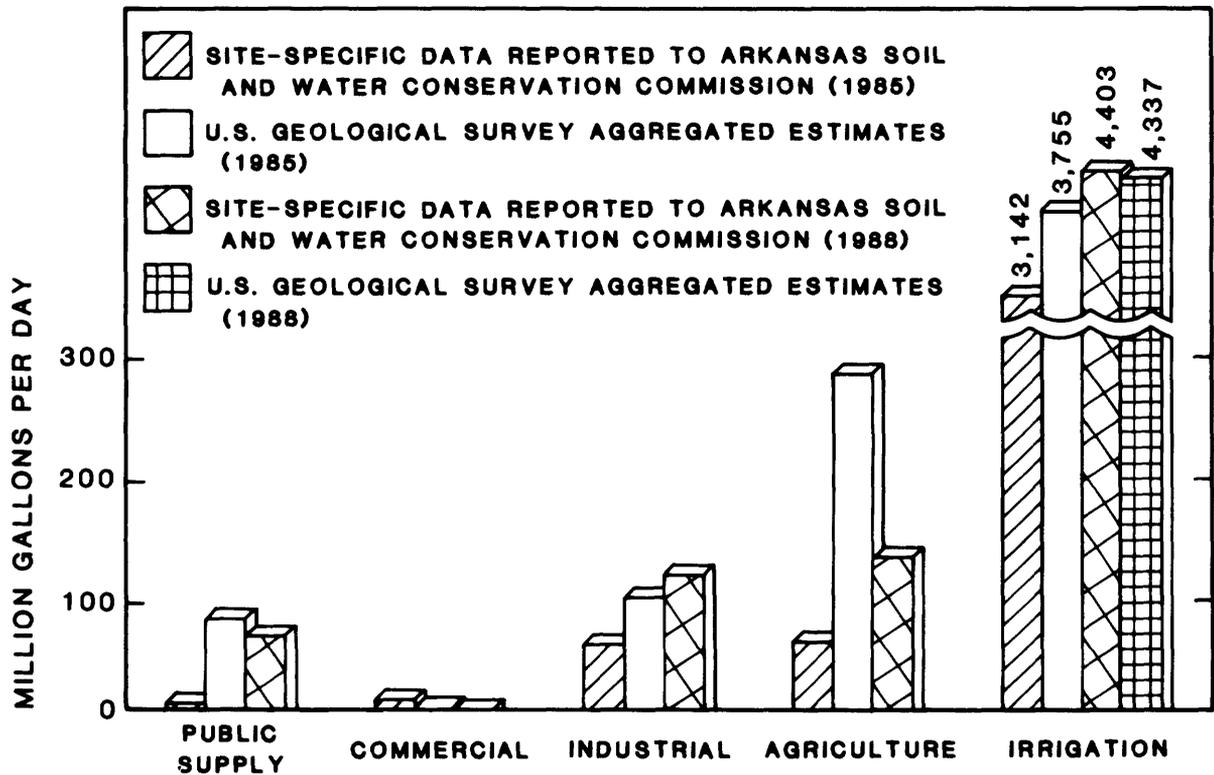
Because large-scale site-specific data collection has only been done in Arkansas since 1985, it is not surprising that the methods and procedures used to collect these data, and the completeness of the reported data, are still improving. Aggregated estimates of water use, on the other hand, have been compiled in Arkansas, using well established methods since 1960 (Stephens and Halberg, 1961). Although it is generally agreed that site-specific data will provide a more accurate and representative data base than aggregated data, it may be a few more years before the reported data are sufficiently complete to be useful for management purposes. Analysis of site-specific data, and comparisons between the site-specific and aggregated estimates, can be used to aid in evaluating the completeness and plausibility of the reported site-specific data. The following discussion is not intended to be an evaluation of the accuracy of either the aggregated or site-specific data, but rather to highlight where the two compare well and to identify aspects of the site-specific data collection, management, and storage process that may need emphasis or refinement.

The latest aggregated estimates of water withdrawals by county, for all categories of use, were made by the USGS for 1985 (Holland, 1987). However, aggregated estimates for irrigation water use were made annually by the USGS during 1985-88. These aggregated estimates can be used to evaluate the completeness of the site-specific data.

Site-specific data reported to the ASWCC and USGS aggregated estimates of water use by category for 1985 and 1988 are shown in figure 5. The lowest ratio of reported site-specific water use to aggregated water use for 1985 was for public supply. Only 5.5 Mgal/d were reported to the ASWCC, but public supply aggregated estimated withdrawals totaled 78 Mgal/d. One possible reason for the low reporting in 1985 is that initially Conservation District offices were asked to collect data for all categories of water use. Public supply, industrial, and commercial users generally did not visit Conservation District offices to report their water usage. The Conservation District personnel have established a rapport with agricultural and irrigation water users and these water users were more likely to visit the office to report water usage. Since 1987, reporting forms have been mailed directly to public supply, commercial, and industrial water users, resulting in much better reporting by public supply and industrial water users. In 1988, 63 Mgal/d were reported to the ASWCC for public supply and 115 Mgal/d were reported for industrial water use (fig. 5).

Although it appears that reported commercial water-use amounts for 1985 were complete (8.4 Mgal/d were reported to the ASWCC, while the USGS aggregated estimates were 2.5 Mgal/d), most of the reported water-use amounts were for aquaculture (fig. 5). The few aquaculture water-use sites that were reported in 1985 were initially categorized as commercial users. Aquaculture water use is now included in the agricultural water-use category. In 1988, only 0.3 Mgal/d were reported to the ASWCC for commercial water use. Because it is often difficult to obtain names and addresses of self-supplied commercial water users, many of those users probably do not receive reporting forms.

