HISTORY OF MORPHOLOGIC CHANGES

TILLATOBA, ABIACA, PELUCIA, AND TOPASHAW CREEKS

YAZOO BASIN, MISSISSIPPI

Prepared for

Soil Conservation Service, U.S.D.A.

Contract No. 53-44423-1-221

BY

CHESTER C. WATSON

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1.

INTRODUCTION

The objective of this report is to summarize the morphologic history of four channels in north-central Mississippi which lie within the Gulf Coastal Plain physiographic province. Each channel flows in a general east-to-west direction between latitude $33^{o}15'$ and 34^{o}. Tillatoba, Pelucia, and Abiaca Creeks originate in the Loess Bluffs subdivision of the physiographic province, and flow into the flat area known as the Yazoo Delta . Topashaw Creek is contained in the North-Central hills subdivision, flowing into Grenada Lake Reservoir. Soil erosion in the watershed and channel, and flooding due to both underfit and sediment-choked channels have been persistent problems since the beginning of European settlement of the watersheds in the 1830's.

2. HISTORY

For the objectives of this report the history of the channels can be divided into three time periods: 1) Early history to 1910, 2) Drainage district period to 1939, 3) Federal involvement since 1939.

2.1 EARLY HISTORY TO 1910

The agricultural development of the Upper Yazoo basin is a history interwoven with the tragedy of soil erosion and improper management of sediment.

Abiaca, Pelucia, and Tillatoba Creeks are located on lands previously inhabited by the Choctaw Indians. The approximate boundary between the Choctaw nation is a northwest-southeast diagonal along the northern Tillatoba Creek watershed divide. Extension of that boundary to the southeast follows the southern Topashaw Creek watershed divide. Although both the Chickasaw and Choctaw did rely on food crops of corn, beans, and melons, their agricultural intensity is judged to be of limited effect upon the watershed.

European agricultural development of the area followed shortly after the cession of Indian lands. Initial negotiations with the Chickasaw by the United States resulted in the Treaty of Hopewell of 1786. By about 1800 pressure from European settlers was being imposed upon the Chickasaw. Subsequent cessions of their land resulted in 1805, 1816, and 1818. The Chickasaw yielded the remainder of their land by the Treaty of Pontotoc Creek of 1832

(Swanton, 1946). The Treaty of Dancing Rabbit in 1830 provided for removal of the Choctaw to Oklahoma.

With the removal of the Indians to lands west of the Mississippi River, a period of remarkable expansion of agricultural development began. Speculation in the new land was termed the "speculative mania of the thirties" (Gray, 1958).

> The opening of these new territories and a fuller realization of the opportunities in areas previously opened but not yet fully occupied paved the way for the craze for speculation which was stimulated by the easy credit and the period of high prices of cotton beginning with the crop year 1833-34. According to a traveller who visited Alabama just before the panic of 1837, the profit on cotton planting was commonly 35 per cent. One planter whom she met bought a plantation for $15,000, valued it two years later at $65,000, and in the second year expected to receive between $50,000 and $60,000 for his growing crop. A mania developed for buying land and slaves, fostered by the employment of State credit in the promotion of banks. During the years 1834 to 1837 inclusive $80,321,000 was invested in bank capital in Mississippi, Louisiana, Arkansas, Florida and Alabama, over three fourths of the total in the first two states. Of the total, $32,321,000 consisted of State loans or private loans guaranteed by the States. The new banks loaned money lavishly on land, slaves, and cotton, at inflated values. In Alabama taxes were repealed in the belief that profits from the State bank would meet all State expenses.

Cotton receipts at Memphis increased from 35,000 bales in 1840 to 150,000 bales in 1850, and to 361,000 bales in 1860.

The effects of agricultural development without consideration of proper soil conservation practices soon became apparent. By 1857 Harper discussed gullied lands along the bluffs and exhausted fields in Mississippi.

Hilgard (1860) provides an early detail account of soil erosion in Mississippi as a result of farming practice:

> "It is greatly to be regretted, that circling was not practiced at an earlier date in this region; for large tracts, originally covered (though not to a great depth) with an excellent soil, have already been irrevocably lost to cultivation by washing. When the surface loam has been penetrated, the latter process goes on with fearful rapidity, and requires the most energetic measures to check it. Not only is the soil, and all that could possibly serve as a foundation for a soil, carried away from the hills, but the materials thus removed cover over the fertile branch bottoms, in company with a flood of sand, which renders them useless for all time to come.

By circling Hilgard was referring to contour plowing. Further references in the 1860 report allude to the need for drainage, "A great improvement in this respect might no doubt be effected by proper drainage of the extensive low swampy portions, in which water remains stagnant during a large part of the summer...".

Lowe (1910) uses the term "bad lands of Mississippi" in referring to a portion of northern Mississippi denuded of vegetation and soil. Hilgard (1860) provides a humerous, yet fatalistic adage taken from a farmer of the time that summarizes the apparent attitude toward the soil: "...good enough as long as it will stay."

An early record of the morphology of the channels is provided in the field notes and the original township plats of the Choctaw and Chickasaw Cession. The field survey of the townships contiguous with streams was conducted in 1831, 1832, and 1833 and early 1834.

Township plats bear the dates of 1832 through 1834. Field notes include references to vegetation, stream width, habitation, and the location of swampland, bottoms, or other land forms.

