Estimation of Sediment-Discharge Reduction for Two Sites of the Yazoo River Basin Demonstration Erosion Control Project, North-Central Mississippi, 1985-94

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ABSTRACT

Sediment-discharge reduction was estimated at two Demonstration Erosion Control sites in north-central Mississippi for the period 1985 through 1994. Decreasing trends were detected in flow-adjusted sediment discharge at Hotopha Creek near Batesville for the study period. The annual reduction in sediment discharge at this site was about 7 percent (0.68 ton per day per year). Decreasing trends were also detected in flow-adjusted sediment discharge at Otoucalofa Creek Canal near Water Valley for the study period. The annual reduction in sediment discharge at this site was about 11 percent (5.33 tons per day per year). The computations used to estimate sediment-discharge reduction were based on time series of instantaneous sediment discharges for the study period. Non-parametric procedures were used to compute trends in sediment discharge and to quantify reductions over time at the two sites. Parametric procedures were then used to verify the non-parametric results.

INTRODUCTION

In 1984, Congress directed the U.S. Army Corps of Engineers and the U.S. Department of Agriculture, Natural Resources Conservation Service (formerly the Soil Conservation Service), to establish demonstration watersheds to address critical erosion and sedimentation problems. The Demonstration Erosion Control (DEC) Project is in the Yazoo River Basin in north-central Mississippi. The project is part of an ongoing joint-agency program of planning, design, construction, monitoring, and evaluation to alleviate flooding, erosion, sedimentation, and water-quality problems by applying environmentally sound management practices in several watersheds located in the bluff hills above the Mississippi River alluvial plain.

In July 1985, at the request of the Interagency Task Force on Yazoo Basin Foothills Erosion and Flood Control, and in cooperation with the Corps of Engineers, the U.S. Geological Survey (USGS) began collecting sediment data for the Yazoo River Basin DEC project. These data will be used by the task force to evaluate the effectiveness of management practices established in the DEC watersheds. Data were to be collected prior to, during, and after watershed-conservation and channel-stability measures were implemented.

In a report by Rebich (1993), preliminary trend analyses were conducted to detect changes over time in daily mean values of stream discharge, suspended-sediment concentration, and sediment discharge for each DEC project site for the period July 1985 through September 1991. In addition, slope estimates indicating general direction of the trend were computed. According to the 1993 report, upward trends for the study period were detected in stream discharge at the DEC sites, which is consistent with rainfall conditions in the study area. Statistically significant downward trends were detected in daily mean suspended-sediment concentration and sediment-discharge data at Hotopha Creek near Batesville and at Otoucalofa Creek Canal near Water Valley indicating possible changes in the factors that contribute to sedimentation and erosion upstream of these two sites. Trend analyses generally indicated no statistically significant trends for daily mean values of sediment data at the remaining sites analyzed.

Purpose and Scope

The purpose of this report is to present estimates of sediment-discharge reduction at Hotopha Creek near Batesville and Otoucalofa Creek Canal near Water Valley. Non-parametric procedures are used to re-compute trends and to estimate reductions in sediment discharge over time at the two sites. Parametric procedures are then used to verify the non-parametric results. The estimates are based on time series of instantaneous sediment discharges for the period of record through September 1994.

Description of Study Sites and Data-Collection Activities

The locations of Hotopha Creek near Batesville in the Hotopha watershed and Otoucalofa Creek Canal near Water Valley in the Otoucalofa watershed are shown in figure 1. The drainage area for Hotopha Creek near Batesville is 35.1 square miles;