Agricultural water use, which includes withdrawals for livestock, poultry operations, and aquaculture, also had a low ratio of reported site-specific data to aggregated data for 1985.



**Figure 5.--Site-specific data reported to the Arkansas Soil and Water Conservation Commission and U.S. Geological Survey aggregated estimates of water use by category for eastern Arkansas, 1985 and 1988.**

Part of the reason for this is that many agricultural water users did not report their water usage. Because irrigation uses about 85 percent of the total amount of water withdrawn in eastern Arkansas, the majority of effort has been placed in obtaining water-use data for irrigation. More recently, efforts by Conservation District personnel to obtain agricultural water-use data has resulted in more complete reporting of agricultural water-use data. Agricultural water use reported to ASWCC for 1988 totaled 130 Mgal/d which was about half the USGS aggregated estimates for 1985 (287 Mgal/d) (fig. 5).

Trends in irrigation water use for 1985 to 1988 (fig. 6) show that irrigation water-use amounts reported to the ASWCC were somewhat less than USGS aggregated estimates for 1985 to 1987 but were nearly equal to aggregated estimates for 1988. The 1988 reported amount was 4,403 Mgal/d, and the estimated amount was 4,337 Mgal/d (fig. 5).

Although in eastern Arkansas the total irrigation water use reported to the ASWCC and the USGS aggregated estimates for irrigation were nearly equal for 1988, significant differences occur for some counties. The percentage difference between reported and aggregated estimates of irrigation water use by county shows how much the reported water use varies from the aggregated estimate for 1985 and 1988 (fig. 7). For example, in 1985, Arkansas County reported about 50 percent more water use than the aggregated estimate. Phillips and Crittenden Counties reported significantly less site-specific water use than the aggregated estimate for 1985. In Craighead, Cross, Lonoke, Mississippi, and Monroe Counties reported water use was in good agreement with the 1985 aggregated estimates possibly indicating complete or nearly complete reporting in those counties. Although reported 1988 water-use amounts for most counties were in reasonably good agreement with the aggregated estimates, Crittenden, Drew, Greene, and Independence Counties all reported more than 50 percent less water use than the USGS aggregated estimates. Five counties reported higher water usage than the aggregated estimate. In Arkansas County reported irrigation water usage was nearly twice as much as the USGS aggregated estimate for 1988 (fig. 7). Reported 1988 water withdrawals for eastern Arkansas counties are given in table 1.

Differences in acreages reported to the ASWCC and estimated acreages for the major irrigated crops account for most of the difference between reported water-use amounts and the USGS aggregated estimates. Those counties that reported significantly different acreages for rice, soybeans, and cotton than were estimated by the Arkansas Agricultural Statistics Service (hereafter referred to as the Statistics Service) are shown in figure 8 (Arkansas Agricultural Statistics Service, 1989). Estimated Statistics Service acreages are based on a sample of approximately 10 percent of irrigated acres. For counties with nearly complete reporting of site-specific data, reported acreages are probably more reliable than the estimated acreages. Comparisons between estimated and reported acreages can be used to identify those counties that may not have complete reporting of water withdrawals. Nearly every county reported lower rice acreages than were estimated by the Statistics Service. Arkansas and Lonoke Counties reported higher rice acreages than were estimated by the Statistics Service. Several counties reported much larger soybean and cotton acreages than were estimated by the Statistics Service. Reported crop acreages for rice, soybeans, and cotton can be found in tables 2 through 4, respectively.

Variation in water application rates for the major crops also accounts for differences between water-use amounts reported to the ASWCC and the USGS aggregated estimates. Reported minimum, average, and maximum water application rates by county for eastern Arkansas for 1988