Hilgard (1860) also provides insight to the early land use and morphology:

> This fine level farming region around Grenada, which extends on both sides along the Yallabusha and Beadupanbogue, is a second bottom or hommock, several miles in width, now almost entirely under cultivation, but originally timbered... This level hommock land, which slopes off gradually into the bottoms proper, is bordered, and interspersed with, poor, sandy low ridges...

As stated on the original township plats for Abyacha (Abiaca) Creek, surveyor Henry T. Williams was paid the princely sum of $4.00 per mile for original township surveys. His survey notes provide little information about the channel size, but the township plats dated 1832 show the channel position and adjacent areas of cultivation.

As surveyed in 1831, Abiaca Creek was tributary to Little River, apparently a distributary of the Yazoo River, with confluence near the present community of Dulweber. At this confluence the channel can be traced to the northeast for about 4 miles, southeastward for about 4 miles, and then to the bluff line at about the present location. Subsequent channel improvement has shortened this previously ten mile reach by about 5 miles. Upstream of the bluff line the channel location appears to have changed little.

Channel sinuosity varied from 1.1 to 1.2 except at the confluence of Coila Creek where sinuosity was 1.3 to 1.5 for three miles.

An area of about two square miles is shown as a field, probably to differentiate it from swampy bottom, immediately adjacent to the bluff line and channel in Sections 10, 11, 15 and 14. The field shape appears to have been developed from a relic fan deposit.

The total area under cultivation in the Abiaca watershed upstream of the bluff line in 1832 is estimated to have been less than 0.5 square miles.

Mr. Henry Hamblen is listed as surveyor for lands along Palusha (Pelucia) Creek. His work shows that Pelucia Creek bifurcated downstream of the bluff line. The south fork flowed along the existing Pelucia floodway, and the north fork followed a route through the present town of Greenwood. The north branch was much larger, 100 feet in width, as compared to about 33 feet in width for the south fork.

At the bluff line Mr. Hamblen noted "...high ground on each side of the creek..." for a distance of about 1,200 feet. Further indications of high ground and prairie downstream of the bluff line suggest Pelucia Creek and Big Sand Creek, about a mile to the north, were delivering sediment to the flat land.

In 1832 Pelucia Creek was 66 feet wide at the bluff line. It flowed in a dense cane and vine bottom that was three-fourths to a half mile wide. Sinuosity varied from 1.2 to 1.5 and was generally more sinuous than Abiaca Creek.

Mr. Alex Downing surveyed the township contiguous with the "Yellow Busha" River in 1832. His plats show the Yalabushah River

(Yalobusha River) with a major tributary named Yellow Busha following the present path of Topashaw Creek. The channel width is not noted except near the present confluence of Little Topashaw Creek, where it was recorded to be about 20 feet. Much of Mr. Downing's description concerns the "Yellowbusha bottom." He describes the land adjacent to lower Topashaw Creek to be, "... all cane subject to inundation" and 1.25 miles wide. Plats made from his surveys show that the bottom was generally 1-1.25 miles wide upstream to the vicinity of the Little Topashaw confluence where the bottom is 1.5 to 2.0 miles in width. Mr. Downing's descriptions portray a, "...low wet swamp." No cultivation is noted in the watershed.

Topashaw Creek sinuosity varies from an average of about 1.4 to 1.1 for the remainder of the stream.

The descriptions of the extensive Topashaw-Yalobusha bottom of 1832 provide an interesting contrast to the "second bottom" hummock along the Yalobusha River near Grenada, as pictured by Hilgard in 1860.

Mr. Downing also surveyed the townships contiguous with Tillatoba Creek. The general location of the channels have changed little. Sinuosity of the stream varied from 1.1 to 1.3 with maximum sinuosity near the Yalobusha-Tallahatchie Co. line. No cultivation of the watershed was noted. The channel varied from 30 to 50 feet in width, and stream banks supported thick growths of cane with pine, oak, and hickory trees. Swamp conditions were noted downstream of the bluff line, but swamps were not as common upstream.

In general the early township plats indicate that the study streams were responding to a less dynamic hydrologic regime than today as discussed in Chapter 3. Also, the early descriptions give evidence of significant sediment transport from the hills to the flat lands even with the lower energy condition. Smith (1982) concludes that these fans and fan development were closely related to the erosional history of the Loess Bluffs and the location of the Yazoo River through time.

2.2. THE DRAINAGE DISTRICT PERIOD TO 1939

With increasing erosion and silt and debris accumulation channel capacity was restricted. Crop lands were buried. Legislative action was taken to organize and to fund solutions to these problems. The first drainage law was enacted in Mississippi, in 1886, and the Chiwappa Creek Swamp Land District was created in 1888 (Olsen and Dumm, 1941). From this beginning a string of similar legislation followed. Nine separate laws controlled the organization of the Swamp Land Districts and Drainage Districts. Each law varied in the type of assessment levied and the composition of the governing board of the districts.

The census of 1930 (U. S. Department of Commerce) provides the following tabulation which indicates the acres of land incorporated into swamp land or drainage districts during five year periods between 1900 and 1929:

1900-1904	5,000 acres
1905-1909	268,368
1910-1914	777,686
1915-1919	823,812
1920-1924	936,126
1925-1929	177,504

Most of the land was incorporated into Drainage Districts, not Swamp Land Districts. The Drainage Districts were administered by a separate Board of Commissioners or by a group that included members of a County Board of Commissioners. Consequently, several districts planned and constructed drainage works along a short reach of stream without coordination. Olsen and Dumm (1941) suggests that the formation of a drainage district may have been the direct result of the activities of a district located upstream that concentrated the flow and caused downstream problems.