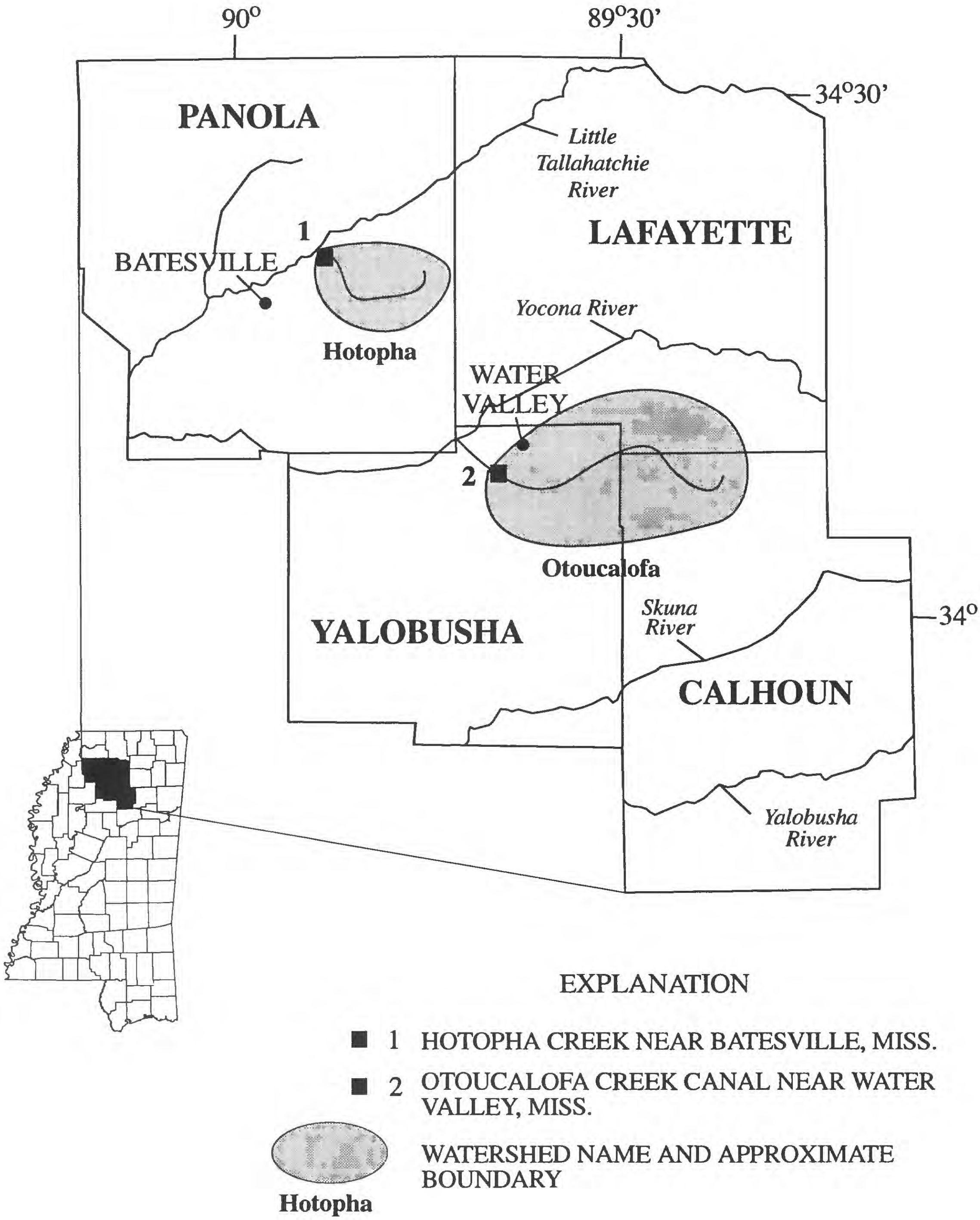

Figure 1. Location of study watersheds and sampling sites.

sediment data-collection activities began in March 1986 and are ongoing. The drainage area for Otoucalofa Creek Canal near Water Valley is 97.1 square miles; sediment-data collection activities began in July 1985 and are ongoing. These sites, as well as the other DEC project sites located in the upper Yazoo River Basin, were selected for the DEC project because their drainage areas are characterized by having large losses of soil and agrochemicals from agricultural lands. There is excessive upland and channel erosion by streams with unstable, deeply incised channels in these watersheds as well. These watersheds are sparsely populated, and land use consists largely of forests, pastures, and small farms.

Trend analyses previously presented by Rebich (1993) were based on daily mean values of stream discharge and sediment data. Drainage areas for these two sites are less than 100 square miles, and storm events characteristically appear as sharp "spikes" in stream discharge hydrographs. Due to the erratic behavior of streamflow at these sites, the use of daily mean values of sediment discharge may misrepresent actual hydrologic conditions and cause some degree of error when trying to estimate sediment-discharge reduction. Therefore, instantaneous stream discharge and sediment-discharge data are used in the calculations for this report.

Stream discharge is routinely measured by personnel of the USGS once every 6 weeks and during selected storms. From 1985 through 1994, about 210 stream discharge measurements were made at the two study sites; these measurements have been analyzed, reviewed, and stored in USGS computer files. The measurements are used to establish and verify stage-discharge relations at each site that are used to compute instantaneous stream discharges from stage data recorded by automatic stage recorders.

Suspended-sediment samples are collected at each site by observers, automatic point samplers, and USGS personnel. Observers collect single, vertically integrated samples 3 days a week (Monday, Wednesday, and Friday) and supplemental samples during selected storms. Each site is equipped with a PS-69 automatic point sampler (pumping-sampler developed in 1969), which is stage-activated for storm sampling. The observer samples and the PS-69 samples are collected at fixed locations in the cross section. Suspended-sediment concentration based on a sample collected at a fixed location can be related to average suspended-sediment concentration for an entire cross section by applying a box coefficient. A box coefficient, or cross-section coefficient, is the ratio of the average suspended-sediment concentration in the cross section to the concentration of a sample collected at a fixed station (Porterfield, 1972). For example, the suspended-sediment concentration of a sample collected from a fixed sampling point at a location where the box coefficient is near 1 should be nearly equal to the average suspended-sediment concentration for the stream cross section. The box coefficient for observer samples collected at the two DEC sites has been calculated to be near 1. Samples collected by PS-69 automatic samplers during storms have box coefficients near 1 during the rising limbs and peaks of suspended-sediment concentration hydrographs.

USGS personnel collect samples on a biweekly basis and during selected storms. Samples collected by USGS personnel may include single, vertically integrated samples but typically are multiple, vertically integrated samples taken at several sections across the stream. The sampling procedures used are described by Guy and Norman (1970). From 1985 through 1994, about 7,000 samples were analyzed and reviewed, and suspended-sediment concentration data were stored in USGS computer files for the two DEC sites. Instantaneous sediment discharge is equal to the product of instantaneous suspended-sediment concentration, instantaneous stream discharge, and a constant to correct units.

SEDIMENT-DISCHARGE REDUCTION ESTIMATES

Estimates of sediment-discharge reduction for the DEC project sites are needed to help evaluate the effectiveness of management practices designed to alleviate flooding, erosion, sedimentation, and water-quality problems. Management practices include bank stabilization, grade-control structures in streams, and sediment-reduction structures in fields that drain into streams. Estimates of sediment-discharge reduction through time at Hotopha Creek near Batesville and Otoucalofa Creek Canal near Water Valley are presented in this section. The following paragraphs include a discussion of how each data set was screened to prevent serial dependence in the analyses, the non-parametric and parametric procedures used to compute the estimates, and the analytical results.

