DATA-COLLECTION METHODS USED IN THE DEMONSTRATION EROSION CONTROL PROJECT IN THE YAZOO RIVER BASIN, NORTH-CENTRAL MISSISSIPPI, JULY 1985 - SEPTEMBER 1997

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CONTENTS

ILLUSTRATION

TABLE

DATA-COLLECTION METHODS USED IN THE DEMONSTRATION EROSION CONTROL PROJECT IN THE YAZOO RIVER BASIN, NORTH-CENTRAL MISSISSIPPI, JULY 1985 - SEPTEMBER 1997

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ABSTRACT

In July 1985 the U.S. Geological Survey began collecting data for the Demonstration Erosion Control project in north-central Mississippi. The project is part of an ongoing multi-agency program for the planning, construction, and evaluation of structures to alleviate erosion, sedimentation, and flooding in the Bluff Hills of the upper Yazoo River Basin. Initially, stream discharge, sediment concentrations, and several water-quality constituents were determined at selected sites in the Demonstration Erosion Control study area. Data have been collected by U.S. Geological Survey personnel, station observers, and automatic samplers.

Data collection began with mercury manometers as stage sensors and recorded data with punch tapes and paper chart recorders. Early efforts to continually monitor water quality by using U.S. Geological Survey flow-through and mini-monitors were discontinued, and a bi-weekly water-quality sampling program was begun. Water-quality data were collected through December 1995 at eight stations and from October 1996 to September 1997 at two stations.

Currently, the U.S. Geological Survey involvement in the project includes the operation of 14 continuous-discharge stations: continuous-sediment data were collected at eight of the 14 stations and continuous-sediment and discrete water-quality data were collected at two of the 14 stations. Gage-height data were collected at the 14 stations by using data-collection platforms which transmit data via satellite to the U.S. Geological Survey. The data-collection platforms also control the programs for the automated samplers and transmit battery voltage, sample count, and rainfall information.

INTRODUCTION

In 1984, Congress directed the U.S. Army Corps of Engineers (USACOE) and the Soil Conservation Service, now known as the Natural Resource Conservation Service (NRCS), to establish demonstration watersheds for the purpose of studying erosion and sedimentation in agricultural watersheds. One of the selected studies, the Demonstration Erosion Control (DEC) project, is located in the upper Yazoo River Basin in north-central Mississippi. The project is an ongoing, multi-agency effort for the planning, construction, and evaluation of projects to alleviate erosion, sedimentation, and flooding problems in the Bluff Hills that border the Mississippi River alluvial plain.

In 1985 the U.S. Geological Survey (USGS) started collecting sediment and water-quality data for the Yazoo River Basin DEC project. These data are collected to monitor the effects of remediation and stabilization projects in the upper Yazoo River Basin and have been published annually since 1989 by the USGS in the report, "Water Resources Data for Mississippi." The data are also available in the USGS Water Data Storage and Retrieval System (WATSTORE).

The purpose of this report is to give an overview of the data-collection methods of the USGS for the DEC project during the period July 1985 through September 1997.

DESCRIPTION OF STUDY AREA

The DEC project study area is located in the upper Yazoo River Basin in north-central Mississippi (fig. 1). Currently the study area consists of eight sub-basins within the Yazoo River Basin, having drainage areas ranging from 35.1 to 305 square miles (table 1). This geographical region consists primarily of agricultural and forested lands. Problems with flooding, stream erosion, and soil loss from agricultural lands are common to the region. Extensive channel-restoration projects, flood-control ponds, and field-level sediment- and discharge-control structures are present in the study area. Possibly, these have affected the hydrology as well as the sediment-runoff characteristics of the region (Rebich, 1993, 1995; Runner and Rebich, 1997).

