Goodwin Creek, Mississippi

(An ARS Benchmark Research Watershed, one of 24 CEAP watershed projects.)

Characteristics

Goodwin Creek drains 2132 ha in Panola County which is in the north central part of the state of Mississippi. Drainage is westerly to Long Creek which flows into the Yocona River, one of the main rivers of the Yazoo River Basin, a tributary of the Mississippi River. The watershed is divided into 13 subwatersheds, which range in size from 28 to 1292 ha. The watershed is located in the loess-covered, bluff hills province just east of the Mississippi River flood plain. Elevation on the watershed ranges from 71 m (233 ft) to 128 m (420 ft) above sea level, with an average channel slope of 0.004 m. The soils on the watershed consist of two major associations. One soil association is the Collins-Falaya-Grenada-Calloway association that is mapped in the terrace and flood plain locations. These soils are poorly to moderately well drained and include much of the cultivated area in the watershed. The other soil association, the Loring-Grenada-Memphis association, developed on the loess ridges and hillsides. These soils are moderately well to well drained on gently sloping to very steep surfaces and include most of the pasture and wooded area of the watershed. The soils are silty in texture and quite easily eroded when the vegetation cover is removed. The climate on the watershed is humid, with average daily maximum temperatures of about 30° C in the summer and 10° C in the winter. Most major runoff events occur during winter and spring seasons. Average annual rainfall of the watershed, measured at the climatological station near the center of the watershed, is 1440 mm, while the mean annual runoff has been determined to be 145 mm at the watershed outlet. Land use on the watershed has changed from nearly equal portions of cultivated, pasture, and wooded in 1980 to 10% cultivated at the present time. Cultivated land is primarily composed of cotton, soybeans, and corn.

Environmental Impacts

1. Water Quality: Runoff contaminated with sediment, phosphorus, and fecal coliforms.
2. Fish and Wildlife Habitat: Aquatic habitat impaired by unstable substrate, lack of pool habitat, and by highly suspended sediment concentrations, which has caused reduced sizes and species composition of fish and invertebrates.
3. Soil Quality: Soil quality has been adversely affected by excessive erosion.

Management Practices

1. Conservation reserve program (CRP, 327).
2. Channel stabilization (584)
3. Grade stabilization structures (410)
4. Stream habitat improvement and management (395)
5. Channel bank vegetation (322)

Research Objectives

Evaluate watershed and channel responses to conservation practices over the period of record of the watershed. Conservation practices on this watershed include conversion of erodible cropland to the conservation reserve program (CRP,327), channel stabilization (584), grade stabilization structures (410), stream habitat improvement and management (395), channel bank vegetation (322).

Approaches

The research related to CEAP on Goodwin Creek will combine field, laboratory, and computer modeling components. The field and laboratory studies will concentrate on the accurate measurement and prediction of sediment transport rates by the channels of the watershed. This capability is critical for the accurate determination of sediment amounts, sources, and contaminants. A key factor that will be studied on Goodwin Creek is the determination of the sources of sediment and its effects on the environment. Previous studies have shown that channel erosion provides a significant contribution to the total sediment load of the watershed. Samples of fine sediment will be automatically collected at the measurement stations of the watershed. These will be combined with experimental measurements of sediment concentration collected using acoustic backscattering to yield a record of sediment load. Soil properties of the watershed will be quantified and used for sediment source determinations and modeling inputs.

Completed (historical) studies have documented the effects of channel and bank stabilization on stream fishes and invertebrates. In particular, populations within reaches stabilized using traditional structures and reaches with structures modified to produce more pool habitat have been compared over 3-10 year periods. Some of these studies have documented the temporal variation in bed material size with channel erosion and deposition and the hydraulic retention at baseflow of reaches with and without small beaver dams.