Screening of Data Sets

The non-parametric and parametric procedures used to compute estimates of sediment-discharge reduction have an initial assumption that the sediment-discharge data are independent. However, if the data are closely spaced together, then serial dependence is likely to exist which can cause problems in data analyses and model predictions (Helsel and Hirsch, 1992). The sediment-discharge data sets for the two DEC project sites have about 3,500 values each for the period 1985 through 1994. These data are based on sediment samples collected by observers, USGS personnel, and automatic point samplers. During typical storms, samples may be collected by all three. Therefore, the existence of serial dependence is likely in each data set and may violate the assumption of independence. To address this problem, one can subsample from the original data sets to reduce serial dependence before proceeding with either procedure to estimate sediment-discharge reduction.

The data sets were screened by using sediment-discharge data based on sediment samples collected by USGS personnel and based on sediment samples collected at the peak of stormflow by the automatic point samplers (box coefficients near 1). The sediment-discharge data based on samples collected by USGS personnel were included in the screened data because these samples were the most representative of the extensive range of the original data set. Because USGS personnel could not visit each site during storm events in some cases, the sediment-discharge data based on samples collected at the peak of stormflow by automatic samplers were included in the screened data to ensure that all or most of the storms during the study period were represented. Boxplots showing a comparison of the screened sediment-discharge data sets with the original sediment-discharge data sets for Hotopha Creek near Batesville and Otoucalofa Creek Canal near Water Valley are presented in figure 2 and figure 3, respectively.

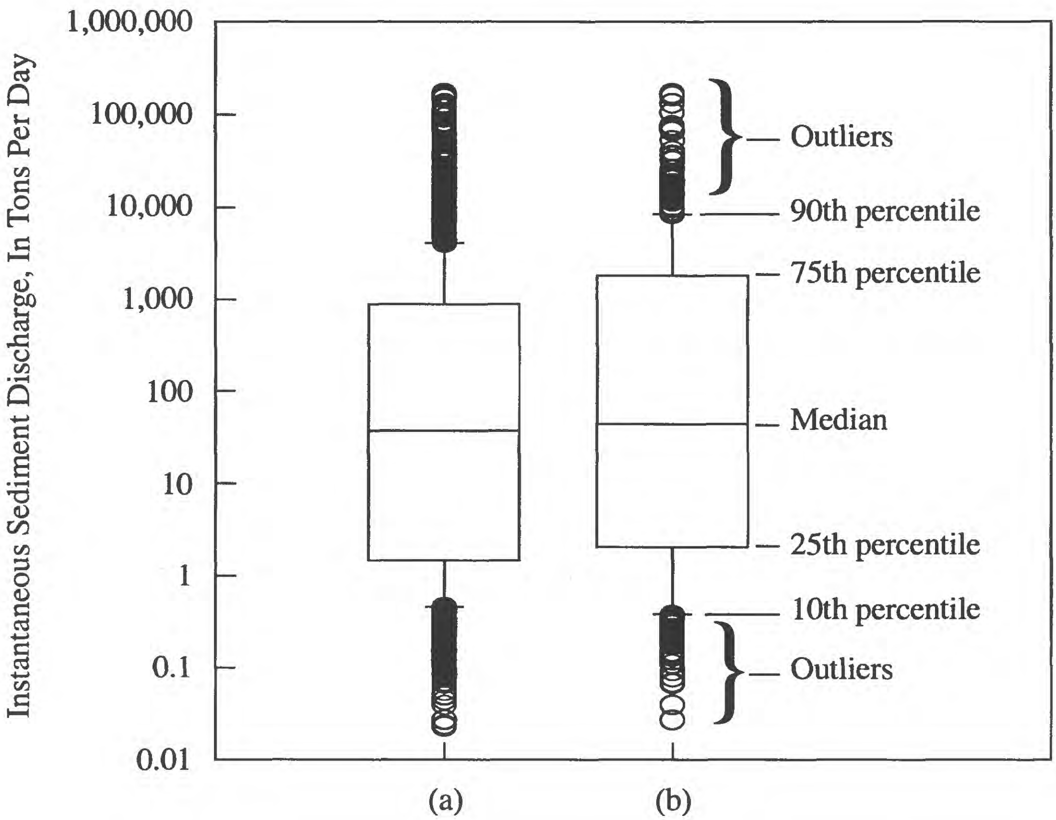

Figure 2. Distribution of (a) all instantaneous sediment discharges and (b) screened instantaneous sediment discharges for Hotopha Creek near Batesville.

Non-Parametric Procedures

Water-quality (and sediment) data generally exhibit the following statistical properties: seasonality, skewness, and serial correlation. These properties call for use of a non-parametric procedure (Smith and others, 1982). The non-parametric Seasonal Kendall test for trend was used to detect trends in daily mean values of stream discharge, suspended-sediment concentration, and sediment discharge for the eight DEC sites (Rebich, 1993). For this investigation, the first step was to use the Seasonal Kendall test for trend on the instantaneous sediment-discharge data for comparison with the trend results from the previous investigation for Hotopha Creek and Otoucalofa Creek Canal. This included using flow adjustment procedures to attempt to remove stream discharge as a source of variance in the sediment data. Then, the Seasonal Kendall slope estimator was used to compute the percentage decrease in sediment discharge.