The original locations selected for data collection included 10 stations in 6 drainage basins. These stations were constructed, equipped, and brought into operation in a three-phase schedule from July 1985 to March 1987. During the first phase, gages were constructed on Batupan Bogue at Grenada, Town Creek at Water Valley, and Otoucalofa Creek at Water Valley. The gages on Batupan Bogue and Otoucalofa Creek were constructed to collect continuous discharge, sediment and water-quality data, whereas the gage on Town Creek was constructed to collect discharge only. In the second phase, four additional gages were constructed; Hickahala Creek near Senatobia, Senatobia Creek near Senatobia, Hotopha Creek near Batesville, and Peters (Long) Creek near Pope. These gages were established as discharge, sediment, and water-quality gages. In the third phase, continuous data-collection sites were established on Fannegusha Creek near Howard, Harland Creek near Howard, and Black Creek at Lexington. In 1987, sediment data collection was discontinued at Senatobia and Fannegusha Creeks.

In 1988, 11 partial-record sites were established within the Hickahala Creek, Otoucalofa Creek, and Black Creek Basins as part of a program to monitor discharge, sediment, and water-quality data spatially within the basins. These sites were not outfitted with stage recording or sampling equipment and have been sampled only during selected storms.

In 1991, data collection began in the Abiaca Creek Basin with the establishment of two continuous and four-partial record stations. The two continuous-record stations were

