St. Joseph River, Indiana

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

Characteristics

St. Joseph River (DeKalb County, IN) - The total drainage area of this basin is approximately 281,000 ha overlapping Michigan, Indiana, and Ohio, emptying into the Maumee River in Ft. Wayne, Indiana (Figure B11, HUC04100003). The area to be evaluated is the Cedar Creek watershed, encompassing 71,000 ha, defined from the point where Cedar Creek empties into the St. Joseph River, just northeast of Ft. Wayne, IN. The majority of this watershed is within DeKalb County, Indiana. Three small sub-watersheds within the Cedar Creek watershed have been selected for detailed monitoring.

The watershed is primarily agricultural, with approximately 64% in cropland and 15% in pasture or forage. Woodlands and wetlands are found on 10%, while the remaining 11% consist of urban, industrial, farmsteads, airports, golf courses, and other land uses. Of the cropland, approximately 54% is in corn, 37% in soybeans, and 9% in wheat. Primary cropping consists of corn-soybean rotations and varying tillage practices. Cultivation practices in DeKalb County from 1990 to 2004 are summarized: (a) corn: 27% No-till, 65% Conventional Till; and 8% Reduced Till; soybean: 67% No-till, 26% Conventional Till, and 7% Reduced Till.

The topography of the watershed varies from rolling hills in Hillsdale, Williams, Noble, and Steuben counties to nearly level plains and closed depressions in DeKalb and Allen counties. The St. Joseph River follows the Fort Wayne moraine, and flows past numerous low bluffs and terraces. This indicates that the river was once much wider and deeper. Much of the St. Joseph River bed is composed of sand and gravel deposits. The average slope of the river's bottom is 1.6 feet per mile.

Soils in the watershed were formed from compacted glacial till. The predominate soil textures are silt loam, silty clay loam, and clay loam. Soil associations include Miami-Morley, Morley-Glynwood-Blount, and Blount-Pewamo. Erosion and over-saturation are the major soil limitations.

Water balance data (1) for Cedar Creek Watershed include: Annual Rainfall - 39.08 in; annual Runoff - 3.53 in. Hydrological characteristics for Cedar Creek Watershed include discharge data from 1947-2002 (3): Maximum - 5580 cfs; Minimum – na; Mean - 255 cfs; Median – na.

Environmental Impacts

1. Water Quality: Runoff contaminated with sediments, nutrients (P, NO_{3}^{-}, NH_{4}^{+}), and pesticides. The St. Joseph River serves as the drinking water supply for the 200,000 people of Fort Wayne. Fort Wayne's Three Rivers Filtration Plant processes 34 million gallons of water daily from the St. Joseph River.
2. Fish and Wildlife Habitat: streams and ditches impacted by suspended sediments that suppressed primary and secondary productivity.
3. Soil Quality: Changes in carbon sequestration as practices are implemented

Management Practices

1. Conservation Crop Rotation 328
2. Cover Crop 340
3. Deep Tillage 324
4. Drainage Water Management 554
5. Fence 382
6. Field Border 386
7. Filter Strip 393
8. Grassed Waterway 412
9. Pasture and Hay Planting 512
10. Pest Management 595
11. Residue Management 329A and 329B
12. Riparian Forest Buffer 391
13. Subsurface Drainage 606
14. Surface Drainage, Field Ditch 607
15. Surface Drainage, main or Lateral 608
16. Water and Sediment Control Basin 638

Research Objectives

1. *Water Quality:* Determine the impact of voluntary, practical, and scientifically based BMPs on pesticide, nutrient, and sediment loads in source water on a watershed basis. The ARS research objective is a part of the Source Water Protection Initiative (SWPI) being implemented in Ohio, Indiana, and Missouri.

2. *Modeling:* Development of the spatial/historical database necessary to run the SWAT model uncalibrated, calibrated and validated for the Cedar Creek watershed and ultimately for the St. Joseph River watershed. SWAT will be used to assist in the assessment of the benefits of conservation practices. Determine to what extent the information obtained from the remotely sensed data can be related to soil profile hydraulic properties.

3. Dissolved Organic Carbon (DOC) and Soil Quality Assessment: Determine effects of different practices on DOC/carbon sequestration.