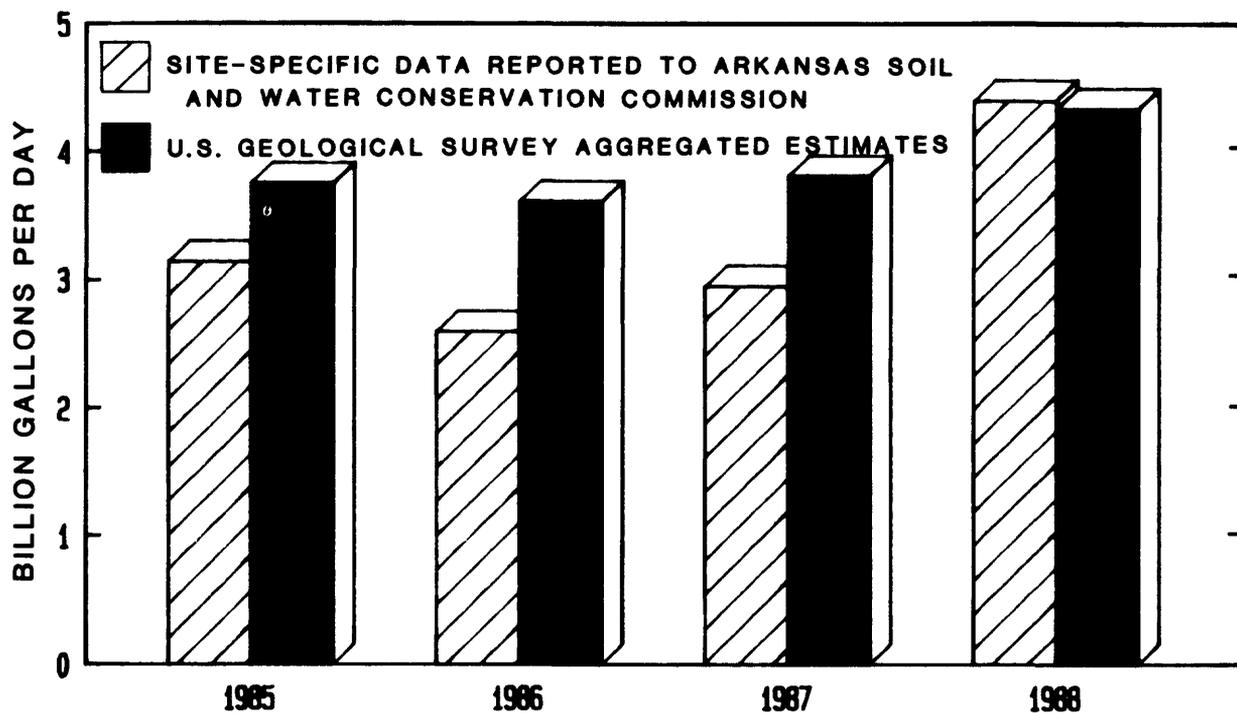


Figure 6.--Site-specific data reported to the Arkansas Soil and Water Conservation Commission and U.S. Geological Survey aggregated estimates of irrigation water use for counties in eastern Arkansas, 1985 to 1988.

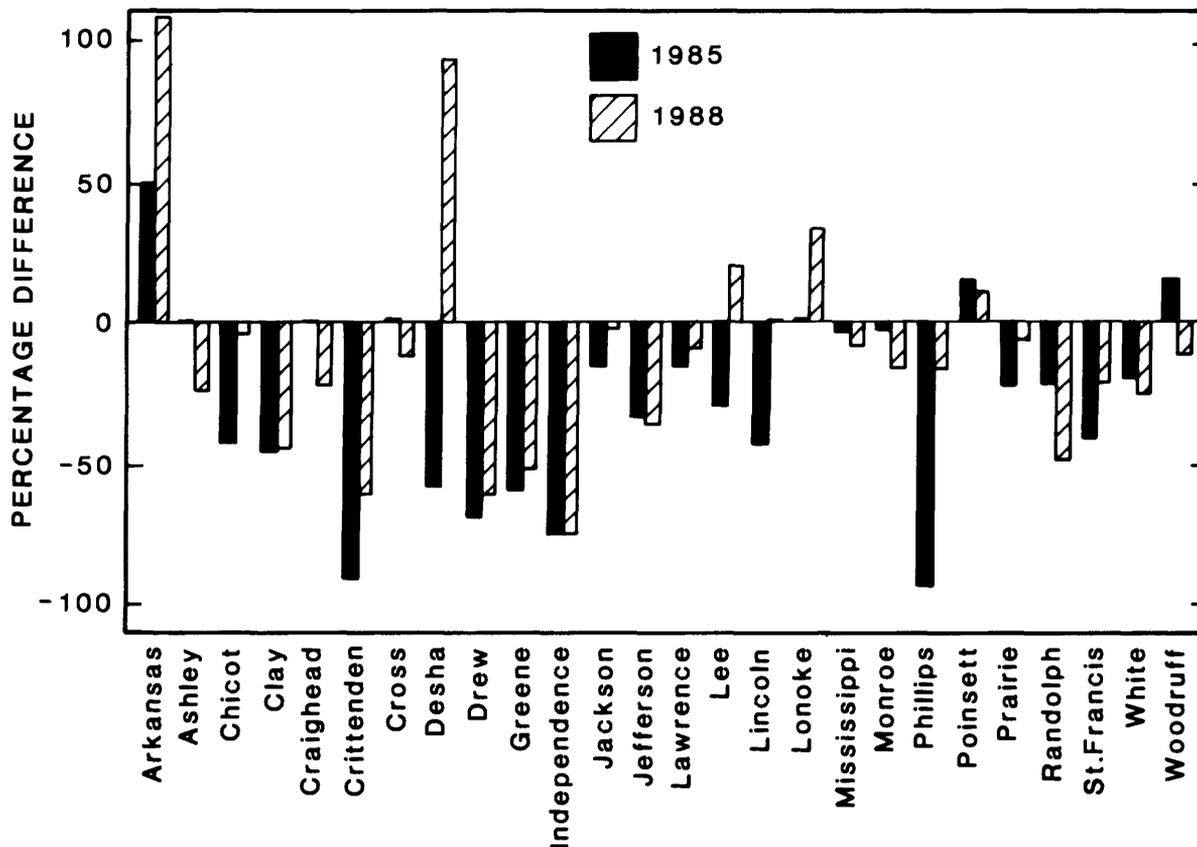


Figure 7.--Percentage difference between water use reported to the Arkansas Soil and Water Conservation Commission and U.S. Geological Survey aggregated estimates for irrigation for eastern Arkansas counties, 1985 and 1988. Percentage difference is based on estimated water use where: [Percentage Difference = (Reported - Estimated) / Estimated]

Table 1.--Water withdrawals reported to the Arkansas Soil and Water Conservation Commission for eastern Arkansas, 1988

[GW, ground water; SW, surface water; values are in million gallons per day; --, no withdrawal reported]