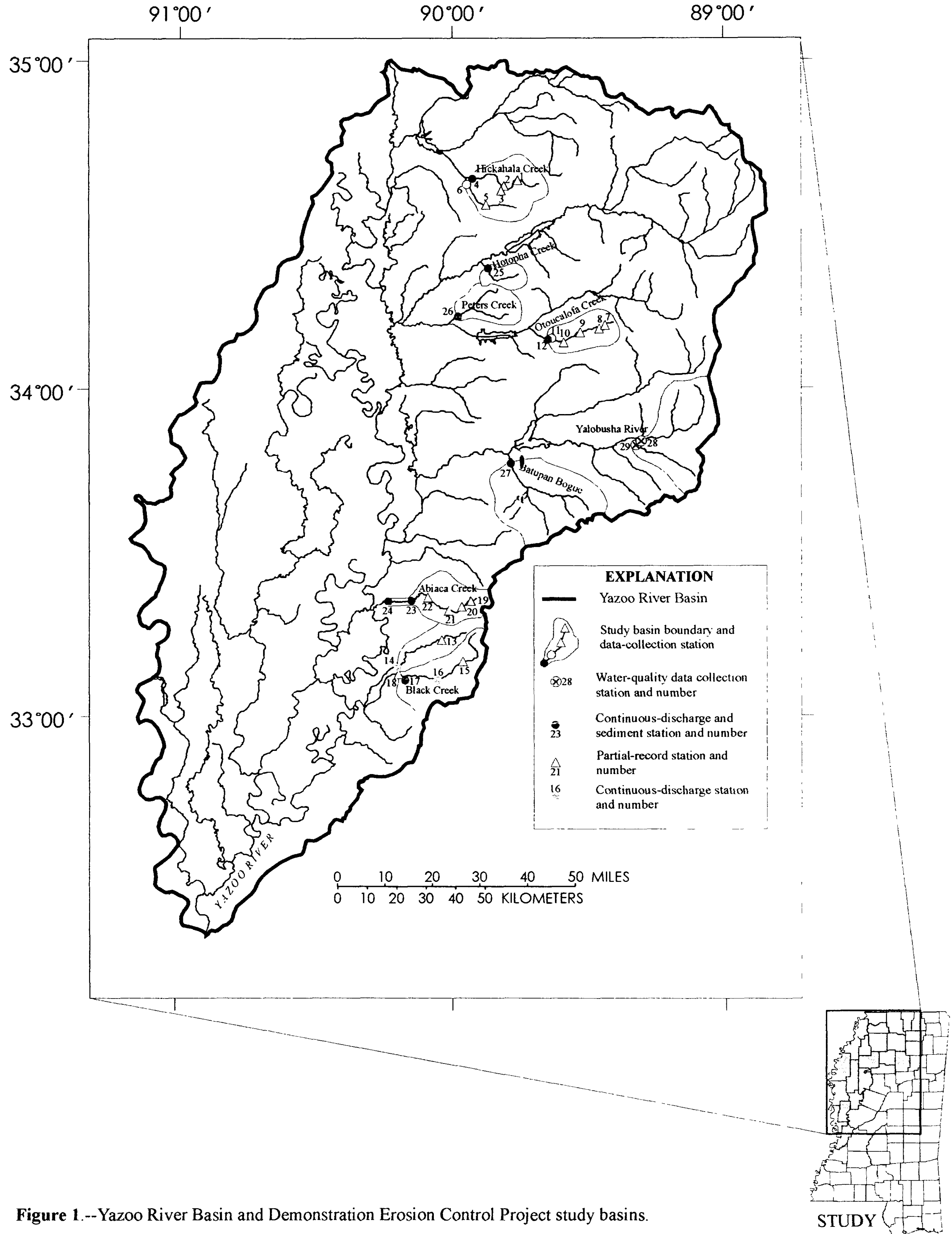

Figure 1.--Yazoo River Basin and Demonstration Erosion Control Project study basins.

Table 1. Data-collection sites of the U.S. Geological Survey for the Yazoo River Basin Demonstration Erosion Control Project, 1985-97
[D.A., drainage area; mi^2, square miles]

Drainage basin	Data-collection site (map ID no., fig. 1)	D.A. mi^2	Period of record	Equipment	Data collected
Hickahala Creek	Hickahala Cr. nr Independence (1)	25.3	Feb. 1988 - Sept. 1997	None	Storm data
Hickahala Creek	Hickahala Cr. nr Looxahoma (2)	44.6	Feb. 1988 - Sept. 1997	None	Storm data
Hickahala Creek	James Wolf Cr. nr Looxahoma (3)	35.2	Feb. 1988 - Sept. 1997	None	Storm data
Hickahala Creek	Hickahala Cr. nr Senatobia (4)	121	Jan. 1986 - Sept. 1997	Stage, sediment	Continuous data
Hickahala Creek	Senatobia Cr. nr Como (5)	20.4	Feb. 1988 - Sept. 1997	None	Storm data
Hickahala Creek	Senatobia Cr. nr Senatobia (6)	82.0	Feb. 1986 - Sept. 1997	Stage only	Continuous data
Otoucalofa Creek	Otoucalofa Cr. nr Paris (7)	8.28	Feb. 1988 - Sept. 1997	None	Storm data
Otoucalofa Creek	Otoucalofa Cr. at Paris (8)	21.0	Feb. 1988 - Sept. 1997	None	Storm data
Otoucalofa Creek	Otoucalofa Cr. E. of Water Valley (9)	46.5	Feb. 1988 - Sept. 1997	None	Storm data
Otoucalofa Creek	Otoucalofa Cr. E-SE of Water Valley (10)	74.0	Feb. 1988 - Sept. 1997	None	Storm data
Otoucalofa Creek	Town Cr. at Water Valley (11)	2.25	Dec. 1984 - Sept. 1997	Stage only	Continuous data
Otoucalofa Creek	Otoucalofa Cr. nr.Water Valley (12)	97.1	June 1985 - Sept. 1997	Stage, sediment	Continuous data
Black Creek	Fannegusha Cr. nr Ituma (13)	39.8	Feb. 1988 - Sept. 1997	None	Storm data
Black Creek	Fannegusha Cr. nr Howard (14)	107	Mar. 1987 - Sept. 1997	Stage only	Continuous data
Black Creek	Black Cr. at Bowling Green (15)	28.2	Feb. 1988 - Sept. 1997	None	Storm data
Black Creek	Black Cr. at Lexington (16)	88.1	Feb 1987 - Sept. 1997	Stage only	Continuous data
Black Creek	Harland Cr. Nr Howard (17)	62.1	Nov. 1986 - Sept. 1997	Stage, sediment	Continuous data
Black Creek	Black Cr. At Howard (18)	178	Feb 1988 - Sept. 1997	None	Storm data
Abiaca Creek	Abiaca Cr. nr Coila (19)	5.64	Oct. 1991 - Sept. 1997	None	Storm data
Abiaca Creek	Abiaca Cr. nr Black Hawk (20)	10.7	Oct. 1991 - Sept. 1997	None	Storm data
Abiaca Creek	Abiaca Cr. at Black Hawk (21)	28.3	Oct. 1991 - Sept. 1997	None	Storm data
Abiaca Creek	Coila Cr. at Seven Pines (22)	39.8	Oct. 1991 - Sept. 1997	None	Storm data
Abiaca Creek	Abiaca Cr. nr Seven Pines (23)	97.2	Oct. 1991 - Sept. 1997	Stage, sediment	Continuous data
Abiaca Creek	Abiaca Cr. at Cruger (24)	97.7	Oct. 1991 - Sept. 1997	Stage, sediment	Continuous data
Hotopha Creek	Hotopha Cr. nr Batesviiie (25)	35.1	March 1986 - Sept. 1997	Stage, sediment	Continuous data
Peters Creek	Peters (Long) Cr. nr Pope (26)	79.2	Dec. 1986 - Sept. 1997	Stage, sediment	Continuous data
Batupan Bogue	Batupan Bogue at Grenada (27)	254	June 1985 - Sept. 1997	Stage, sediment	Continuous data
Yalobusha River	Yalobusha R. nr Calhoun City (28)	305	Oct 1996 - Sept. 1997	Stage, sediment	Continuous data
Yalobusha River	Topashaw Cr. nr Calhoun City (29)	*	Oct 1996 - Sept. 1997	Stage, sediment	Continuous data