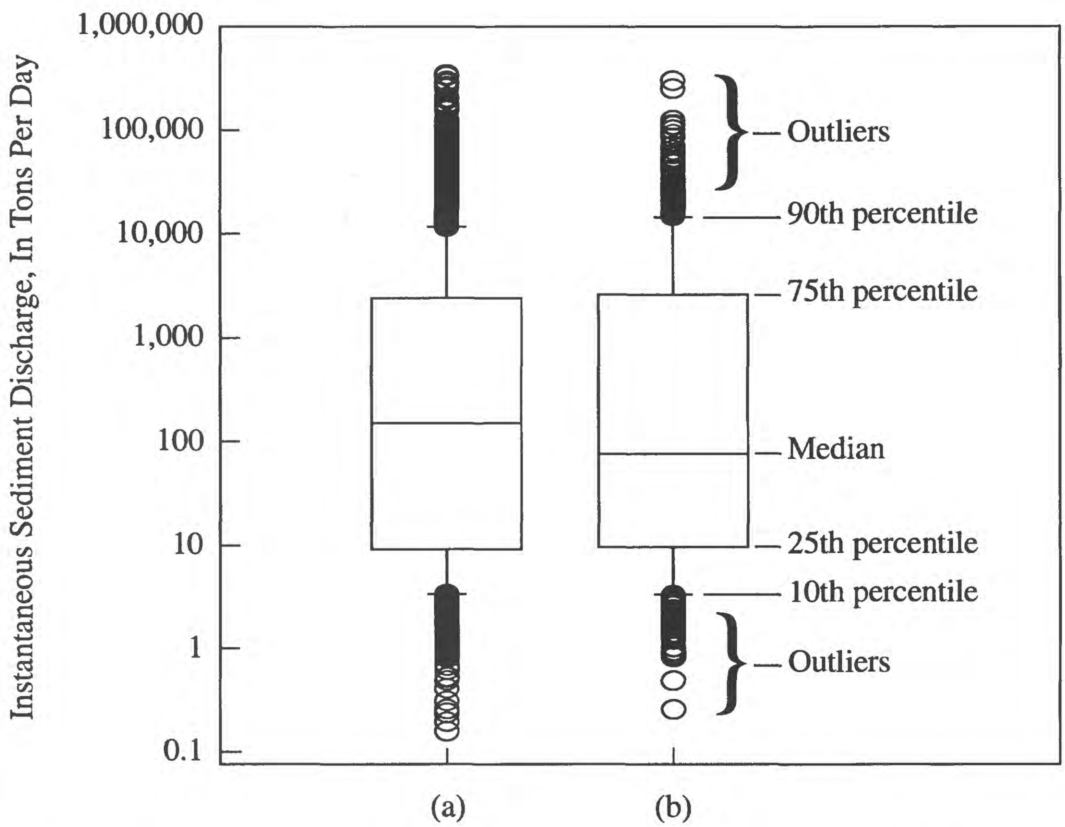

Figure 3. Distribution of (a) all instantaneous sediment discharges and (b) screened instantaneous sediment discharges for Otoucalofa Creek Canal near Water Valley.

Seasonal Kendall Test

The Seasonal Kendall test for trend is based on the Kendall's Tau test, which is a distribution-free test that uses the ranks of the data instead of the magnitudes (Smith and others, 1982). In this test, a positive value for the test statistic (Kendall's Tau) indicates an upward trend, a negative value indicates a downward trend, and a value near zero indicates no trend (Hirsch and others, 1982). The Seasonal Kendall test minimizes the effects of seasonal variability on the detection of trends by comparing only values from the same season of each year (Schertz, 1990). A season does not necessarily mean a climatic season, but is defined in this report as "a period of a year from which a single value will be selected to compare to values from the same season or period from other years" (Schertz, 1990). The test statistics for each season are then summed to determine an overall test statistic for the period of record.

The hypothesis of the Seasonal Kendall test is that no trend exists in the time series of data tested. A "p-value" associated with the results of the test is the probability of detecting a trend if the data were randomly ordered (Hirsch and others, 1982). The p-value associated with the trend result is then compared to a selected level of significance. If the p-value is less than the level of significance, then one accepts that a trend in the data does exist (or, that the hypothesis of no trend is rejected). A formal explanation and derivation of the Seasonal Kendall test is given by Hirsch and others (1982).

Requirements for the Seasonal Kendall test include an adequate period of record, a selected number of seasons, and a level of significance. According to Hirsch and others (1982) and Schertz (1990), 5 to 10 years of record is considered to be adequate. Nearly 10 years of data are available for both Hotopha Creek near Batesville and Otoucalofa Creek Canal near Water Valley. The number of seasons used to perform the Seasonal Kendall test was selected to represent the range of values in the sediment data for a year of record; however, selecting a large number of seasons could result in the elimination of independence in the test data (Hirsch and Slack, 1984). Trend analyses were based on 12 seasons per year or one set of values per month. However, variations in the sampling frequency were random; some months had more data than others because of extra samples collected during storms. Therefore, the sediment-discharge value on the median day of the month was used to perform the trend test as specified in Helsel and Hirsch (1992).

A level of significance must be selected to indicate whether the results of the Seasonal Kendall test conducted on a particular subset are considered statistically significant. If the p-value of the trend test is less than the level of significance, then the result can be considered statistically significant. The level of significance used here is 0.1, the same as that used by Smith and others (1982). P-values reported in this report are based on two-sided tests (see Helsel and Hirsch, 1992, for explanation of two-sided tests).

Flow Adjustment

Suspended-sediment concentration is correlated with stream discharge, generally increasing as stream discharge increases (Schertz, 1990). If increasing trends in stream discharge are detected at a site, increasing trends in suspended-sediment concentration may be expected as well, simply as an artifact of stream discharge at that particular site. Likewise, because sediment discharge is a product of suspended-sediment concentration and stream discharge, an increase in sediment discharge will probably be detected as well if an increase in stream discharge exists. For example, figure 4 illustrates how a decrease in suspended-sediment concentration can be masked by an increase in stream discharge. As stream discharge (black bar) increases, sediment discharge (white bar) increases as well, even though suspended-sediment concentration (gray bar) decreases over time. However, if the variability due to stream discharge is removed, trend testing would have greater probability of detecting a trend when one exists, and the trend would not be an artifact of the history of stream discharge at that site (Schertz, 1990).