County	Public supply		Commercial		Industrial		Agriculture nonirrigated		Agriculture irrigated		County total
	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW	
Arkansas	3.94	--	--	--	7.20	38.10	0.52	2.03	477.74	291.56	775.79
Ashley	1.22	--	--	--	--	--	.50	--	66.48	7.97	121.47
Chicot	1.13	--	--	--	--	--	12.61	--	83.66	71.79	169.19
Clay	1.18	--	--	--	--	--	.12	--	103.13	4.10	108.53
Craighead	8.67	--	--	--	--	--	--	.89	163.88	16.08	189.52
Crittenden	1.20	--	--	.01	--	--	--	--	35.49	.96	37.66
Cross	1.61	--	--	--	--	--	.06	.08	229.85	13.43	245.03
Desha	3.02	--	--	1.43	11.32	3.14	2.30	251.88	79.88	352.97	
Drew	2.14	--	--	--	--	--	.39	--	20.18	3.97	26.68
Greene	.40	--	0.29	--	--	--	14.13	.09	67.98	.74	83.63
Independence	.88	--	--	--	--	19.96	--	--	5.80	.99	27.63
Jackson	1.36	--	--	--	--	--	1.66	.24	229.57	10.49	243.32
Jefferson	10.42	--	--	35.37	--	--	--	--	111.45	12.10	169.34
Lawrence	1.06	--	--	--	--	--	.09	--	157.26	8.95	167.36
Lee	1.62	--	--	--	--	--	.09	--	160.38	2.40	164.49
Lincoln	.78	--	--	--	--	--	3.45	.07	96.51	15.22	116.03
Lonoke	1.55	--	--	--	--	--	55.45	2.29	293.20	66.58	419.07
Mississippi	6.66	--	--	1.60	--	--	--	--	81.01	3.03	92.30
Monroe	1.57	--	--	--	--	--	2.66	.42	128.76	15.65	149.06
Phillips	1.62	--	--	--	--	--	.03	--	76.97	.46	79.08
Poinsett	1.35	--	--	--	--	--	3.52	1.95	351.49	20.45	378.76
Prairie	.29	--	--	--	--	--	20.37	--	149.17	42.55	212.38
Randolph	.13	--	--	--	--	--	--	--	22.90	6.24	29.27
St. Francis	2.74	--	--	--	--	--	--	--	103.18	10.56	116.47
White	.65	5.00	--	--	--	--	.05	--	47.64	21.06	74.40
Woodruff	.58	--	--	--	--	--	.75	--	142.68	17.51	161.52
Total	57.77	5.00	.29	--	45.61	69.38	119.59	10.36	3,658.24	744.71	4,710.95

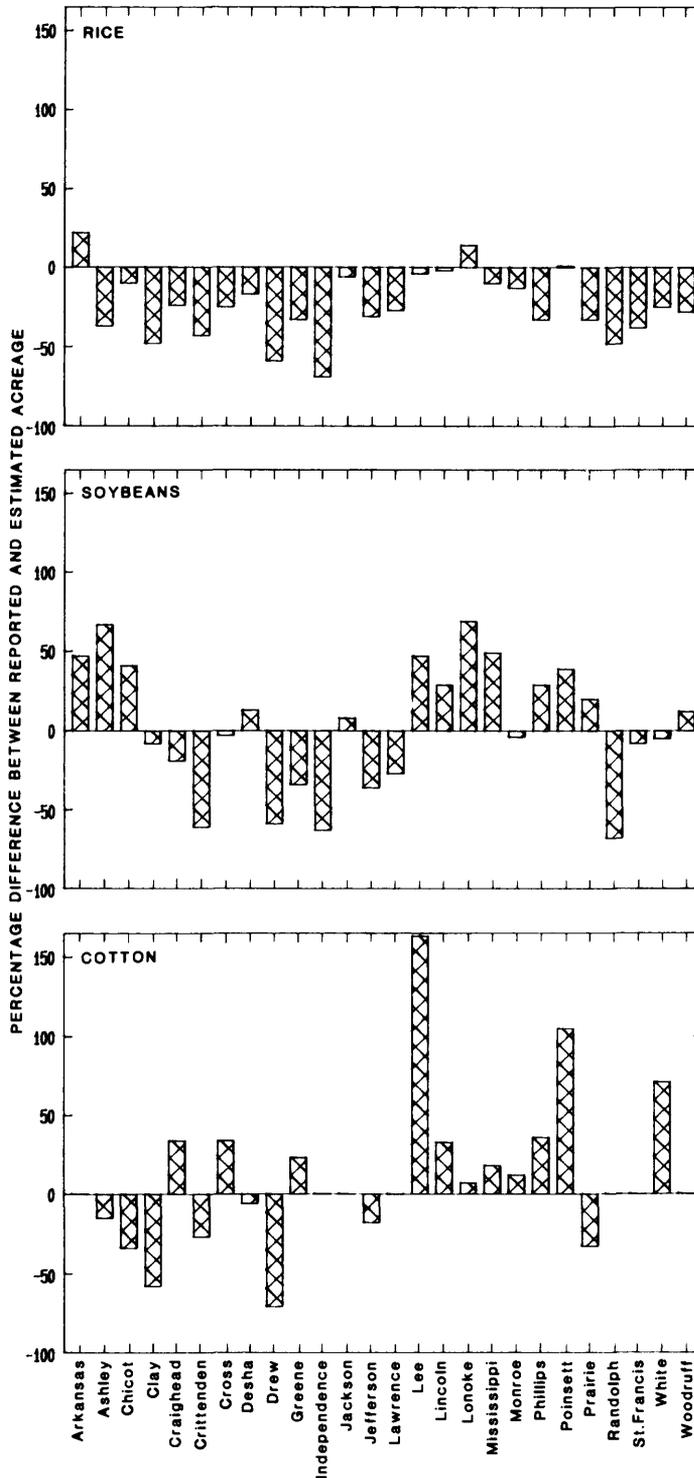


Figure 8.--Percentage difference between reported and estimated crop acreage for rice, soybeans, and cotton for counties in eastern Arkansas, 1988. Percentage difference is based on estimated acreage where:  $[\text{Percentage Difference} = (\text{Reported} - \text{Estimated}) / \text{Estimated}]$  (Estimated crop acreage from U.S. Department of Agriculture Statistical Reporting Service, 1989.)