* Drainage area combined with Yalobusha River for data compilation and statistical analyses.

established to collect continuous discharge, continuous sediment, and discrete water-quality data, The partial-record sites were established to collect discharge-, sediment-, and water-quality data during storms and low-flow periods.

In October 1996, the Yalobusha River near Calhoun City and Topashaw Creek near Calhoun City were added to the DEC project data-collection network. These stations were added as continuous discharge, continuous sediment, and discrete water-quality sites.

Currently, discharge-, sediment-, and water-quality data are being collected at 14 continuous-record stations and at 15 partial-record stations in 8 drainage basins. The total drainage area upstream of the USGS sampling sites is 1,360 square miles. Of this area, 1,050 square miles is upstream of continuous sediment stations.

DATA COLLECTION

The collection and compilation of data for the purpose of computing continuous-discharge record was done in accordance with USGS technical standards as described in the applicable USGS technical publications (Rantz and others, 1982). Sediment samples were collected by three methods: sampling by USGS personnel, sampling by gage observers (local residents under contract with the USGS), and sampling by PS-69 automatic samplers. Water-quality samples and data were collected by USGS personnel during scheduled field trips and storms. All sediment and water-quality samples and data were collected in accordance with USGS standard sampling procedures (Guy and Norman, 1970; Wilde and others, 1998).

Sampling Equipment

Owing to technological advances, the equipment used by the USGS for data collection has changed considerably since the start of the data-collection activities. The original stage recorders were analog punch tapes and paper-chart recorders driven by mercury manometers, with the exception of Town Creek at Water Valley where the equipment was a stilling well, float, and analog encoder system. The original automatic sediment samplers were PS-69 samplers obtained from the Federal Interagency Sedimentation Project (FISP) and were operated to collect samples during storms. The PS-69 samplers were activated by the manometers when the stream reached a predetermined stage, and the sampling interval was controlled by timers on the samplers and by stage-change indicators on the manometers. The distance from the water surface to the sampler determined the pump required for the samplers. The samplers have a capacity of 72 samples which allows several storms to occur without requiring maintenance and servicing of the samplers. In addition to stage recording and sediment sampling, an attempt to record continuous water-quality data was made using USGS flow-through monitors and mini-monitors.

The manometers and paper tapes have been replaced by electronic data-collection platforms (DCP's). The DCP's record stage, precipitation, and battery voltage information and transmit the data via satellite to the USGS. The DCP's are also programmed to control the PS-69 samplers and to record the number and time of the sediment samples taken. The sample number is also transmitted via satellite to the USGS. The PS-69 is currently used on the DEC project because of the durability of this equipment along with its ability to collect a large number of samples between servicing visits, which make it ideal for the field conditions present in the study area.