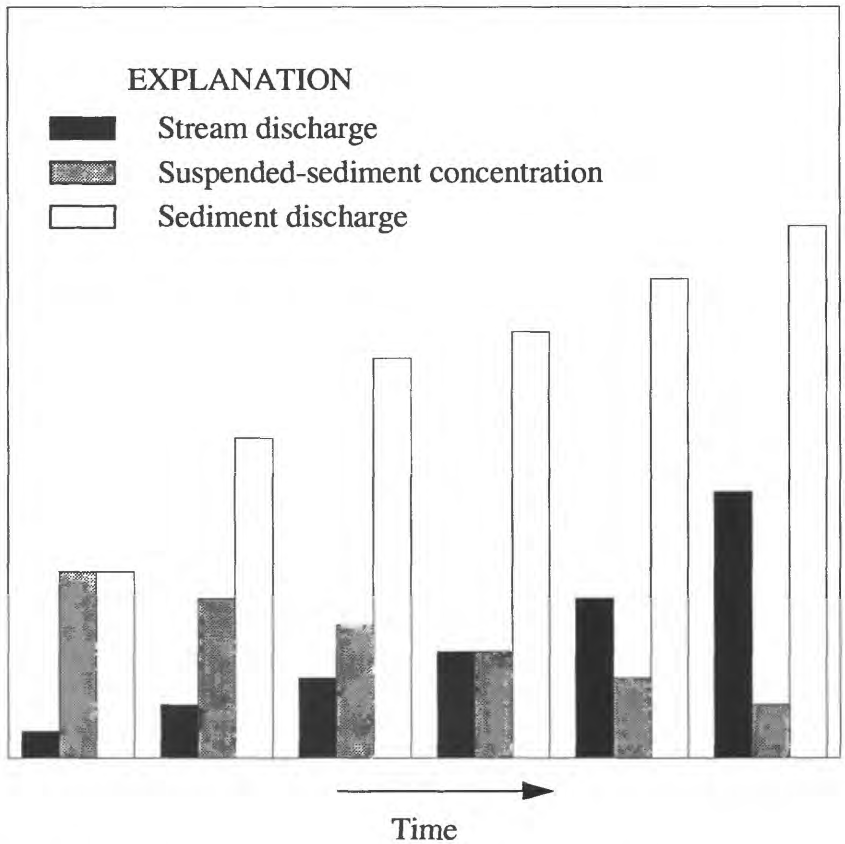

Figure 4. Example of increase in sediment discharge primarily influenced by increase in stream discharge while suspended-sediment concentration decreases.

Increases in daily mean values of stream discharge were statistically significant at all of the DEC project sites for the study period 1985-91, primarily due to changes in rainfall conditions in the study area (Rebich, 1993). Consequently, increases in daily mean values of suspended-sediment concentration and sediment discharge were also observed where trends were detected. Similar results were observed when the Seasonal Kendall trend test was run on the instantaneous stream discharge and sediment data for this investigation. Thus, flow adjusting the sediment-discharge data was considered important to determine if underlying trends were being masked by increases in stream discharge.

The technique used to remove the effects of stream discharge on sediment discharge is to compute a time series of flow-adjusted concentrations (FAC's) and test this time series for trend. The FAC is defined in this report as a residual computed by subtracting a predicted value from an actual value of instantaneous sediment discharge. Predicted values are computed from a mathematical expression that describes the relation between stream discharge and sediment discharge. A locally weighted scatterplot smooth, or LOWESS, was the expression that was used in this investigation to describe the relation between stream discharge and sediment discharge (Helsel and Hirsch, 1992). Once the residuals were computed, then the Seasonal Kendall trend test was run on the time series of residuals.

Seasonal Kendall Slope Estimator

After using the Seasonal Kendall test to identify trends in the sediment-discharge data, the Seasonal Kendall slope estimator can be used to estimate the magnitude and direction of the trend. This slope estimate is the median of all the possible slopes computed from the ordered pairs of data in the trend test. The median of differences is the change per year due to the trend (Smith and others, 1982). Because the median of the differences is used, this slope estimate is resistant to extreme values (or outliers) and to seasonal variation (Hirsch and others, 1982). In the previous investigation (Rebich, 1993), the Seasonal Kendall slope estimator was computed to indicate the general direction of the trend only. The magnitudes of the slope estimates were also reported; however, the magnitudes were based on daily mean values. As previously stated, daily mean values may not accurately describe extreme fluctuations during storm events in small watersheds such as Hotopha Creek and Otoucalofa Creek Canal; thus, the magnitudes of the slopes that were computed in the previous investigation may misrepresent the sediment-discharge reductions at the DEC sites.

For this investigation, the Seasonal Kendall slope estimator is computed using instantaneous values of sediment discharge at both sites for the study period. By using instantaneous data, the slope estimates more accurately describe the magnitude of trends in sediment discharge and provide a more accurate estimate of sediment-discharge reduction where decreasing trends are detected. The computed slope estimates are expressed as percentage change per year in sediment discharge. The slope estimates, or percentages, can then be multiplied by the median sediment-discharge value in the data set to give the annual sediment-discharge reduction in original units (tons per day).

Parametric Procedures

Most of the original methods used to estimate sediment discharge are based on a simple regression, or "rating curve," method of first estimating sediment concentration and then computing sediment discharge (Ferguson, 1986; Koch and Smillie, 1986). The rating curve method is a simple log linear model that assumes that suspended-sediment concentration is related to stream discharge according to the following equation (Cohn and others, 1992):

$$C = exp\left(\beta_0 + \beta_1 lnQ + \varepsilon\right)$$

where

C is suspended-sediment concentration,
Q is stream discharge,
β_0 and β_1 are parameters typically estimated by regression techniques, and
ε is an independent random error assumed to be normally distributed with zero mean and variance.