Table 2.--Rice acreage and water application statistics for eastern Arkansas, 1988

[Application rates represent amount of water applied per acre of irrigated land, in feet]

County	Number of reports	Sum of acreage	Average acreage	Minimum acreage	Maximum acreage	Average application rate	Minimum application rate	Maximum application rate	Application rate variance
Arkansas	2,095	111,968	53	1	875	3.30	0.25	5.00	0.29
Ashley	155	12,916	83	7	180	2.88	.83	4.00	.27
Chicot	364	37,234	103	12	1,450	2.75	.07	4.50	.46
Clay	552	32,391	60	5	300	2.95	.50	5.35	.15
Craighead	956	50,939	53	5	240	2.89	.20	3.00	.11
Crittenden	118	12,015	103	1	225	3.14	.29	8.57	.98
Cross	845	57,077	68	1	250	3.50	.33	5.32	.13
Desha	437	32,223	74	10	712	4.59	.70	8.00	.88
Drew	75	6,477	86	10	257	2.98	1.50	3.00	.03
Greene	646	31,536	49	4	165	2.05	.90	3.00	.05
Independence	41	2,646	65	9	300	2.27	2.17	3.00	.07
Jackson	1,145	67,296	59	5	400	2.99	2.50	3.03	.00
Jefferson	388	34,134	88	9	350	2.44	.83	4.00	.08
Lawrence	739	42,785	58	5	220	3.76	.30	4.00	.38
Lee	664	34,467	52	2	190	3.31	3.00	4.00	.09
Lincoln	402	27,935	69	3	270	2.99	1.00	3.00	.01
Lonoke	1,457	81,748	56	3	800	2.92	.50	4.17	.15
Mississippi	169	14,911	88	0	230	2.95	.00	3.00	.16
Monroe	671	37,209	56	7	300	2.53	1.00	4.00	.04
Phillips	250	16,385	67	10	250	2.99	1.00	3.00	.02
Poinsett	1,363	99,760	73	4	809	3.00	.50	4.00	.01
Prairie	862	38,022	44	2	750	3.59	.67	6.00	.43
Randolph	145	9,175	63	6	230	2.94	2.00	3.75	.12
St. Francis	394	24,648	63	2	200	3.11	1.50	3.90	.01
White	752	21,415	28	3	250	2.61	.50	5.00	.11
Woodruff	648	35,895	55	2	320	3.71	2.00	6.00	.27
Total	16,333	973,204	66			3.04			

Table 3.--Soybean acreage and water application statistics for eastern Arkansas, 1988

[Application rates represent amount of water applied per acre of irrigated land, in feet]

County	Number of reports	Sum of acreage	Average acreage	Minimum acreage	Maximum acreage	Average application rate	Minimum application rate	Maximum application rate	Application rate variance
Arkansas	2,231	192,895	87	1	1,336	2.04	0.25	5.00	0.63
Ashley	120	10,001	84	7	809	.77	.20	2.00	.15
Chicot	283	32,556	115	5	1,800	1.05	.15	3.00	.38
Clay	313	17,506	57	2	280	.77	.14	3.00	.19
Craighead	679	39,708	58	4	320	.99	.30	3.00	.03
Crittenden	103	11,619	113	5	510	1.00	.00	3.00	.19
Cross	866	71,865	83	3	450	1.06	.05	4.00	.20
Desha	556	39,471	71	5	800	2.59	.17	7.00	.70
Drew	53	3,298	62	10	300	.79	.33	1.67	.10
Greene	225	9,880	44	2	160	.63	.20	1.50	.09
Independence	25	1,115	45	5	97	1.15	1.00	2.00	.03
Jackson	844	54,006	64	3	809	.98	.50	3.00	.18
Jefferson	278	21,689	78	7	350	1.11	.50	3.00	.09
Lawrence	297	17,411	59	2	250	1.02	.30	4.00	.41
Lee	660	44,162	67	3	500	1.38	.50	4.00	.17
Lincoln	391	28,457	73	6	400	.72	.30	3.00	.04
Lonoke	1,553	111,480	72	1	800	1.04	.25	3.50	.17
Mississippi	290	38,874	135	0	530	.79	.00	2.00	.08
Monroe	750	51,007	68	3	695	1.01	.67	2.50	.01
Phillips	237	20,706	98	10	540	1.00	1.00	1.10	.00
Poinsett	1,138	95,973	84	5	510	1.01	.05	3.00	.21
Prairie	907	62,190	69	3	705	.98	.18	3.50	.09
Randolph	36	2,524	70	10	150	1.31	.30	1.50	.14
St. Francis	372	30,193	81	4	500	1.51	1.00	3.12	.05
White	417	14,171	34	3	300	.63	.33	1.33	.05
Woodruff	699	49,457	71	3	700	.75	.16	3.00	.11
Total	14,323	1,072,214	75			1.08			

Table 4.--Cotton acreage and water application statistics for eastern Arkansas, 1988

[Application rates represent amount of water applied per acre of irrigated land, in feet]