Olsen and Dumm (1941) list the following Drainage Districts (D.D.) and Swamp Land Districts (S.L.D.) in Mississippi as of January 1, 1937 for the study streams:

DISTRICT	YEAR ORGANIZED	MILES OF DITCHES
Abiaca D.D.	1920	4.25
Pelucia S.L.D.	1910	3.50
Pelucia D.D.	1920	19.00
Topashaw D.D.	1915	None
Topashaw D.D. No. 2	1913	4.75
Topashaw S.L.D.	1912	11.00
Tillatoba D.D.	1924	None
North Tillatoba D.D.	1935	None

Records of these early districts are meager. Some construction plans of these districts were filed in the State of Mississippi Archives in Jackson, Mississippi. A more complete but less detailed record exists in the series of drainage district reports that were compiled in 1940 by the Mississippi Board of Development under the direction of the Soil Conservation Service, U.S.D.A. Partial collections of this report series are available at the Archives and at the Vicksburg District, Corps of Engineers.

The following paragraphs describe the early district efforts as summarized from available Mississippi Board of Development reports:

Abiaca Creek -

The district was primarily concerned with the flooding of the farm lands downstream of the bluff line. This excerpt describes the problems central to present and past conditions:

> Abiaca Creek has a watershed of about 95 square miles and, although this creek originally followed well defined channels, the sand and silt eroded from the deforested uplands and transported downstream soon filled the natural channels, forcing floodwaters to pour over district lands in thin sheets.

The original plans for improved drainage included construction of about 2.5 miles of channel to relieve flooding near the Yazoo River confluence. A wide floodway using "...hog wire and brush piles" was planned to prevent overbank flooding, and a sediment trap "...would retain silt and prevent upstream channel erosion." At the completion of the planned channel, construction funds remained and the channel was extended another 1.75 miles thus eliminating the planned sediment trap.

Following construction, head cuts formed in the channel and moved upstream. Flooding in 1932 resulted in closure of the constructed channel. By 1940, as much as 9 feet of silt had been deposited over prior farm land.

In 1940 recommendations were made for reconstruction of the channel and for the design of a spillway and sediment trap to lessen the consequences of channelization.

Pelucia Creek -

The combined efforts of the Pelucia S.L.D. and the Pelucia D.D. provided a floodway on Pelucia Creek that extended from about two miles upstream of the confluence with the Yazoo River, upstream to the bluff line. The Leflore County portion of the floodway levees was constructed with a centerline spacing of 120 feet. Upstream the Carroll County levee spacing varied from 250 to 600 feet.

The central channel in 1940 was a little over 10 feet deep at the bluff line. This depth decreased downstream to about 2 feet below ground level at the Leflore-Carroll County line. About two miles west of this boundary the channel thalweg was 2 to 4 feet above ground level. It then decreased to a depth of about 12 feet below ground level at the downstream extent of the levees. The slope of the channel was reported to be uniform in the floodway, and no specific mention is made of upstream headcutting.

Topashaw Creek -

Topashaw S.L.D. and Topashaw D.D. No. 2 were responsible for channelization of Toposhaw Creek from the confluence with the Yalobusha River upstream to a point about a mile upstream of Little Toposhaw Creek. The work of Toposhaw D.D. in Webster county, generally paralleling Little Toposhaw Creek, provided for 18,000 feet of 10'-deep channel planned for a slope of 0.0025, however, actual construction slope may have been 0.0030.

Channelization of the stream resulted in degradation and widening of the upper channel and aggradation of the lower reaches. By 1940 the lower 3.5 miles was subject to frequent flooding, the lower 1,000 feet was abandoned due to aggradation. In Chickasaw County the main channel had widened to 140 feet and degraded to a depth of 25 feet. Degradation and widening had not fully affected the Little Topashaw drainage lateral.

Middle Fork Tillatoba Creek -

The two districts that were formed to improve Tillatoba Creek planned no channelization. The primary interest was to provide flood protection from flooding in Panola County. Levees were constructed along the north bank of the channel.

2.3 FEDERAL INVOLVEMENT AFTER 1939

The two primary benefits provided by the Federal Government were planning on a total watershed basis, and the institution of soil conservation practices that were designed to reduce the sediment supply. Acting in cooperation with various local districts, the staff of the U.S.D.A., Soil Conservation Service has planned and implemented measures needed to provide drainage and to reduce flooding. These activities were authorized by the Flood

Control Act, Public Law 534, 78th Congress and approved December 22, 1944, and subsequent amendments.

Watershed work plans for each of the study streams were prepared during the period 1958 to 1968 by the Soil Conservation Service, U.S.D.A. The work proposed in each work plan represents the first concerted effort to provide total watershed soil conservation, flood protection, and channel stabilization. The work plans have not provided the final solution for all problems in the watershed, but these plans were comprehensive treatments of the principal problem at the time of plan initiation. As opposed to earlier efforts by individual drainage districts, the SCS efforts have involved a broader view of the watershed problem incorporating both upland soil conservation practices and improved drainage. Therefore, treatment for the entire watershed was provided.

