Impacts of Reforestation upon Sediment Load and Water Outflow in the Lower Yazoo River Watershed, Mississippi

Background

The Center for Bottomland Hardwoods Research, USDA Forest Service, was contracted in January 2013 by the U.S. Endowment for Forestry and Communities to conduct research on the impacts of reforestation and forest management on water quality and flood attenuation. Following is a summary of their report, *Impacts of Reforestation upon Sediment Load and Water Outflow in the Lower Yazoo River Watershed, Mississippi* (in press, Ecological Engineering).

Summary

Assuming that other conditions remained the same except for reforestation, this project demonstrated that the percentage increase in forest land is proportional to the percentage decrease in total volume of water outflow, which contributes to flooding, and to the total reduction of the mass of sediment load through watershed outlets. Stated simply, reforestation reduces surface water runoff and prevents runoff-associated soil erosion generated by agricultural practices.

Methodology and Study Sites

Modeling was used to quantify the effects of reforestation on water outflow (water flowing out of watersheds) attenuation and sediment load reduction in two watersheds in the Lower Mississippi River Alluvial Valley. Specific objectives included: 1) using the U.S. EPA's BASIN-HSPF model for predicting the water outflow and sediment load in selected watersheds; 2) calibrating and validating the hydrological and sedimentation components of the model using actual field data; and 3) applying the model to investigate the impacts of reforestation (conversion of agricultural land into forests near the streams being modeled) on water outflow attenuation and sediment load reduction.

Two Lower Mississippi River Alluvial Valley watersheds were selected (Fig 1.): (1) the Lower Yazoo River Watershed in the southern part of the Yazoo River Basin, which represents a large scale watershed (152,753 acres), and (2) the Peters Creek Watershed from the Yocona Sub-basin, a somewhat smaller watershed (50,338 acres). The major reason for selecting these two watersheds was the availability of field observed data that are necessary for model calibration and validation.

Two simulation scenarios were performed. The first was chosen to predict the water outflow and sediment load without reforestation (0% conversion); the second was selected to project the potential impacts of reforestation upon water outflow attenuation and sediment load reduction following the conversion of 25%, 50%, 75%, and 100% of the agricultural lands into forests near the streams.

Results

Comparison of the simulation results with and without reforestation showed that a conversion of agricultural land into forests near the streams greatly attenuated water outflow and reduced the sediment load contributed by the reforested areas from the Yocona River to all lower reaches within the Lower Mississippi River Basin adjacent to the Gulf of Mexico. The predicted reduction occurred because

forests reduce surface water runoff and prevent runoff-associated soil erosion. In general, the larger the conversion area, the greater the water outflow attenuation and sediment load reduction that resulted, although specific outcomes were site-dependent. For the Lower Yazoo River Watershed, a two-fold increase in forest land area would result in approximately a two-fold reduction in the annual volume of water outflow as well as an annual reduction in the mass of the sediment load into the stream (Fig. 2).

Water outflow attenuation is defined as the reduction of water volume flowing out of the watershed per acre increase in forest per year. On average, for each acre increase in forests, the water outflow through the Lower Yazoo River Watershed outlet was reduced by 0.082 acre-ft/y and through the Peters Creek Watershed by 0.0005 acre-ft/y. Results demonstrated that reforestation near streams had profound impacts and is a useful practice for water outflow attenuation.

Sediment load reduction is defined as the mass of sediment that is not eroded into the stream per acre increase in forest per year. On average, for each acre increase in forests, the sediment load through the watershed outlets was reduced by 1.6 ton/y for the Lower Yazoo River Watershed and 0.1 ton/y for the Peters Creek Watershed. Results showed that reforestation near the streams had discernible impacts on sediment load reduction. Specific sediment load reductions were site–dependent; discrepancies between the Lower Yazoo River and Peters Creek Watersheds were attributed to the different scales and locations within the watersheds.

Water attenuation and sediment reduction were greater in winter compared to summer. This occurred because of the wetter winters and drier summers in these watersheds, and because vegetation takes up water and forest canopies intercept rainfall in the summer but not in the winter. Under the 0% conversion scenario, during winter there is no vegetation in place to capture runoff and prevent sedimentation compared to summer when there would be a cover crop (e.g., soybeans) to capture water and hold sediment. So, the winter 0% conversion scenario would start off with greater runoff and sedimentation compared to that of summer. The greater magnitude in runoff and sediment reductions is based on greater initial flows to begin with in winter.

The overall message from this modeling effort is that an increase in forests decreased the annual average water outflow and sediment load from the watersheds.

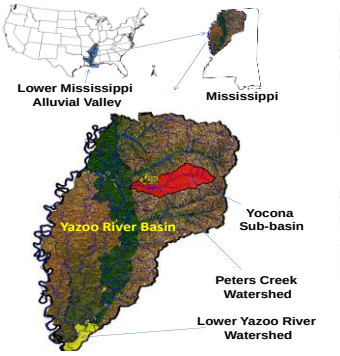

Figure 1. Locations of Yazoo River Basin along with Lower Yazoo River and Peters Creek watersheds.

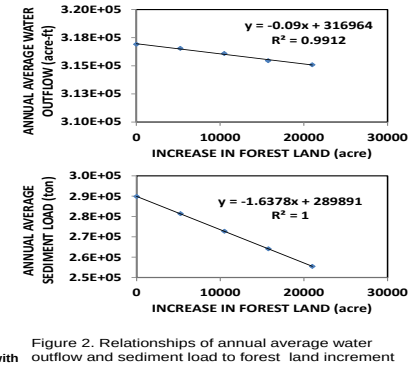

Figure 2. Relationships of annual average water outflow and sediment load to forest land increment for the Lower Yazoo River Watershed.

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