FLOOD AND SEDIMENT INTERPRETATION AT THE HISTORIC SCULL SHOALS MILL

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REFERENCE: *Proceedings of the 1997 Georgia Water Resources Conference*, held March 20-22, 1997, at The University of Georgia, Kathryn J. Hatcher, Editor, Institute of Ecology, The University of Georgia, Athens, Georgia.

Abstract. Interpretation of the written historic record was combined with observation of alluvial land forms to construct the history of sedimentation at a historic mill site, and to inform possibilities for flood protection. The results correctly predicted additional, previously hidden remains and demonstrate the crucial role of sedimentation in the village's economic history.

INTRODUCTION

Scull Shoals is an abandoned nineteenth century mill village site on the Oconee River, managed as a historic site by the U.S. Forest Service.

Surface flooding has invited concern about potential deterioration of the mill's remains, and consequently the possibility of protection. General knowledge of the Piedmont region suggested that flooding and its companion, sedimentation, had had a dynamic history since European settlement began, and that dynamic adjustments are continuing to occur. Ongoing alluvial adjustments have a direct causal bearing on present and future flood locations and heights. Consequently the site's alluvial history and processes were investigated to place bounds on feasible alternative measures.

The research reported in this paper was supported by the U.S. Forest Service. It is reported in detail by Ferguson (in press a).

CHANGE IN THE SITE

In its time, Scull Shoals was the biggest water mill on the Oconee (Coulter, 1964). A mid-nineteenth century drawing shows at least three related buildings. The mill supported 500 laborers on 2,000 spindles and looms. It was the first brick cotton mill in Georgia; it is a candidate as the state's first paper mill. It supported a village with residences, storehouses and shops.

But today the place is empty of people. All the structures are in ruins. Low piles of brick are the only signs of houses and shops. The river grades smoothly past the site, without any sign of a shoal or dam. The only visible remains of the mill are a few low stone piers and walls, an adjacent ditch or channel crossed by an arched brick bridge. The mill remains are located in the backswamp of today's floodplain. On one side the floodplain slopes upward to sand levees alongside the river channel; on the other the Oconee backswamp merges with the floodplain of a tributary stream.

EROSIONAL HISTORY IN THE WATERSHED

In the nineteenth century and the early part of the twentieth century, cotton farming exposed the region's soil to rainfall. According to Trimble's (1974) study using geographic methods, total erosion in the watershed above Scull Shoals was 8.35 inches, sufficient to yield 413,000 acre-feet of sediment. This enormous volume is now concentrated in the stream and river valleys, where it overlies the preexisting sediment and alluvial landforms.

Figure 1 shows the cumulative erosion over time, based on interpretation of Trimble's data. The most rapid erosion happened between about 1870 and 1930.

Erosive cultivation declined after about 1930, and is now mostly absent. Open cotton fields have been replaced with the vegetative cover, organic mulch, and open, structured soil of old fields and second-growth woods. Although sediment is still suspended in rivers, the total load has declined.

SEDIMENTATION HISTORY AT THE MILL

The arrival of sediment at Scull Shoals was inferred from the written historic record and the observation of alluvial land forms. The shoal and the mill dam and buildings have been fixed features against which sediment has risen.

The first mill was built shortly after 1800. It might have exploited the shoal's natural fall with a simple diversion to a small power system at low head. With the technology of the time, the natural fall must have been at least 4 feet in order to supply power by a simple diversion, with no dam.

In 1860 a dam was built, presumably, to produce maximum head, at the crest of the shoal. The head that it produced was equal to its height of 10 feet (Coulter, 1964). Therefore the shoal below the crest was already buried 4 feet deep.

By 1887, the visible fall at the dam was reduced to 4 feet (Hunt, 1980, p. 316-319). Therefore the cumulative

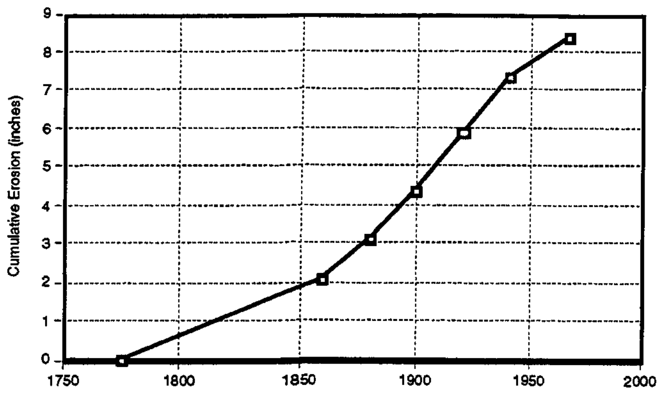


Figure 1. Cumulative erosion in the Oconee watershed above Scull Shoals.