For the purposes of summary, the component measures which were incorporated into the study-stream work plans were as follows:

A.) Conservation cropping practices

B.) Revegetation of critical areas

C.) Terracing, field waterways, diversion ditches

D.) Tributary pipe overfall

E.) Desilting basins

F.) Floodwater retarding structures

G.) Streambank stabilization

H.) Channel clearing and snagging

I.) New channel excavation and cutoffs

The following tabulation is a summary of measures incorporated into the study stream work plans:

WATERSHED	DATE PREPARED	MEASURES INCORPORATED INTO WORK PLAN
Pelucia	August, 1958	A.,B.,C.,D.,E.,F.,G.
Abiaca	December, 1962	A.,B.,C.,D.,E.,F.
Topashaw	January, 1968	A.,B.,C.,D.,F.,H.,I.
Tillatoba	January,1960	A.,B.,C.,D.,E.,F.,H.,I.

Lower Topashaw Creek was also covered under another work plan which was completed along with the Yalobusha River in 1966. Head cutting and channel erosion from the 1966 construction precluded the need for the 1968 program.

As indicated by this summary, emphasis has been placed on control of watershed erosion from overland sources and the reduction of peak discharge into the main channels. These measures have generally been successful in reducing watershed soil loss; however, significant loss is continuing from channel bed and banks. Continuing soil loss from bed and banks may be due in part to reduction of the upland watershed sediment supply.

In 1962, the major problems for Abiaca Creek watershed were flooding downstream to the bluff line, and sediment accumulation in the downstream reach. During the period 1941 through 1960, 4.2 floods per year occurred. The objectives of the 1962 work plan were to reduce flooding and to reduce sediment delivered to the lower reach by 63%.

Pelucia Creek watershed problems were similar to those in the Abiaca Creek watershed. In the Yazoo Delta region, flooding occurred about 2 times per year during the period 1940 to 1955. Deposition of sediment in the lower reaches was a problem. In addition, between the bluff line and Highway 17, land loss due to channel meandering was 0.94 acre per channel mile. Gravel mining operations were also identified as large contributors of sediment.

The problems on Tillatoba Creek in 1960 were reported to be primarily flooding of agricultural areas along Tillatoba Creek and upstream of South Fork confluence. Flooding occurred on the average of 4 times per year. Headcuts were reported to be progressing upstream. It was reported that below the headcuts the channels were "...wide, deep, and have a tendency to meander." Flooding did not occur below the headcuts because of increase channel capacity.

In addition to the watershed land treatment measures, stream channel construction provided 41,960 linear feet of new channel and cutoffs, 31,505 linear feet of enlargement, and 65,785 linear feet of clearing and snagging. This channel work was begun in and below the active headcuts near the confluence and were continued upstream. Finally, as a result of severe channel degradation, a major grade control structure was constructed on Middle Fork Tillatoba Creek in 1978. The purpose of the structure was to intercept the headward eroding headcuts.

The problems in the Topashaw watershed alluded to in the 1968 work plan are primarily the result of flooding. Bear Creek and Little Topashaw were flooding three times per year. As stated in the work plan, "Flooding in this watershed is unique in that flooding occurs on the upper ends of most of the streams and the channel never floods on the lower end. This is a result of an erosion overfall cycle moving upstream on the channel systems."

In 1968, 3.84 miles of excavation and enlargement of the channels in Chickasaw and Webster Counties was approved but not constructed as a result of headcutting from downstream channelization. In 1966, in Calhoun County on Topashaw Creek and Bear Creek, channel excavation, cutoffs, and channel enlargement had been completed upstream to the Chickasaw County line.

3.

WATERSHED SYSTEM RESPONSE

Historical information has shown that with settlement of the region there began dramatic changes in land use. Climatic change can also play an important role in watershed response, but a study by Riley (1962) showed that, for an 80 year period prior to 1960, 90% of the time the annual precipitation varied only by 25% from the long term average. Therefore, it is likely that land use change and channelization are the primary cause of channel response.

3.1 CHANGES IN RUNOFF, SEDIMENT YIELD, AND SEDIMENT TRANSPORT CAPACITY

Dendy, Ursic, and Bowie (1979) provided data from nineteen small single-use watersheds and five large mixed cover watersheds. The results of that study and a previous study by McGregor, et. al., (1969) indicate that long-term sediment yield for various land use categories is directly proportional to runoff. Data from the single-use plots proved to provide good estimates of sediment yield for the large mixed-cover watersheds. Table 3.1 summarizes the single-use data measured for the two referenced studies.

If we assume pre-European settlement conditions to be generally in the forest-lands category, then average annual runoff of about 5-10 inches/year and average annual sediment yield of about 0.005-0.15 tons/acre/year are reasonable values. At the period of peak cotton prices and peak drainage district activity, the combination of heavy cultivation and bare-fallow and eroding lands could have reasonably resulted in runoff values of 15-25 inches per year of runoff, with sediment production of about 50 tons/acre/year. Present values are about 15-25 inches runoff annually, and 5-10 tons/acre/year of sediment yield from the watershed.

