A STUDY OF THE AMOUNT OF SEDIMENT CARRIED BY RUN-OFF WATER

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The problem of the removal of sediments by surface movement of water has been studied for a long period of time. Under natural conditions in Oklahoma erosion has been reduced to a minimum by the presence of prairie and forest cover but man in his attempt to develop a more intensive type of agriculture has destroyed those factors which tend to restrict erosion. To those who are interested in a permanent agriculture this is a serious matter and at the present time two extensive movements are in progress; one of them interested in the control of floods and the other interested in soil conservation.

For several years research has been conducted at the Missouri Agricultural Experiment Station on the amounts of sediment carried in runoff water and data have been secured which show that crops which cover the surface of the ground greatly retard erosion. In much of Oklahoma with the exception of the wheat belt row crops cover a major portion of the cultivated land and conditions are very favorable for soil washing. In Texas studies similar to those conducted in Missouri are in progress and recently the United States Department of Agriculture has started an extensive erosion survey in many different places, one of which is located near Guthrie, Oklahoma.

As a result of the interest which has been developed in soil conservation many interesting statements have been made in regard to the rate of soil losses. In two different addresses which were heard by the senior author certain data were presented which certainly impressed the seriousness of soil erosion on the minds of those present. One of these statements was that the Arkansas River in flood stage carried 17 percent of total solids. The other was that a swollen stream at flood stage was carrying 50 percent of total solids. A brief review of the literature indicated that some of the streams in the western part of the United States carried large amounts of sediments. La Rue[3] reports that the Colorado River carries as high as 3.263 per cent silt in some floods, but the velocity must exceed 3 feet per second for much silt to be carried; altho a current of four or five feet per second may not carry much sediment. Data on the Gila river show as much as 9.406 per cent silt.

Pierce[4] states that 9 per cent of silt occurred in a stream flowing at the rate of 8 feet per second.

Parker[3] found 0.6734 per cent of sediment in the Cimarron river at Englewood, Kansas, when the stream was at flood stage.

Stabler[6] reports that the maximum amount of suspended matter in the North Fork of Red River near Granite, Oklahoma, was 1.6 per cent and the average for floods during the period of 1905 to 1907 was less than 1 per cent. During the period 1905 to 1906 near Mangum on the Salt Fork of Red River the maximum amount of sediment carried in suspension was .779 per cent.

Since a limited amount of data was found on the sediments carried by runoff water in Oklahoma further information seemed advisable.

EXPERIMENTAL

During the past year several good opportunities were available for studying the amount of sediment carried by streams at flood stage because of the heavy rainfall which occurred during the spring months. Samples of water were secured from streams near Stillwater on different dates following heavy rains and also other samples were secured where runoff water was passing over cultivated land and where it was leaving terrace outlets. A part of the data secured are given in Table I.

TABLE I
TOTAL SEDIMENT AND SOLUBLE SALTS IN SAMPLES OF FLOOD WATER SECURED NEAR STILLWATER, OKLAHOMA

No.	Location of Sample	Date	Velocity of water in feet per second	Per cent of suspended matter	Per cent of soluble salts
1	Stillwater Creek Bridge, 2 mi. west of Stillwater	4-14-29	3.04	.356	.014
2	Stillwater Creek Bridge, 2 mi. west of Stillwater	4-14-29	3.04	.353	.017
3	Stillwater Creek Bridge, 2 mi. west of Stillwater	4-15-29	2.02	.279	.021
4	Stillwater Creek Bridge, 2 mi. west of Stillwater	4-15-29	2.02	.269	.021
5	Stillwater Creek Bridge, 2 mi. west of Stillwater	*4-15-29	2.02	.268	.022
6	Black Bear Creek near Morrison	4-15-29		.199	.022
7	Spillway, Boomer reservoir, Stillwater	4-15-29		.038	.022
8	Cimmaron River Bridge, Coyle	4-15-29		.239	.080
9	Cow Creek Bridge, 2 mi. west of Stillwater	4-24-29	3.76	.800	
10	Stillwater Creek Bridge west of Stillwater	4-24-29	3.00	.980	
11	Agricultural Experiment Station Farm, Stilwater	4-24-29		2.680	
12	Agricultural Experiment Station Farm, Stillwater	4-24-29		1.500	
13	Agri. Experimental Station Farm, Stillwater **	4-24-29		.400	
14	Agricultural Experiment Station Farm, Stillwater	4-24-29		.960	

*Sample taken near bottom of channel in water 5 feet deep.
**Sample taken where water was flowing across a road, temporary pond above.