Sediment source information will be determined in the suspended sediment of Goodwin Creek during runoff events using activities of ^{7}Be and ^{210}Pb. Activities of ^{7}Be and ^{210}Pb are measured from precipitation, soil, bank, and suspended sediments in the Goodwin Creek watershed. Gamma spectroscopy is used to determine the activities of ^{7}Be and ^{210}Pb in all samples. Suspended sediment in Goodwin Creek is a mixture of landscape derived and bank derived sediment. The activities of ^{7}Be and ^{210}Pb of the surface soils will be significantly higher than corresponding activities of the bank sediments. The radionuclide signature of the suspended sediment will lie intermediate along a mixing line between the signatures of the two end-member sources of sediment. Thus, fine suspended sediment in Goodwin Creek has an intermediate radionuclide signature that is quantified in terms of the relative contribution of landscape derived and bank sediment. This data will be valuable in evaluating source information from CONCEPTS and AnnAGNPS.

Continuous monitoring of hydrologic, hydraulic and geotechnical controls of streambank failures is being conducted along an active meander bend and at edge of field gullies. The data from these studies are used to enhance a deterministic model of bank stability, to support finite-element modeling of seepage, and to develop a predictive model of gully migration and erosion. Top-bank vegetative treatments are being monitored to quantify the hydrologic and mechanical effects of riparian vegetation on bank stability and their potential role as a conservation measure. These efforts will provide data for enhancements to routines in CONCEPTS and AnnAGNPS.

The historical and newly acquired conservation data from NRCS will be used with AnnAGNPS and CONCEPTS to evaluate watershed and channel responses to conservation practices over the period of record of the watershed. The simulated values will be verified using field-collected data on sediment concentrations, sediment sources, and bank retreat rates. This will assure that the models are adequately representing the processes acting on the watershed. Model simulations using AnnAGNPS and

CONCEPTS will be made to evaluate different scenarios of conservation practices and sources of sediment. Changes in water quality parameters from 1985 through 2005 will be evaluated in terms of the conservation practices used on the watershed.

Selected References

1. Alonso, C. V, and R.L. Bingner. 2000. Goodwin Creek Experimental Watershed: A unique field laboratory. ASCE, Journal of Hydraulic Engineering, 126(3): 174-177.
2. Kuhnle, R. A., Simon, A., Knight, S. S. 2001. Developing Linkages Between Sediment Load and Biological Impairment for Clean Sediment TMDLs. Wetlands Engineering and River Restoration Conference, ASCE, Reno, Nevada, August.
3. Langendoen, E. J., R. L. Bingner, C. V. Alonso, and A. Simon. 2001. Processbased stream-riparian modeling system to assess stream TMDLs. In Proceedings of the Sediment: Monitoring, Modeling, and Managing, 7th Federal Interagency Sedimentation Conference, Reno, NV, 25-29 March 2001. p. VII-57 - VII-64.
4. Pollen, N., Simon, A., and Collison, A. 2004. Advances in assessing the mechanical and hydrologic effects of riparian vegetation on streambank stability. *In* Riparian Vegetation and Fluvial Geomorphology. Bennett, S. and A. Simon (Eds.). Water Science and Application 8, American Geophysical Union, pp. 125-140.
5. Simon, A., Curini, A., Darby, S.E., and Langendoen, E.J., 2000, Bank and nearbank processes in an incised channel. Geomorphology, v. 35 193-217.
6. Steiner, M., J.A. Smith, S.J. Burges, L.C. Sieck, and C.V. Alonso. 2002. How much rain reaches the surface? Lessons learned from very high-resolution observations in the Goodwin Creek watershed. Proceedings, 16th Conference on Hydrology, American Meteorological Society, Orlando, Florida, pp. 61-65.
7. Wood, A.L., Simon, A., Downs, P.W., and Thorne, C.R., 2001, Bank-toe processes in incised channels: the role of apparent cohesion in the entrainment of failed bank material. Hydrological Processes, 15(1), 39-61.

Collaborators and Cooperating Agencies and Groups

NRCS has established two SCAN (soil climate analysis network) sites on Goodwin Creek. These sites provide longterm geographically distributed soil climatology data. One wooded and one pasture site were chosen where soil moisture and temperature at several different depths were being measured.

NOAA has identified Goodwin Creek for co-location of solar surface radiation budget (SURFRAD) and surface thermal energy and CO2 exchange (FLUXNET) monitoring stations as part of nationwide networks. Data on those parameters is collected on a continuous basis and related to other watershed processes.

University of Mississippi National Center for Physical Acoustics (NCPA) has been involved in ongoing cooperative projects to use acoustics to improve the measurement of sediment transport on Goodwin Creek.

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