TABLE 3.1-Annual rainfall, runoff and sediment yields for the single-cover watersheds in Upland North Mississippi

	Annual Rainfall		Annual Runoff		Annual Sediment Yield	
Land Use or Cover Type	Average (inches)	Range (inches)	Average (inches)	Range (inches)	Average (tons/ac.)	Range (tons/ac.)
Open Land:						
Cultivated	48.9	47.1-61.1	15.39	6.2-24.0	23.85	6.7-43.1
Pasture	52.2	47.1-61.0	16.52	12.9-23.4	1.61	1.21-2.03
Bare Fallow	-	-	20.00	10.0-30.0	65.00	25.0-105.0
Forest Land:						
Abandoned Fields	51.4	42.3-61.1	6.65	1.2-20.7	0.141	0.013-0.544
Depleted Hardwoods	51.2	42.6-60.0	5.94	1.2-13.1	.118	.018-.316
Pine and Hardwoods	50.5	38.4-62.4	8.74	0.4-19.8	.051	.001-.206
Pine Plantations	54.7	43.4-70.7	1.49	.1-9.7	.011	.001-.079

In addition to the increase in supply of water and sediment to the channels from the watershed, the relative variation of discharge and sediment transport capacity of the channels is of concern.

Straightening of the channels in the various drainage districts increased channel capacity. Increased gradient, a result of decreased sinuosity from 1.7 to 1, could have increased hydraulic capacity by 2 to 5 times. An increase of channel depth which may double hydraulic radius together with a decrease in sinuosity could increase sediment transport capacity by about 50 times the original channel.

These estimates are based on normal flow characteristics of a channel on a valley slope of 0.002, with an original sinuosity of 1.7, and with an original depth of about 5 feet. Sediment transport capacity varies as the 3 to 5 power of velocity.

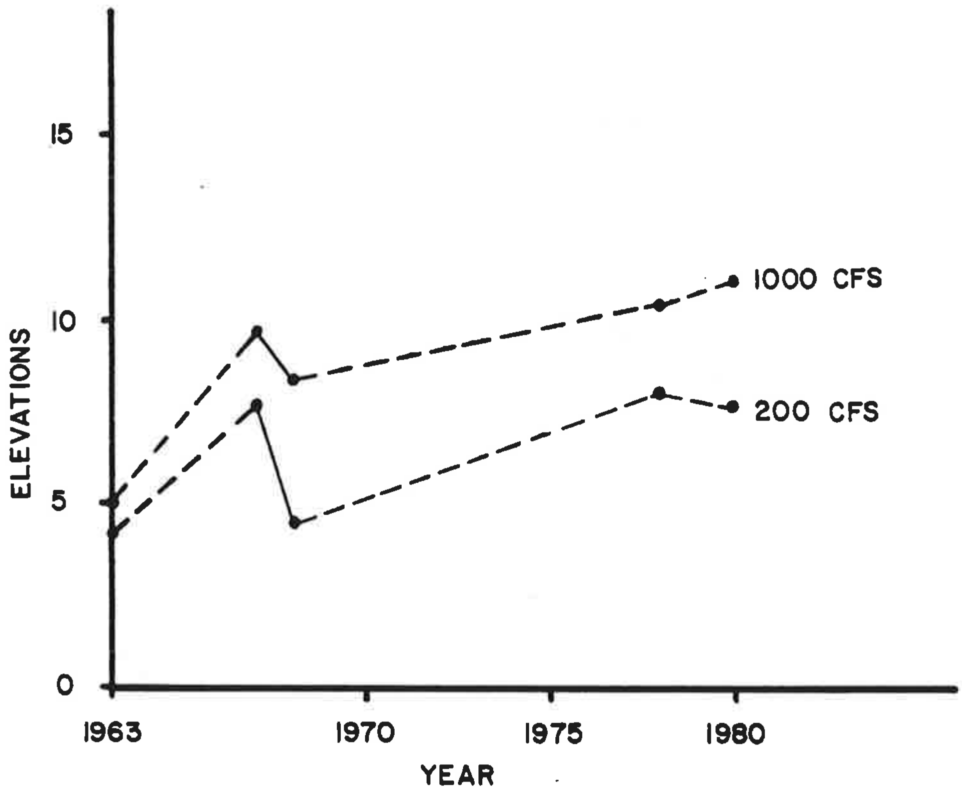
Thus, the changes in sediment yield and sediment transport capacity may be summarized as follows:

Yield Year	Average Annual Runoff (In/Yr)	Average Annual Sediment (T/Acre/Year)	Channel Sediment Capacity (mult. of 1830)
1830	5	0.05-0.15	1
1920	15-25	50	3-50
1980	15-25	5-10	3-50

It is clear from the watershed data available and the computed changes in channel sediment transport rates that in 1830 the hydrologic regime was less dynamic than in 1920 or 1980. In addition, it is evident that conservation efforts since 1920 have reduced upland watershed sediment yield, but channel sediment transport capacity has not been reduced.