County	Number of reports	Sum of acreage	Average acreage	Minimum acreage	Maximum acreage	Average application rate	Minimum application rate	Maximum application rate	Application rate variance
Arkansas	--	--	--	--	--	--	--	--	--
Ashley	351	33,827	96	12	809	1.12	0.40	3.00	0.15
Chicot	190	18,434	97	10	450	1.20	.15	5.25	.71
Clay	25	1,052	42	12	100	1.01	.40	2.00	.26
Craighead	132	8,036	61	4	215	1.00	1.00	1.00	.00
Crittenden	17	1,599	94	30	200	.75	.00	1.50	.24
Cross	8	668	83	31	160	.76	.05	1.50	.36
Desha	538	35,755	66	3	550	2.71	.54	5.77	.48
Drew	55	3,711	67	10	160	1.02	.33	2.00	.11
Greene	22	1,226	56	15	130	.77	.08	1.20	.12
Independence	--	--	--	--	--	--	--	--	--
Jackson	3	63	21	12	34	.42	.25	.50	.03
Jefferson	281	24,446	87	12	300	1.04	.40	2.50	.07
Lawrence	--	--	--	--	--	--	--	--	--
Lee	50	5,257	105	1	640	.93	.50	1.10	.06
Lincoln	300	19,955	67	7	440	.78	.40	3.00	.07
Lonoke	331	18,267	55	3	250	1.24	.33	3.00	.17
Mississippi	172	17,762	104	0	550	.66	.00	1.50	.07
Monroe	147	8,989	61	5	230	1.51	1.00	2.50	.03
Phillips	115	8,193	73	5	360	1.10	1.10	1.20	.00
Poinsett	112	8,185	73	6	365	.81	.17	3.00	.22
Prairie	6	536	89	8	170	.89	.33	1.33	.10
Randolph	--	--	--	--	--	--	--	--	--
St. Francis	15	877	58	25	125	1.30	1.17	3.12	.24
White	--	--	--	--	--	--	--	--	--
Woodruff	--	--	--	--	--	--	--	--	--
Total	2,870	216,838	69	--	--	1.00	--	--	--

are depicted graphically in figure 9. This figure shows those counties that reported a wide range of application rates and those counties which reported nearly the same application rate. The figure also shows the variation in average application rates among the counties. The largest average application rates for all crops were for Desha County (tables 2-4). Greene County reported the lowest average application rates for rice and soybeans. Phillips County had an extremely low variance in reported application rates for all crops indicating nearly everyone in the county reported the same application rate (tables 2-4). In Craighead County everyone reported a 1 ft application rate for cotton (there was no variance in reported rates) (table 4).

The geographic distribution of water withdrawals is just as important, if not more important, than the amount of water withdrawn. Many of the Conservation Districts are now increasing their efforts to obtain latitude and longitude locations for irrigation and agricultural water withdrawal points. It is critical for site-specific water-use data to have accurate locations associated with the data if it is to be of use in other hydrologic investigations. The U.S. Department of Agriculture, Soil Conservation Service has determined latitude and longitude for the majority of wells and reliefs in eastern Arkansas. A comparison of wells plotted from locations determined by the Soil Conservation Service and wells plotted from locations reported to the ASWCC show that some of the reported data do not contain locators (fig. 10). For example, Cross County's reported water withdrawals compared favorably with the USGS aggregated estimates (fig. 7), however, those withdrawal points do not have locators associated with them in the data base. The amount of water withdrawn in a given county can be derived from aggregated estimates, but it is virtually impossible to estimate the distribution of water use within the county without site-specific data.

## **ALTERNATE PROCEDURES**

Several changes in the collection of site-specific data might improve the data collection efficiency and quality of the data. Better training of data collection personnel, improved quality assurance, and different reporting methods are procedures which might be used in the future to improve site-specific data collection in Arkansas.

Training of Conservation District personnel in completion of reporting forms may improve the quality of irrigation and agricultural site-specific water-use data. Conservation District personnel have never had formal instruction in completing water-use reporting forms and probably would benefit from instruction on determining latitude and longitude, and hydrologic unit codes. Instruction on methods of calculating water use based on crop type and irrigated acreages might also be helpful.

Improved quality assurance at both the data entry and field level may also improve the quality of the site-specific data. Cross-checking latitudes and longitudes, hydrologic unit codes, and legal descriptions to ensure that they fall within the appropriate county boundaries could improve the quality of the reported data. Occasionally, irrigators and farmers report unrealistic water-use amounts. Field checking selected sites might help the water user to report more realistic water-use amounts.

Different reporting methods may improve the efficiency of data collection. Automating data collection for irrigation and agricultural data by having irrigators and farmers report water withdrawals directly to Conservation District personnel equipped with computers and the