Corresponding instantaneous sediment discharge can then be computed by the following equation:

$$L = KQexp\left(\beta_0 + \beta_1 lnQ + \varepsilon\right)$$

where

L is sediment discharge, and
K is a conversion factor.

These instantaneous sediment-discharge values can then be used to compute daily, monthly, and annual sediment discharge averages. However, flaws have been identified when using this method, such as retransformation bias and lack of fit due to missing variables (Cohn and others, 1992).

The rating curve method is based on first transforming instantaneous stream discharge and suspended-sediment concentration data to their natural logs. Suspended-sediment concentration values predicted from regression equations are then transformed back to original units prior to computing sediment-discharge values. Research has shown that bias is introduced in the retransformation process, and true sediment discharge may be underestimated by as much as 50 percent (Ferguson, 1986; Koch and Smillie, 1986). Several methods have been introduced to correct for retransformation bias when computing sediment discharge. Cohn and others (1989) introduced the minimum variance unbiased estimator, or MVUE. In their research, MVUE performance was compared to other correction techniques and was shown to perform as well or better, especially in cases when sediment discharges are computed during high-flow conditions (see also Gilroy and others, 1990). However, other research points out that such estimator techniques are sensitive to assumptions, particularly if a normal distribution is assumed, and that "blanket" application of these techniques is cautioned (Thomas, 1988). In addition to retransformation bias, lack of fit due to missing variables is another flaw in using the rating curve technique to estimate sediment discharge. Variations due to time trends, seasonality, and other characteristics of the data such as hysteresis are not adequately accounted for in the rating curve method. Cohn and others (1992) suggest using a single, multivariate regression model to account for these variations in the stream discharge and sediment data.

For this investigation, the ESTIMATOR software developed by the USGS to estimate constituent loads was used to estimate sediment-discharge reduction (Cohn and others, 1992). Retransformation bias and multi-variables are considered in the software. The multiple regression model used in these analyses as suggested in the literature is as follows (Cohn and others, 1992):

$$lnC = \beta_0 + \beta_1 lnQ + \beta_2 (lnQ)^2 + \beta_3 T + \beta_4 \sin(2\pi T) + \beta_5 \cos(2\pi T) + \varepsilon$$

where

T is decimal time (for example, May 20, 1986, is approximately 1986.38),
β_0 and $\beta_1 lnQ$ are from the rating curve method,
$\beta_2(lnQ)^2$ accounts for the curvature in the ln(C)--ln(Q) relation,
$\beta_3 T$ accounts for changes over time in the study reach for the study period, and
$\beta_4$sin(2pT) and $\beta_5\cos(2\pi T)$ account for seasonality.

The ESTIMATOR software transforms the data into natural log units, computes all of the regression coefficients for predictive equations for suspended-sediment concentration and sediment discharge, and uses the MVUE technique to re-transform the results back to original units. For this investigation, the $\beta_3 T$ term is the most important, in that the coefficient, β_3, is the overall slope of trends in sediment discharge over time due to changes in the study reach for the study period. β_3 is reported as a percentage change over time and is used to compare to the Seasonal Kendall slope estimate computed in the non-parametric procedures.

Analytical Results

All of the instantaneous data were transformed into natural log units prior to using the Seasonal Kendall test and computing the slope estimate. The Seasonal Kendall trend test was conducted on unadjusted stream discharge, suspended-sediment concentration, and sediment-discharge data to compare to previous trend analyses. Because suspended-sediment concentration and sediment-discharge data were strongly correlated at these sites, flow-adjustment techniques were used on sediment-discharge data directly. The Seasonal Kendall test was then used to detect trends in flow-adjusted sediment discharge, and the Seasonal Kendall Slope Estimator was computed to estimate corresponding sediment-discharge reduction. The estimates were then transformed into percentage values for the convenience of the reader.

For Hotopha Creek near Batesville, p-values associated with trend tests conducted on all of the unadjusted, instantaneous data sets were all greater than 0.1, which indicates that no statistically significant trends existed at this site (table 1). After using the flow-adjustment techniques on the Hotopha Creek sediment-discharge data to remove the variability due to stream discharge, the Seasonal Kendall tend test was re-run on the time series of residuals. The p-value associated with the test was 0.0161, which is less than the chosen level of significance 0.1, indicating a statistically significant trend in the flow-adjusted sediment-discharge data (table 1). The corresponding Seasonal Kendall slope estimate indicated that the annual reduction in sediment discharge for the study period at this site was about 7 percent per year. Figure 5 is a plot of the residuals over time and a trend line with 7 percent per year slope plotted as well. Although the slope line is depicted as linear in figure 5, linearity in the overall trend is not implied. The product of this slope estimate and the median sediment-discharge value at this site (9.04 tons per day) gives an annual reduction in sediment discharge at Hotopha Creek of 0.68 ton per day per year.

Table 1. Results of Seasonal Kendall and ESTIMATOR analyses to estimate sediment-discharge reduction at Hotopha Creek near Batesville and Otoucalofa Creek Canal near Water Valley

Test - Data Set	p-value	Slope estimate (percent per year)
HOTOPHA CREEK NEAR BATESVILLE		
Seasonal Kendall - unadjusted stream discharge	0.3041	5.1
Seasonal Kendall - unadjusted suspended-sediment concentration	0.1482	-8.1
Seasonal Kendall - unadjusted sediment discharge	0.7240	-3.2
Seasonal Kendall - flow-adjusted sediment discharge	0.0161	-7.4
ESTIMATOR - sediment discharge	0.0324	-10.0
OTOUCALOFA CREEK CANAL NEAR WATER VALLEY		
Seasonal Kendall - unadjusted stream discharge	0.0569	8.7
Seasonal Kendall - unadjusted suspended-sediment concentration	0.6032	-5.1
Seasonal Kendall - unadjusted sediment discharge	0.8176	2.6
Seasonal Kendall - flow-adjusted sediment discharge	0.0008	-10.6
ESTIMATOR - sediment discharge	0.0057	-11.4