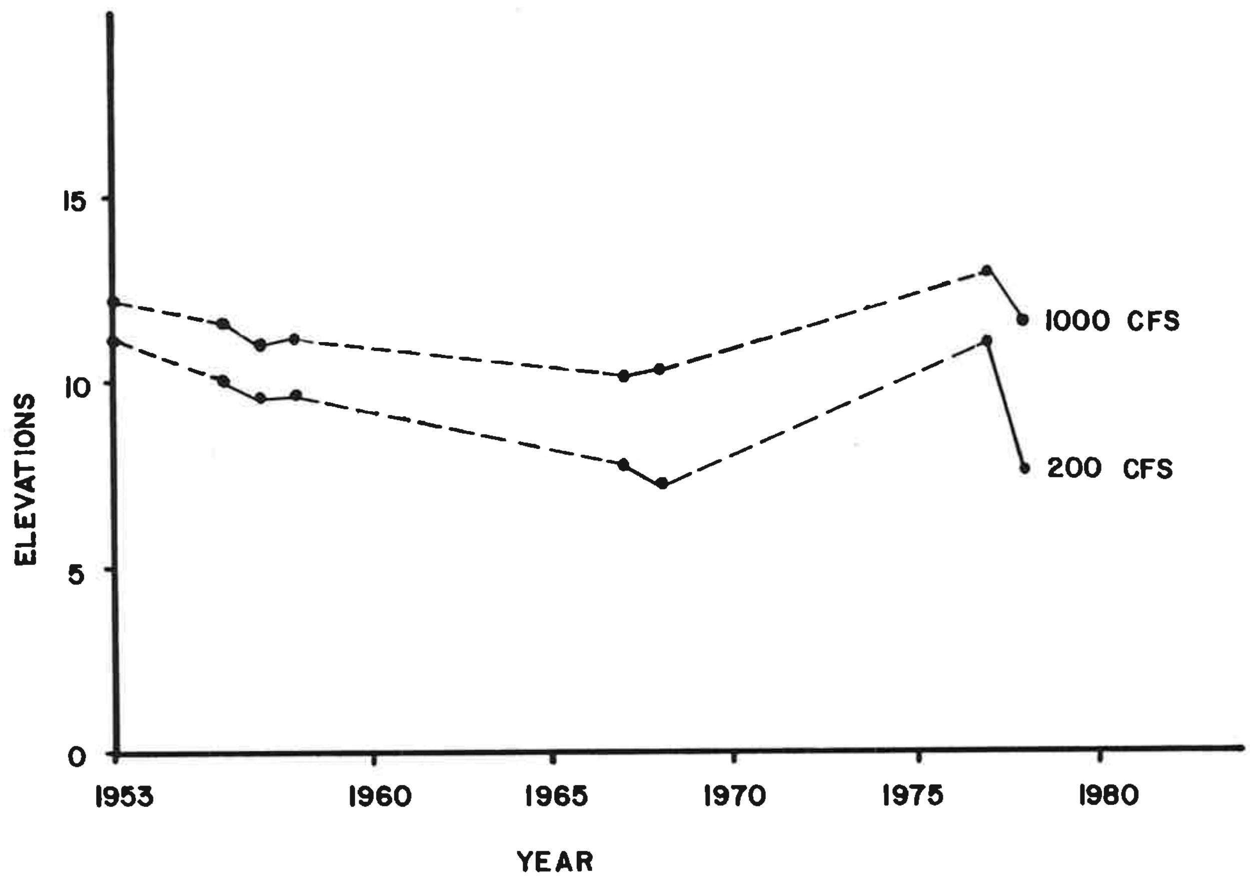
3.2 SPECIFIC GAGE ANALYSIS

The specific gage graph is among the most powerful tools available for channel analysis. The graph represents the gage height for a specific flow plotted on the ordinate with the abscissa representing time. In this case calendar years were used. Increase in stage with time indicates aggradation or deterioration of channel capacity, and conversely a decrease in stage with time indicates



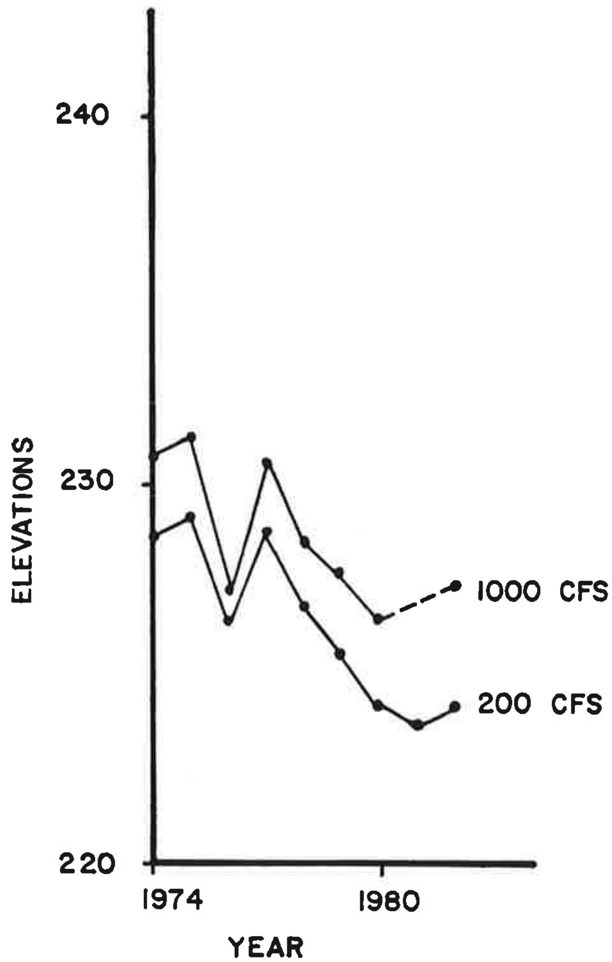
ABIACA CREEK AT PINE BLUFF, MISS.