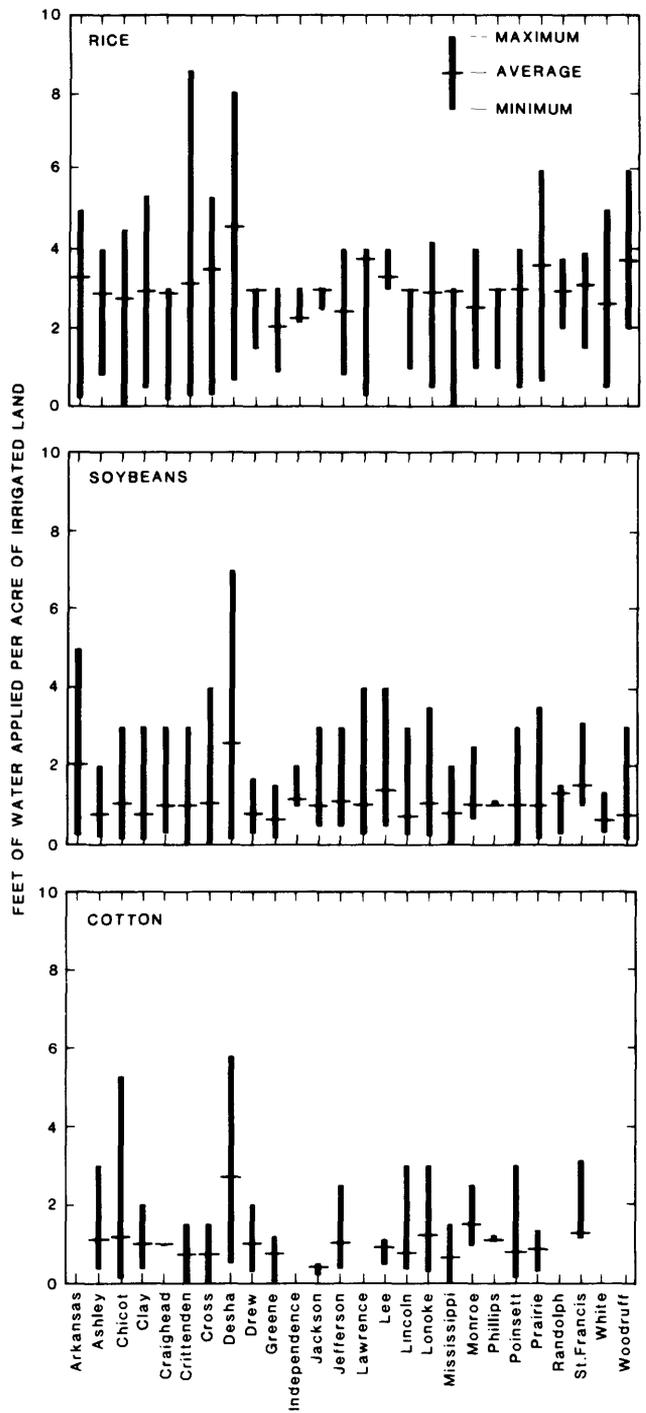
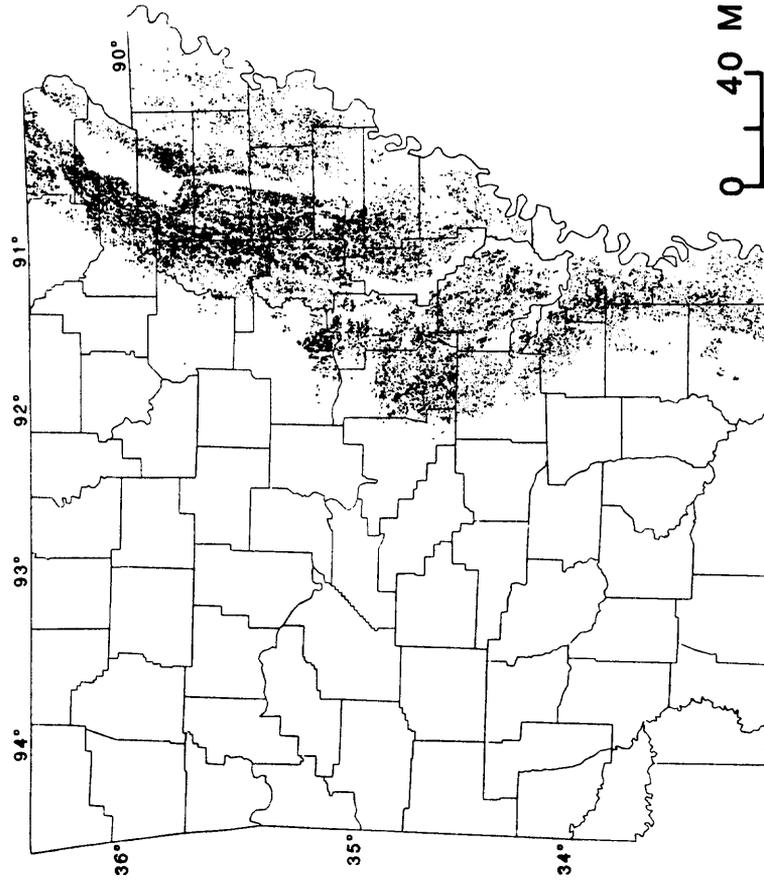
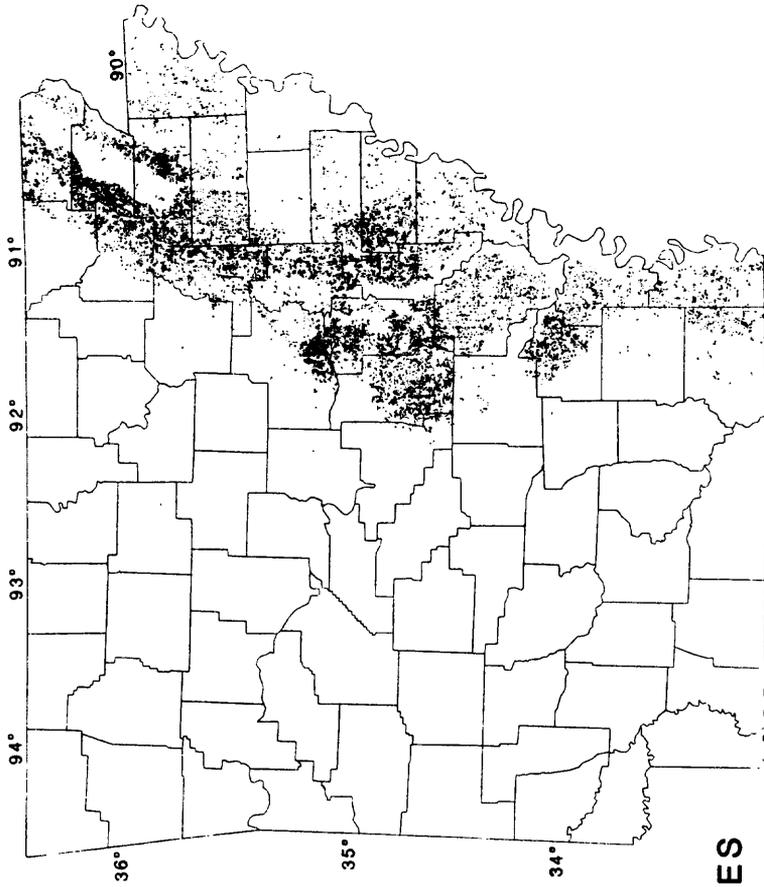