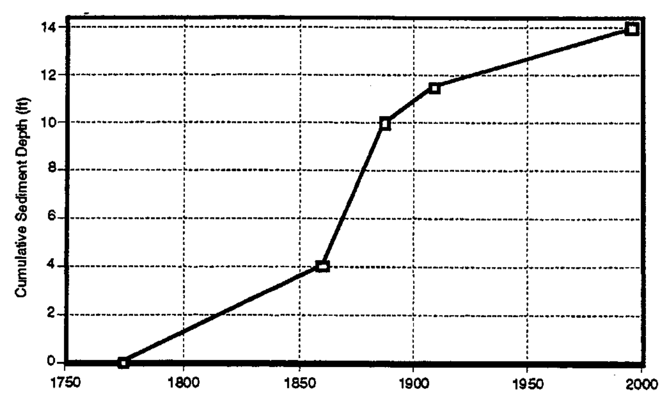


Figure 2. Cumulative sediment depth at the base of the shoal at Scull Shoals.

depth of sediment at the base of the shoal was 10 feet.

In 1887 a great flood occurred following enormous rainfalls. The water mill was no longer operable (Coulter, 1964). Extraordinary flooding in the period of highly erosive land use could have carried an enormous one-shot load of sediment.

Two years later, a report of the Chief of Engineers of the U.S. Army (cited in Hunt, 1980, p. 318) stated that the mill's water power had "failed from silting of the river below the dam". Head was reduced to 4 feet under favorable conditions.

In about 1909, only 2.5 feet of fall remained at the dam (Hunt, 1980, p. 316-319). Therefore cumulative sediment depth was 11.5 feet.

Today, the dam is entirely buried and hidden from view. If it is assumed that the 1860 headwater intake is at or near the floodplain surface where a headwater-like channels can be seen, then the floodplain surface is at or near the top of the dam. Therefore the total sediment depth today is 14 feet.

The result of these interpretations is summarized in Figure 2. The steep slope in the late nineteenth century indicates the period of most rapid sedimentation. It corresponds roughly to the period of most rapid watershed erosion.

BURIAL HYPOTHESIS

It must be hypothesized that a substantial quantity of the mill's remains are buried in anthropogenic sediment. This hypothesis is supported by the great quantity of erosion in the watershed, alluvial land forms that sedimentation left behind, the relationship of the land forms to visible mill remains, the absence today of a significant natural fall in the river or any sign of a dam, and written accounts of the rise in the mill's tailwater during the cultivation period.

Figure 3 shows the hypothesized change in the river bed in the period of European settlement. Before settlement, the channel flowed at a relatively low gradient to the crest of the bedrock shoal, fell sharply down the shoal, and then continued downstream at a low gradient. Farming-generated sediment raised the channel to a relatively steep gradient in accord with the heavy sediment load. The sediment's downstream progress was delayed by the Scull Shoals dam, and other dams elsewhere on the river system. After the sediment filled the dam ponds, it flowed unrestrained down the river system during the most erosive land use period—hence the great rise in sediment after 1860. It filled the valley particularly deeply at the base of the shoal, hence the great rise in tailwater that caused the failure and burial of the mill. Sufficient sediment accumulated that the river now forms a continuous gradient across all of the buried features.

Thus sediment has covered all the power system, the structure(s) that housed the system, and the dam(s) attached to the power system. As one walks around on the floodplain surface, the bulk of the mill remains are under one's feet. The portions of mill piers and walls visible above-ground today may represent the top of the ground floor where the power system was housed.

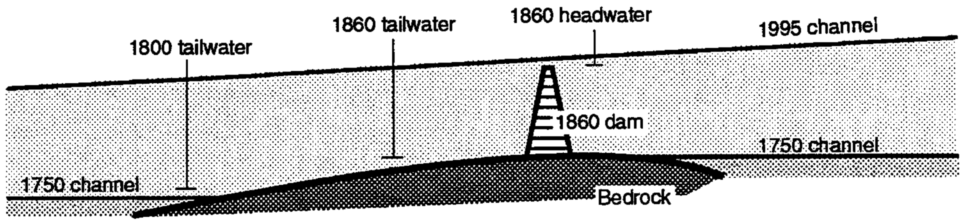
Direct evidence, confirming the burial hypothesis, was provided by subsurface surveys. A magnetic survey found a large iron mass, presumably a turbine, buried in the mill area (Kittner, 1995). A radar survey found alluvial sedimentary layers lying against buried masonry walls.

According to this hypothesis, the buried shoal and dam could be located along the river essentially adjacent to the mill. This would place the mill in its most logical position to take advantage of the site's natural fall. But they may not be buried entirely beneath today's channel. As the river bed rose upon its sediment, it was free to meander laterally. The shoal and dam may be buried under what is today a dry floodplain surface.

PROSPECTS OF FLOOD PROTECTION

The magnitude of contemporary surface flooding at the mill was established during site visits in late 1995. A USGS gaging station is fortuitously located on the

Figure 3. Hypothesized change in the river profile at Scull Shoals.