FIGURE 3.1



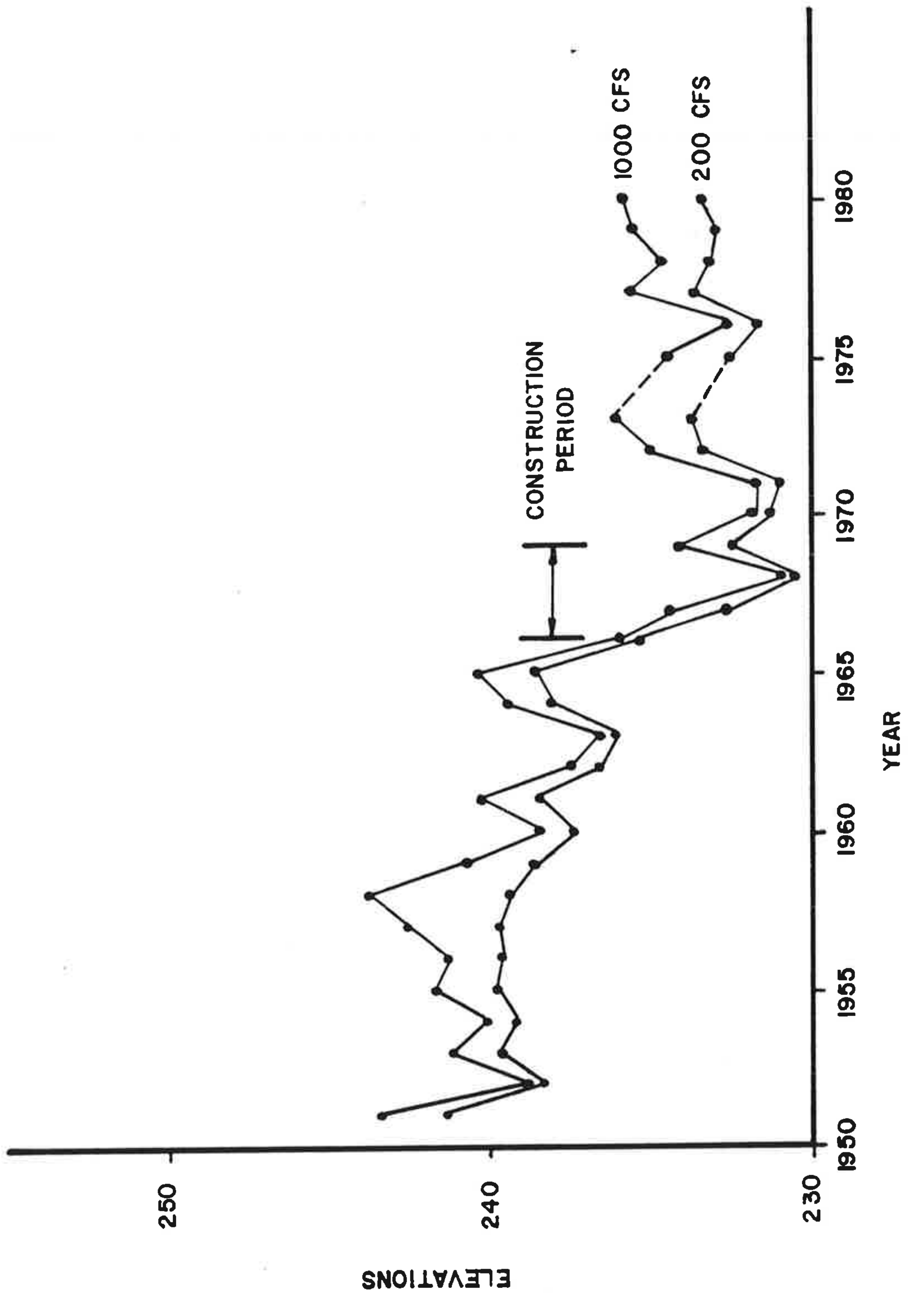
PELUCIA CREEK AT VALLEY HILL, MISS.

FIGURE 3.2



TILLATOBA CREEK BELOW OAKLAND, MISS.

FIGURE 3.3



TOPASHAW CANAL NEAR CALHOUN CITY, MISS.

FIGURE 3.4

channel degradation or an increase in channel capacity.

Figures 3.1 through 3.4 are the specific gage graphs for the following locations: Abiaca Creek at Pine Bluff, Pelucia Creek at Valley Hill, Tillatoba Creek below Oakland, and Topashaw Creek near Calhoun City, Mississippi.

Some confusion can result in reviewing the stage and discharge data published. First it should be understood that only measured discharge records were used in developing the specific gage records. Published values of discharge are based on a stage-discharge relationship which may represent the average relationship for several years. This procedure tends to mask annual trends.

In general, the solid line of the specific gage record indicates data in that year, and the dashed line indicates no useable data for that discharge in the year plotted. Measurements of discharge were not available every year for each gage.

The trend for Abiaca Creek at Pine Bluff, Mississippi, (Fig. 3.1) is that of general aggradation. The number of measurements per year and the years for which data is available are sufficient to give only a trend, however, these data clearly portray an aggrading channel reach.

Figure 3.2 for Pelucia Creek at Valley Hill, Mississippi indicates annual variation, but the general trend indicates a relative constant stage versus discharge relationship. No aggradation or degradation trend is defined.

The data available for Tillatoba Creek below Oakland, Mississippi (Fig. 3.3) is shown for eight years of record. The location of this gage is about one mile upstream of the Type-C grade control structure constructed on that channel in 1978. The data indicates a continued increase in channel capacity, or a continued channel degradation even two years after the grade control was built. This could be explained by channel straightening between the gage and the grade control structure, or this may reflect continuing adjustment of an over-steepened reach upstream of the headcut which was stopped by the structure. The limited data for 1981 and 1982 indicate that the desired stabilizing effect of the downstream structure has begun to take place.