Approaches

Water Quality: The research is using paired sub watersheds at different scales within the St. Joseph River Watershed at DeKalb County, Indiana, to compare surface runoff, subsurface drainage, and stream level water quality parameters with and without CORE 4 BMPs and/or other BMPs considered effective for this resource need (as agreed upon and implemented by NRCS and growers); and using watershed water quality models and long term climatic data to generate probability estimates of the water quality benefits achievable through comprehensive implementation of these conservation practices throughout these watersheds. Since 2002, ARS has identified 11 sub watersheds, ranging in size from 6 to 10,600 ac, for water quality monitoring.

Modeling: A network of real-time weather stations is currently being constructed that will provide input to SWAT and will provide insights into the spatial variability and uncertainty of weather input data. Remotely sensed soil moisture data will be used to characterize drainage patterns at the watershed scale and thus determine surface soil hydraulic properties over large areas. Data is being gathered from producers that will provide input

information from each tract within the monitored watersheds regarding management practices and timing.

Dissolved Organic Carbon (DOC) and Soil Quality Assessment: DOC has been measured for 2003 and 2004 at each sampling point (Figure 3). Experimentation is also ongoing regarding the loss of C and N with eroding sediments, and the possible enrichment of eroding aggregates with labile C and N. In addition, soil quality sampling is currently being conducted on the small AS1 and AS2 watersheds and will begin in the Upper Big Walnut (Ohio) watershed in 2005.

Small Watershed, Field and Plot Scale Experiments: Scientists at the National Soil Erosion Research laboratory are also designing and implementing additional experiments at the St Joseph River Watershed to address specific research issues related to water quality. These research results will help improve the basic science in watershed hydrology and be used to interpret the water quality results from monitored sub-watersheds. A list of these research projects is shown below:

1. Rainfall simulation studies at the field plot scale to quantify effects tillage on nutrient, pesticide and sediment losses. Tillage treatments include: conventional no-till, precision-till, and conventional tillage. In conjunction with the tillage treatment, pesticides studied include atrazine, metolachlor, glyphosate and aminomethyl-phosphonic acid (AMPA), the primary metabolite of glyphosate. Runoff samples are also analyzed for: nitrate, ammonium, total nitrogen, orthophosphate and total phosphorus.
2. Compare the hydrologic response and water quality results from the controlled field plot rainfall simulation studies to data collected from monitored subwatersheds (Figure 3) to address the scaling issue in watershed hydrology.
3. Examine water quality impacts from different surface inlet designs. In the pothole topography of the St Joe River Watershed, surface inlets are commonly used to provide drainage of excessive water from depressions. This rapid surface drainage may carry pollutant-laden runoff to drainage tiles and ditches. Beginning in 2005, a pair of closed depressions each draining approximately 3 ha (AD1 and AD2, Figure 3) will be installed with tile riser (current practice, or control treatment) and blind inlet (proposed BMP). Special flumes will be installed in the drain line to monitor flow and water quality. Additional depressional areas will be identified and instrumented as the research progresses.
4. Evaluate practices to control in-stream transport of nutrients in managed drainage ditches and potential physical and chemical treatments of drainage ditch sediments to reduce downstream delivery of nutrients.

Collaborators and Cooperating agencies and groups

St Joseph River Watershed Initiative is a local non-profit organization that cooperates with ARS in maintaining the water quality sampling sites, preserving the collected samples, collecting land use and management practice data in the study area and communicating with land owners and farm operators for the SWPI/CEAP project.
NRCS (State and Field Offices) is providing technical assistance and program support for identified conservation practices to be implemented in the watershed.
City of Ft Wayne is analyzing the weekly grab samples collected from the watershed for pesticides.
America's Clean Water Federation is coordinating the SWPI Project and assisting the congressional support.

Purdue University: Agricultural Economics Department is conducting a social-economic assessment of conservation effects in the watershed.
State and Local Agencies: Soil and Water Conservation Districts, Indiana Dept of Natural Resources, Indiana Dept of Environmental Management, Purdue University Cooperative Extension, and other organizations have been involved in promoting BMPs for improved water quality.

Selected references

1. Indiana T by 2000 Watershed Soil Loss Transects
2. Long-Term Hydrologic Impact Assessment model, Pandey, S., Harbor J., Engel B., A Web-Based Tool to Assess Impacts of Land Use Change. Urban and Regional Information Systems Association, Annual Conference Proceedings. 2001.
3. US Geological Survey, Water Resources Data http://nwis.waterdata.usgs.gov/in/nwis/

St. Joseph River Watershed 281,000 ha