Oconee at Penfield, one mile downstream from Scull Shoals.

On November 10, 1995, a receding flood was observed leaving flood marks at the level of the uppermost brick on the mill's arched bridge. At the gaging station, the peak flow of that flood had a daily discharge of 6,680 cfs. In the annual-maximum series of high flows, the recurrence interval of this discharge is about 1.2 years.

The approximate height of larger floods was extrapolated from the known height of the 1.2 year flood, using USGS records relating Penfield gage height to discharge, and Stamey and Hess' (1993, p. 52) relationships of recurrence interval to discharge rates at the gaging station. The 50 year flood is about 13 feet higher than the 1.2 year flood, making it 13 feet higher than the top of the mill's arched bridge.

Surface flooding at the mill occurs whenever the Oconee, the tributary stream, or both overflow their banks. Out-of-channel water washes toward the mill from every direction. When a flood recedes, standing water remains in the mill's topographic sump for weeks.

Surface water in the mill sump is presumed to be hydraulically continuous with ground water in the alluvium. The ground water is recharged by infiltration whenever the river and stream overflow their banks, and during every rainfall. Water standing in the mill sump remains long after channel flows have receded because of the low rate of ground water flow through the alluvium back to the river channel.

Buried mill remains are in contact with ground water. The frequency and duration of saturation increase with depth in the alluvium. If the sediment is more than 10 ft deep, then the foundations of the mill are below not only today's normal water level in the Oconee River, but also the permanent water level of Lake Oconee.

Thus flood protection is neither feasible nor constructive. The construction of a dike extensive enough to give significant protection from surface flows would conflict with the preservation objective of the site. There is no possibility of preventing rain water or ground water from collecting in the mill's topographic sump. Buried mill remains are in contact with ground water; the most deeply buried remains are permanently saturated.

ONGOING ALLUVIAL PROCESSES

The sediment that was added to the river corridors during the cotton period is still in the floodplains and is still moving. Headwater and small tributary streams throughout the watershed are incising into their sediment deposits. Their erosion produces sediment that washes downstream. The overall mass is gradually shifting downstream.

Secondary sediment eroded from upstream tributaries, supplemented by that from any continuing hillslope erosion, reduces net sediment outflow at mainstem locations such as Scull Shoals. Deposition of levee and backswamp sediments observed following the November 1995 flood shows that sediment is continuing to arrive from upstream, although building of floodplains could still be happening at a low rate even while the bed begins slowly downcutting. The morphology of the nearby tributary suggests quasi-equilibrium of both the tributary and the Oconee channel by which it is controlled. Consequently the rate of vertical change of the channel at Scull Shoals is very slow, whatever its direction. The channel is maintaining near-equilibrium while gradually readjusting to past stresses. The incision process at such places is lagging behind that of typical headwaters.

In the long run, perhaps after further gradual aggradation, the Oconee channel is expected to incise. The tributary must follow the Oconee to meet it at grade. As the river sinks into contact with the buried dam, it may adjust horizontally toward an older, dam-controlled alignment. Flood heights and ground water levels may gradually decline. The day may come, many human generations in the future, when the upper mill remains will be free-standing except for an apron of sediment with the water of the river lapping at its base.

As the river cuts down at Scull Shoals, while a delta forms at the head of Lake Oconee, gradient, energy, and potential depth of channel incision will decline. If sediment at Scull Shoals is more than 10 feet deep, then the lowest portions of the mill remains are below the lake's permanent water level and will never be exposed. Thus the river's incisive potential can be realized only partly, and only slowly.

IMPLICATIONS FOR PIEDMONT WATERSHEDS

These results illustrate, for a typical Piedmont watershed, the magnitude of anthropogenic disturbance that occurred in the past, the alluvial readjustments that are taking place today, the length of time that will be required to complete those readjustments, and the difficulty of overcoming the legacy of prior environmental disturbances.

In principle, the incising of Piedmont channels is a natural process of equilibration to contemporary regimes of sediment and water, and we need not stand in its way.

However, in small tributary streams the process of incision can be destructively rapid, because they tend to lack counterbalancing influences proportional to the alluvial disturbance from which they must adjust. This has invited construction of grade controls and streambank stabilization measures in some small streams (Ferguson and Gonnsen, 1993).

In contrast, main streams such as the Oconee at Scull Shoals are reacting relatively slowly, because they continue to receive sediment from their eroding tributaries. Stabilizing measures should not be added to streams that are already within the homeostatic zone of shifting equilibrium (Ferguson, in press b). The Oconee and other main Piedmont rivers are resilient and self-regulated, while continuing to change in the long run. The overall rate of adjustment will ultimately decline. As sediment shifts downstream, vegetation will take over relatively stable banks, turbidity will decline, and the system will further approach equilibrium.

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