An examination of the data presented indicates that the total sediment carried by streams in the vicinity of Stillwater is lower than that carried by streams in southwest Oklahoma and in the Colorado River and its tributaries. Samples of water taken from Stillwater Creek at flood stage on April 14 contained considerably more suspended matter but less soluble salts than on the following day when the stream had receded in height and velocity. On April 15 about the same amount of sediment was in suspension at the surface as was present in the water near the bottom of the channel. On April 24 the amount of sediment carried by the

stream as it was rising was much greater than on April 14 but the speed of the current was practically the same. In both instances heavy rainfall had occurred and in the latter case about three inches of rain fell in less than two hours. This resulted in a very rapid rise in the height of the stream and probably accounts for the increase in the amount of suspended material. Samples of water secured from water flowing over cultivated land contained much larger amounts of sediment than was found in suspension in the flood waters of the creeks which were studied. Much of the sediment in water flowing across the cultivated land settled quickly indicating that fine sand predominated over the silt and clay. This condition would vary considerably in soils of lifferent texture. The area on which these samples were secured was a loam. Sample No. 13 was taken where part of the water was flowing across a road because the culvert was not large enough to carry all of it and the current was slackened considerably in the temporary pond which formed. Comparing the amount of sediment in this sample with Sample No. 12 which was taken from the field a few hundred feet north of the point where the water crossed the road, it will be noted that the major portion of the sediment was dropped when the water passed thru the pond. The sediment in the overflow from Boomer reservoir also illustrates the difference between water flowing into and out of a lake, less than 10 per cent of the sediment entering the lake passing over the spillway. In case of streams carrying a heavy load of sediment and flowing into a flood control reservoir the effect would be a rapid filling of that portion of the reservoir which was designed to hold water for irrigation purposes and this is a problem which will cause engineers considerable trouble if combination irrigation and flood control reservoirs are constructed as was recently suggested by Alvin Rucker in the Daily Oklahoman, published at Oklahoma City, Oklahoma, Oct. 27, 1929.

In an experiment conducted by R. W. Baird of the Oklahoma Agricultural experiment station on an area of 1.15 acres having a total length of 650 feet and an average width of 77 feet with a levee along the lower side having a variable grade from 0 at the beginning to 4 inches per 100 feet at the outlet, definite measurements of total runoff and the amount of sediment in the runoff water have been secured. The slope of the land is about 3.9 per cent.

From April 28, 1928 to October 31, 1929 a total of 41.07 inches of rain fell. Of this amount 14.167 inches passed thru the weir at the terrace outlet. This is 34.49 per cent of the total rain that fell. In case of some of the heavier rains more than two-thirds of the total rainfall passed thru the weir. The total solids in the runoff water varied considerably depending on the condition of the soil. Some of the heavier rains that fell rapidly did not remove as much soil as smaller rains. The lowest amount of sediment in runoff water was 0.05 per cent and the highest value was 0.80 per cent. The average amount of sediment carried in the runoff water was 0.205 per cent for 22 rains which were large enough to cause runoff.

A comparison of the figures secured on the sediment carried by water coming from terraced land indicates that the values are lower than the

maximum sediments occurring in streams at flood stage. This would indicate that terraced land would prevent a silting in of stream channels but would not prevent the gradual filling of reservoirs which are being recommended as a means of flood control.

The total amount of sediment removed from one acre of terraced land over the period of this experiment which was 20 months was about 5,150 pounds of soil. The total amount of sediment removed from a depression in two acres of unterraced land which received water from three acres of adjoining land was equivalent to a loss of 45 tons of soil per acre over the five acres during the same period of time. These data merely show the marked differences which occur when the runoff water is allowed to concentrate at different places in a field as compared to areas where the water movement is controlled with levees having a low gradient.

Even tho the land is terraced the rate of erosion of cultivated soil would still go on nearly six times as fast as the average figure given for Oklahoma by the National Conservation Commission[5] which is one inch in 720 years.

SUMMARY

A study was made of the amount of sediment carried in runoff water occurring in streams at flood stage, and from terraced and unterraced soil.

In the cases studied, streams at flood stage contain less than one per cent of total solids in suspension when the rate of flow is 3 feet per second or less.

Water flowing across cultivated fields carries much larger quantities of sediment which is quickly dropped when the velocity of the water decreases.

Water coming from terrace outlets contains on the average less total solids in suspension than streams at flood stage. In this study it was found that runoff water reduces the amount of erosion to less than eight per cent of that occurring on unterraced land.

It was estimated that at least 90 per cent of the sediment carried into Boomer Reservoir at Stillwater, Oklahoma, settle out before the excess water passes over the spillway.

REFERENCES

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