The gage for Topashaw Creek near Calhoun City (Fig. 3-4) provides the longest history of channel response available for the four study channels. Sufficient length of record and density of measurement is available to show the manner of change in gage height which may be expected in an alluvial channel.

This specific gage provides a clear example of the effects of stream channelization. The period 1966-1969 was during the construction for two watershed work plans which required channel enlargement, cutoffs, and clearing and snagging. Figure 3.4 indicates that the stage for 1,000 CFS was reduced by about five feet. Subsequent to this initial lowering, the 1,000 CFS stage rose 3 feet, then fell two feet, and continued cycling. The general trend of this specific gage since construction has been toward aggradation back to a pre-construction-stage discharge relationship.

3.3. SYSTEM RESPONSE

Figure 3.4 clearly demonstrates the effects of channelization during construction; however, changes other than that produced by construction are evident during the entire 30-year period of the gage record. With the exception of downstream obstruction or channelization, the likely cause for the changes in stage-discharge relationship is change in the quantity of sediment being transported by the channel. Change of channel size and pattern also effect the rating curve and they can be related to water and sediment discharge.

The quantity of sediment being transported into or out of a particular cross-section is governed by the amount of sediment supplied and by the sediment transport capacity of a particular channel cross-section. In Section 3.1 there was a brief discussion made of watershed changes that affect runoff, sediment supply, and sediment transport capacity. The specific gage analysis in Section 3.2 provides a view of channel response at one cross-section on each channel.

While analysis of the response at a single cross-section through time is very beneficial, it is critical that the entire channel length and fluvial system be examined. For example in Figure 3.4 the sharp decrease in channel capacity experienced in 1969, may be because of upsteam headcutting, on which produced a more efficient channel for sediment transport to the cross-section at the gage, i.e., sediment was temporarily stored in 1969 at the gage site thereby reducing channel capacity.

In a similar manner and over a longer time period, the aggradation of Abiaca Creek, as shown in Figure 3.1, may be the result of additional sediment supply from upstream channel head-cutting, which was caused initially by channelization at the gage site. The trend of Topashaw Creek since the construction period (Fig. 3.4) may be another example of this feedback. Schumm (1977) describes this type of complex response:

> Consider the probable response of a drainage basin to rejuvenation. When baselevel is lowered, erosion and channel adjustment occur near the mouth of the basin and, in fact, the main channel probably will be adjusted to the change long before the information reaches the upstream tributaries. However, when the tributaries are in turn rejuvenated, the increased sediment production is fed into a channel that has already adjusted to the baselevel change but not to increased sediment loads from upstream. It appears that the original incision is not the only adjustment the main channel makes. In fact, a complex sequence of responses can be envisioned.

The result of the dramatic land use change or the equally dramatic effects of channelization cannot be confined to just the stream channel, to the upland watershed, or to the reaches of sediment storage, but each segment of the system will ultimately be involved in the complex series of response and feedback adjustments until a new equilibrium is attained.

Trimble (1974) alludes to a long-term complex response in watersheds of the Southern Piedmont. Following initial land use change in the 1700's, this upland sediment was eroded and stored in-channel and in terraces along the stream. Beginning in the 1930's, conservation efforts reduced upland sediment supply to the channel. By the middle 1950's the previously stored sediments were re-mobilized and began to migrate downstream.

Remobilization resulted in channel degradation, and in the

1970's examples were cited of stream bank and adjacent pasture erosion as a result of channel incisions. Denby, et. al. (1979) found on several large mixed-cover watersheds in Mississippi that channels and gullies, while constituting less than 2% of the watershed contributed 50% to 60% of the sediment yield. This has been substantiated in subsequent studies (Harvey and Watson, 1981). A significant portion of the sediment now being transported by study channels is either directly due to complex response from relatively recent channelization or to the long-term complex response, as a result of successful upland watershed conservation efforts.

4.

SUMMARY

In general each of the study channels has reacted to the settlement and land use change in much the same way: (A) Although swamped-out bottoms were evident prior to European farming methods, channel filling and swamping-out were aggravated by excessive sediment from ill-advised land use practices; (B) Channel degradation and bank erosion due to the increased stream power resulting from channelization; (C) Channel filling and flood capacity reduction due to aggradation from bank erosion plus upland sediment sources; and (D) Degradation and bank erosion due to additional channelization.

While this scenario characterizes the study channels response in a broad fashion over the past 150 years, a more complicated system is obvious to those familiar with the channels.

Of the many complex relationships affecting channel morphology, one of the most apparent that complicates the stabilization of the present channels is the variation of the material through which the channel is flowing. As the channel degrades through a layer of material that has historically resisted erosion into underlying sands which are relatively easily transported, the effect is similar to an increase in sediment supply. Thus, a massive increase in sediment can begin in a localized manner immediately downstream of each of the headcuts that are presently moving through the system.

It is unlikely that the channels have ever reached a quasi-equilibrium after being disturbed by the major land use change and channel excavation projects. Certainly, the complex response in each of the channels that was initiated by the channelization is still occurring. The cycles of gradient and shape adjustment in the channels are not simple nor easily defined, and the channel response is likely to vary temporally and spacially along a single channel. Nevertheless, identification of the cycles and the related causitive factors are essential to understanding and controlling of the channels.

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