USGS flow-through water-quality monitors and mini-monitors were used for approximately 1 year. Problems were encountered with the flow-through monitors due to the high sediment concentration of the water which damaged the pumping mechanism. Sediment was also a problem for the mini-monitors as the high sediment loads in the streams clogged the sensors. In 1987 the water-quality monitors were removed, and a bi-weekly water-quality sampling program was begun.

The stage-recording and sampling equipment is housed in pre-cast fiberglass or aluminum shelters located on the stream bank where possible, or on the downstream side of a bridge. Data recorders are powered by 12-volt batteries. The PS-69 automatic samplers require 36 volts DC and are powered by AC power via an inverter where possible, or by three 12-volt batteries in series where AC power is not accessible.

The equipment used for manual sediment sampling is available through the FISP in Vicksburg, Miss. Depending upon stream conditions, one of several depth-integrated sediment samplers is used to collect suspended-sediment samples (Guy and Norman, 1970). Low-flow conditions generally allow for wading of the stream for measurement and sampling purposes. Under these conditions samples are taken with a DH-48 depth-integrating, suspended-sediment sampler attached to a hand-held rod. When stream depth or velocity prohibits the wading of a stream, a DH-59 suspended-sediment sampler, lowered by hand from a bridge, or a D-74 sampler on a truck-mounted power boom is used. For depths greater than 15 feet, a P-61 point sampler is used. Station observers collect samples using the DH-48 hand sampler, the DH-59 rope sampler, or a D-74 sampler mounted to the bridge.

Due to the deteriorated condition of the bridge at Harland Creek near Howard, no high-flow measurements or truck-mounted sampling is possible using the standard truck-mounted rig equipment. For this site, a bank-mounted cableway system was installed to allow field personnel to make high-flow measurements and to collect samples.

Bed-material samples were taken using one of three samplers supplied by the FISP. At low water, when wading was possible, a BMH-53 piston-type bed-material sampler was used. When the water was too deep or velocity too high to wade, either a BMH-60 hand-line, or a BM-54 bed-material sampler mounted on a power rig was used.

Water-quality samples for laboratory analysis were taken by USGS personnel using the grab-sample method. Field measurements are obtained using Hydrolab water-quality monitors, which measure and record temperature, pH, dissolved oxygen, specific conductance, and turbidity.

Suspended- and bed-material sediment samples are analyzed at USGS sediment laboratories located in Baton Rouge, La., Tuscaloosa, Ala., or Rolla, Mo. Water-quality samples are analyzed at USGS labs in Denver, Colo., and Ocala, Fla.

Sampling Program

The DEC project sampling program is divided into two parts, sediment sampling and water-quality sampling. Sediment samples are collected by one of three methods: USGS sampling, gage-observer sampling, and PS-69 automatic samplers. USGS personnel visit each site at regular intervals to take sediment samples and perform general gage maintenance. Samples are also taken during storms to measure sediment concentrations during high flow. The automatic samplers are manually activated at the time of a USGS storm sample to calibrate the automatic samplers. USGS personnel use either the equal-width or equal-discharge increment sampling methods to obtain a sampling of the stream cross section. USGS personnel also collect a two-bottle, single vertical sample that replicates an observer sample. These additional samples are collected to establish correction coefficients for the observer samples.

Station observers are employed to collect sediment samples, note stage, and measure water temperature three times each week. The observers collect single-vertical, depth-integrated samples at a predetermined location in the cross section. Coefficients are applied to concentrations from single-vertical and point samples to adjust them to the average concentration for the stream cross section. On well-mixed streams, the point and single-vertical samples are generally representative of the entire cross section, and the coefficient nears 1.0 (Vanoni, 1977). The observers also collect samples at high stages to assist in the calibration of the automatic samplers.

The automatic samplers are stage-activated with sampling programs dependent on the current stream activities. After the sampler is activated, it samples as long as the cutoff stage is exceeded. The sample interval is dependent on the rate of change of the stage. All samples collected are analyzed for total sediment concentration. Selected samples, usually those from high stages, are analyzed for sand/silt percentages and, occasionally, a total particle-size analysis. Analysis of PS-69 samples for sand/silt concentrations helps determine if intake placement for the sampler is appropriate in relation to the streambed. Periodic bed-material analyses for grain size are performed on samples from the continuous sediment sites.