The results of the Seasonal Kendall slope estimate were confirmed using the ESTIMATOR software (parametric procedures). The results of the regression diagnostic tests, such as the t-test, indicated that the most significant component of the model was stream discharge ($\beta_1 lnQ$), as expected. The t-test statistic associated with β_1 was 27.32. However, the other components were also considered significant but subtle components of the model. The coefficient, β_3, which is the slope of the trend in sediment discharge, was computed to be negative 10 percent per year (table 1). This slope is in the same range as the Seasonal Kendall slope estimate computed for this site. The t-test statistic associated with β_3 was -2.10 with a corresponding p-vaue equal to 0.0324.

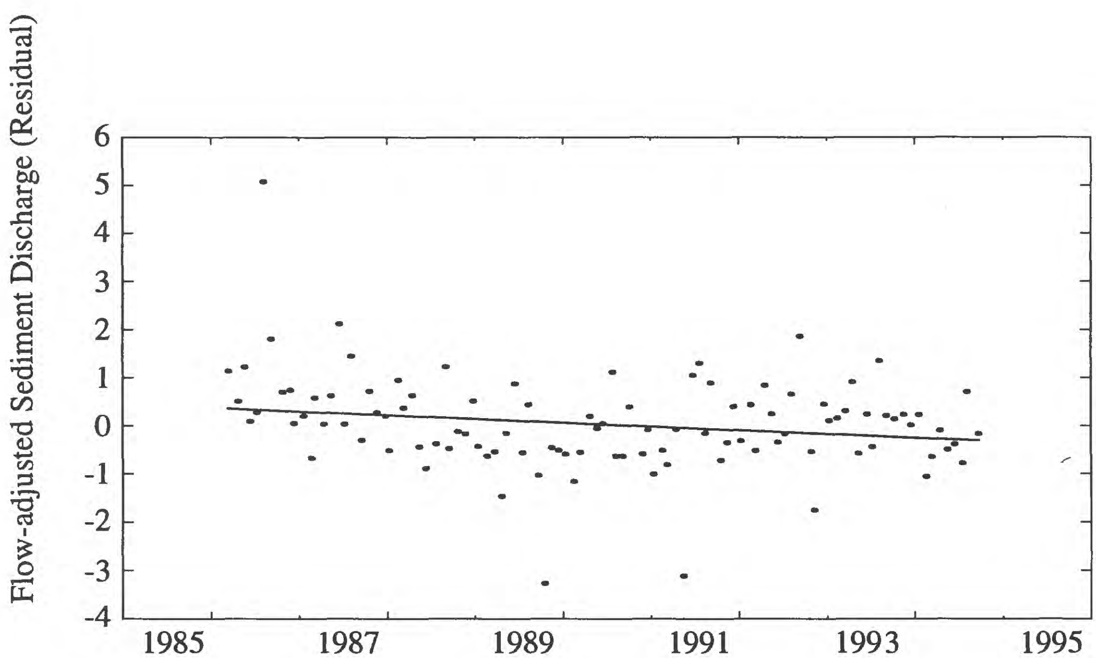

Figure 5. Flow-adjusted sediment discharge and trend line for Hotopha Creek near Batesville for the period March 1986 through September 1994.

For Otoucalofa Creek Canal near Water Valley, the p-value associated with the trend test conducted on instantaneous stream discharge data was 0.0569, which indicates a statistically significant trend (table 1). The general direction of the corresponding slope estimate was positive indicating an increase in stream discharge for the study period at this site; these results are comparable to the results of the previous investigation. The p-values associate with the trend tests conducted on the unadjusted suspended-sediment concentration and sediment-discharge data were greater than the pre-selected level of significance of 0.1, indicating that no statistically significant trends existed.

After using the flow-adjustment techniques on the Otoucalofa Creek sediment-discharge data to remove the variability due to stream discharge, the Seasonal Kendall trend test was re-run on the time series of residuals. The p-value associated with the test was 0.0008, which is less than the chosen level of significance 0.1, indicating a statistically significant trend in the flow-adjusted sediment-discharge data (table 1). The corresponding Seasonal Kendall slope estimate indicated that the annual reduction in sediment discharge for the study period at this site was about 11 percent per yer. Figure 6 is a plot of the residuals over time and a trend line with the 11 percent slope per year plotted as well. The product of this slope estimate and the median sediment-discharge value at this site (50.18 tons per day) gives an annual reduction in sediment discharge at Otoucalofa Creek of 5.33 tons per day per year.