Figure 9.--Reported minimum, average, and maximum water application rates for rice, soybeans and cotton for counties in eastern Arkansas, 1988.



**LOCATION OF WELLS INVENTORIED  
BY SOIL CONSERVATION SERVICE**



**WELL LOCATIONS REPORTED TO THE  
ARKANSAS SOIL AND WATER  
CONSERVATION COMMISSION**

**Figure 10.--Location of wells inventoried by the Soil Conservation Service and well locations reported to the Arkansas Soil and Water Conservation Commission for eastern Arkansas, 1988.**

appropriate software may improve data collection efficiency. Conservation District personnel could enter the information, verbally reported by the water user, directly into the site-specific data base. This might eliminate the need for a paper copy of the reporting form, as well as eliminate several processing steps.

## SUMMARY AND CONCLUSIONS

Water-use data collection has been an integral part of water resources investigations in eastern Arkansas for many years. From 1960 to 1985, aggregated estimates of water use were collected and compiled by the USGS. Realizing that aggregated estimates were not sufficiently detailed to be useful in many hydrologic investigations, State legislators enacted legislation requiring the reporting of ground- and surface-water withdrawals. Since 1985, the ASWCC in cooperation with the USGS have been collecting site-specific water-use data.

Continued improvements in the collection and management of site-specific data in Arkansas will produce a more complete and reliable water-use data base. Although total water-use amounts reported to the ASWCC and USGS aggregated estimates for irrigation are in reasonably good agreement for 1988, significant differences occur for some counties. Water-use amounts reported to the ASWCC for Crittenden, Drew, Greene, and Independence Counties were more than 50 percent less than the USGS aggregated estimates, possibly indicating incomplete reporting in those counties. Several counties reported water-use amounts greater than the aggregated estimates. Most of the variation between water-use amounts reported to the ASWCC and USGS aggregated estimates is due to differences in reported and Arkansas Agricultural Statistics Service estimated crop acreages. With complete reporting of water withdrawal points, reported acreages are likely to be more accurate than the estimated acreages. Many irrigators may not know how much water was applied to a particular crop; however, most irrigators know how many acres of a particular crop were planted in a given year. Improvements in the collection and management of water-use data, along with implementation of quality-control measures, could result in a high quality site-specific water-use data base for Arkansas.

High quality site-specific data provide an accurate and representative estimate of water use. Site-specific data are needed to help managers to evaluate current water demands and trends in water use. It is important to be able to define existing water supplies and present rates of depletion (or recharge) so that water managers can predict the availability of the water resources for the future. Site-specific data can be used to determine where water is withdrawn and how much water is withdrawn. This information is essential for many hydrologic models used to evaluate the response of the hydrologic environment to stresses (such as water withdrawals) placed on it. Site-specific data also can be used to establish a dynamic "baseline" for water allocation purposes. High quality site-specific water-use data also could eliminate some of the uncertainties associated with the current methods of estimating aggregated water use using statistical sampling or regional calculations.

## SELECTED REFERENCES

- Arkansas Agricultural Statistics Service, 1989, Arkansas agricultural statistics 1988: University of Arkansas Report Series 312, 56 p.
- Baker, N.T., Cole, E.F., and Holland, T.W., 1990, Arkansas water supply and use in National water summary 1987--Hydrologic events and water supply and use: U.S. Geological Survey Water-Supply Paper 2350, p. 165-172.
- Freiwald, D.A., 1985, Average annual precipitation and runoff for Arkansas, 1951-80: U.S. Geological Survey Water-Resources Investigations Report 84-4363, 1 sheet.
- Halberg, H.N., 1972, Use of water in Arkansas, 1970: Arkansas Geological Commission Water Resources Summary 7, 15 p.
- 1977, Use of water in Arkansas, 1975: Arkansas Geological Commission Water Resources Summary 9, 28 p.
- Halberg, H.N., and Stephens, J.W., 1966, Use of water in Arkansas, 1965: Arkansas Geological Commission Water Resources Summary 5, 12 p.
- Holland, T.W., 1987, Use of water in Arkansas, 1985: Arkansas Geological Commission Water Resources Summary 16, 27 p.
- Holland, T.W., and Ludwig, A.H., 1981, Use of water in Arkansas 1980: Arkansas Geological Commission Water Resources Summary 14, 30 p.
- Mathey, S.B., compiler, 1990, National water information system user's manual volume 2, chapter 5. Water-use data system: U.S. Geological Survey Open-File Report 90-198, 438 p.
- Stephens, J.W., and Halberg, H.N., 1961, Use of water in Arkansas, 1960: Arkansas Geological and Conservation Commission Special Ground-Water Report 4, 8 p.