The current sediment-sampling program consists of 10 continuous data-collection sites in 8 drainage basins. At each site, samples are collected by USGS personnel, station observers, and automatic samplers. USGS personnel visit each site on a 3-week interval for sampling and gage maintenance and measure flow at least once every 6 weeks. Sites with active stream work in the reach near the gage are measured more often to assist in the discharge analysis of the site. A more active storm sampling and measurement program has been established to better determine high-flow characteristics for the streams.

The water-quality sampling program started with the installation of USGS flow-through and mini-monitors. Continuing problems prompted their removal after 1 year. At that time, a bi-weekly water-quality sampling program was implemented. As part of the program, four field measurements (temperature, pH, dissolved oxygen, and specific conductance) were taken, along with water samples to be shipped for analysis. Lab analyses for nitrogen, phosphorus, and total organic carbon were done. A special sampling program was established in 1987 for pesticides and bed-material quality. The annual sampling program for pesticides and herbicides was implemented to provide data to determine seasonally typical runoff from the largely agricultural drainage basins. Bed-material samples from each of the 10 water-quality sampling sites were analyzed on a semi-annual basis for trace elements, once during high-flow periods and once during low-flow periods.

In 1988, as part of the water-quality sampling program, intensive 48-hour studies were started in three of the six drainage basins. During these studies, the gage sites and the partial-record sites in a basin were sampled on regular intervals over the duration of a storm event. Sediment and water-quality samples were collected at low flow before an anticipated storm, and sampling continued on a regular interval until after the storm had passed. The objective of these studies was to characterize the sediment and water-quality constituents before, during, and after a storm event, as well as spatially within the basin. The sampling usually spanned a 2-day period but was extended when required. Samples were collected for analysis of constituents similar to the routine sampling program, as well as coliform and fecal streptococci bacteria. The water-quality sampling program was temporarily discontinued in December 1995 and was reestablished, in a reduced form, in October 1996. Currently, two stations are sampled at 3-week intervals, similar to the previous sampling program, and data on four field parameters are collected at the two sites.

Since July 1985, the U.S. Geological Survey has collected more than 74,000 sediment samples as part of the DEC project. Of these samples, approximately 6,400 have been analyzed for sand and silt percentages, with 40 total particle-size analyses having been done. Seventy-four bed-material samples have been taken at the sediment sites and have been analyzed for particle-size distribution. More than 1,500 discharge measurements have been made to develop stage-discharge ratings for the sites, track shifts in the ratings, and to compute the sediment loading rates. More than 6,000 water-quality samples have been collected at the DEC sites. Fifty-six intensive studies have been done, 28 during storms and 28 at low flows. Results from the analysis of the sediment and water-quality samples are used to monitor the effects of sediment, erosion, and flood-control measures implemented in the region. Data have shown the possible existence of downward trends in sediment yield from some of the basins (Rebich, 1993; Rebich, 1995; Runner and Rebich, 1997). A yearly compilation of the sediment, discharge, and water-quality data collected on all the DEC sites is published in the USGS annual data report for Mississippi

APPLICATIONS FOR DATA

The results from the USGS sediment and water-quality sampling program have been used by the public- and academic-sector researchers for various projects. The sediment and water-quality data are being used to evaluate the effects of completed and ongoing remediation in the upper Yazoo River Basin. Sediment data from several of the continuous sediment sites have been analyzed to determine if any trends exist in the overall sediment yield from the drainage basins. Decreasing trends in sediment loading have been determined for Hotopha Creek near Batesville and Otoucalofa Creek near Water Valley (Rebich, 1995). Another study showed possible decreasing trends for Hickahala Creek near Senatobia and Peters Creeks near Pope (Runner and Rebich, 1997).

Discharge data from the DEC sites are also used in conjunction with the USGS stream-gage network for the development of regional flood-frequency equations for Mississippi, as well as flood, stage-duration, and low-flow studies specific to the Bluff Hills region.

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