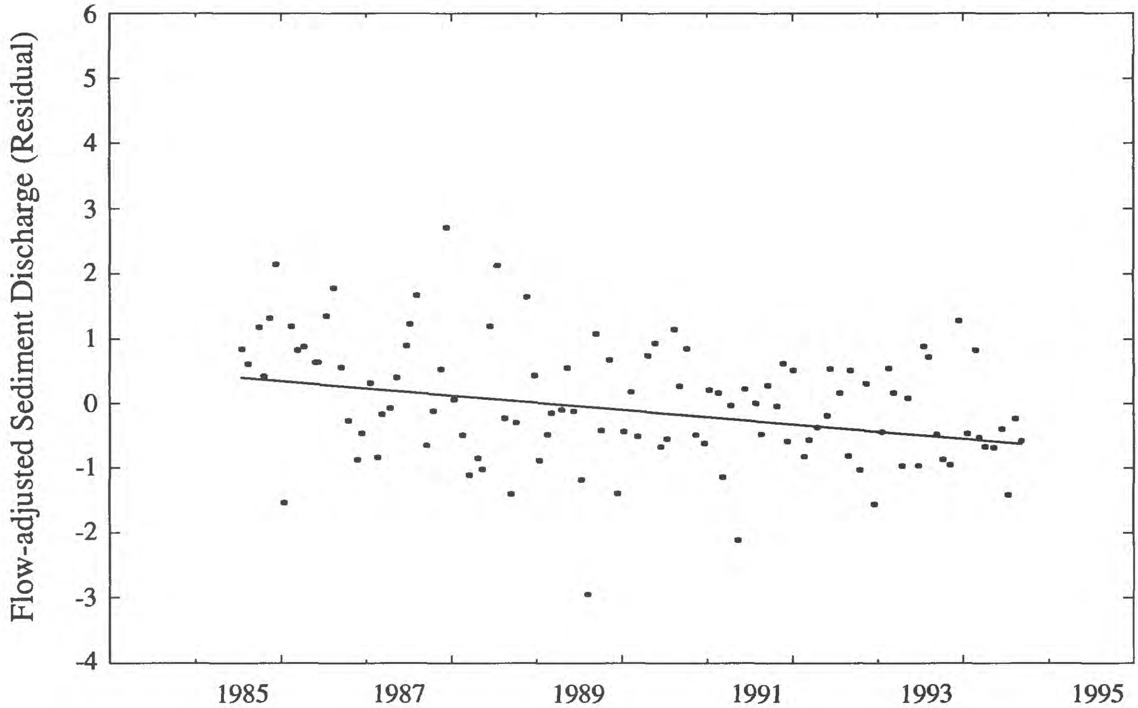

Figure 6. Flow-adjusted sediment discharge and trend line for Otoucalofa Creek Canal near Water Valley for the period July 1985 through September 1994.

The results of the Seasonal Kendall slope estimate were confirmed using the ESTIMATOR software (parametric procedures). Once again, the regression diagnostics tests indicated that stream discharge was the most significant component of the model. The t-test statistic associated with β_1 was 23.36. The coefficient, β_3, which is the slope of the trend in the sediment discharge, was computed to be negative 11 percent per year (table 1). This slope is the same as that computed in the Seasonal Kendall analyses. The t-test statistic associated with β_3 was -2.74 with a corresponding p-value equal to 0.0057.

SUMMARY

In July 1985, at the request of the Interagency Task Force on Yazoo Basin Foothills Erosion and Flood Control, and in cooperation with the U.S. Army Corps of Engineers, the USGS began collecting sediment data for the Yazoo River Basin DEC project. These data will assist the task force in evaluating the effectiveness of the ongoing sediment data-collection program. In a previous investigation, trend analyses were conducted to detect changes over time in the daily mean values of stream discharge and sediment data for the DEC project sites. Trends were detected in daily mean values of sediment data at two of the DEC sites indicating possible downward trends in the factors that contribute to sedimentation and erosion at these two sites.

This report presents estimates of sediment-discharge reduction at the two DEC sites where trends were previously detected, specifically, Hotopha Creek near Batesville and Otoucalofa Creek Canal near Water Valley. The computations are based on time series of instantaneous sediment discharges rather than daily mean sediment discharges for the period 1985 through 1994. Non-parametric procedures were used to recompute trends in sediment discharge and to estimate reductions over time at the two DEC sites. Parametric procedures were then used to verify the non-parametric results.

For the non-parametric procedures, the data sets were screened by using sediment-discharge data based on sediment samples collected by USGS personnel and based on sediment samples collected at the peak of stormflow by automatic point samplers. The Seasonal Kendall test for trend was used on the instantaneous sediment-discharge data for comparison with the trend results from the previous investigation for Hotopha Creek and Otoucalofa Creek Canal. This test included using flow-adjustment procedures to attempt to remove stream discharge as a source of variance in the sediment data. Then, the Seasonal Kendall slope estimator was computed to estimate the percentage decrease in sediment discharge over time. This percentage was then multiplied by the median sediment-discharge value in the data set to give the annual sediment-discharge reduction in original units.

The estimates of sediment-discharge reduction as computed using parametric procedures are intended to compare to the Seasonal Kendall slope estimates. The software that was used is based on a multiple regression model that considers retransformation bias. One of the coefficients in the model is the percentage change in sediment discharge over time due to changes in the study reach for the study period. This percentage change over time was used to compare directly to the Seasonal Kendall slope estimate computed in the non-parametric procedures.

Decreasing trends were detected in flow-adjusted sediment discharge at Hotopha Creek near Batesville for the study period. The corresponding Seasonal Kendall slope estimate indicated that the annual reduction in sediment discharge for the study period at this site was about 7 percent per year. The product of this slope estimate and the median sediment-discharge value at this site (9.04 tons per day) gives an annual reduction in sediment discharge at Hotopha Creek of 0.68 ton per day per year. The results of the Seasonal Kendall slope estimate were confirmed with the parametric procedures. The model coefficient that indicates the trend in the sediment discharge over time was computed to be negative 10 percent per year, which is in the same range as the Seasonal Kendall slope estimate.

Decreasing trends were also detected in flow-adjusted sediment discharge at Otoucalofa Creek Canal near Water Valley for the study period. The corresponding Seasonal Kendall slope estimate indicated that the annual reduction in sediment discharge for the study period at this site was about 11 percent per year. The product of this slope estimate and the median sediment-discharge value at this site (50.18 tons per day) gives an annual reduction in sediment discharge at Otoucalofa Creek of 5.33 tons per day per year. The results of the Seasonal Kendall slope estimate were confirmed with the parametric procedures. The model coefficient that indicates the trend in the sediment discharge over time was computed to be negative 11 percent per year as well.

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