Upper Big Walnut Creek, Ohio

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

Characteristics

Upper Big Walnut Creek Watershed is an 11-digit HUC (05060001-130) located in central Ohio. The watershed is approximately 492km^2 and is situated in Delaware (66%), Franklin (1%), Morrow (21%), Licking (9%), and Knox (3%) counties in Ohio. The watershed is comprised of 467 perennial and intermittent stream miles that drain into Hoover Reservoir. Hoover Reservoir has a residence time of 180 days and serves as source water for approximately 800,000 residents in and around Columbus. Average annual precipitation over the watershed is 1020 mm.

Four major soil associations are distributed throughout the watershed. The four associations are the Amanda-Centerburg (3.5%), Bennington-Pewamo-Cardington (60.0%), Cardington-Alexandra (14.8%), and Centerberg-Bennington (19.7%). Soils in the Upper Big Walnut Creek watershed can generally be described as nearly level, clayey, and poorly drained.

Crop production agriculture comprises the largest land use classification within the watershed. The primary agricultural crops are corn, soybeans, and wheat. An extensive portion of the watershed used for agricultural production is systematically tile-drained. Without the tile systems, agricultural production would be limited. In addition to crop production agriculture, a significant transition from agriculture to urban land use is occurring in the watershed. Delaware County is rated in the top 10 most rapidly urbanizing counties in the United States. The urban land use component is comprised of single- and multi-unit dwellings as well as parks and golf courses. These land use changes may significantly alter the hydrology and water quality characteristics of the watershed.

Environmental Impacts

Average annual levels of atrazine in the reservoir have fluctuated around the established MCL of 3µg L^{-1}, and the Columbus Division of Water has cited atrazine as well as other agrichemicals as potentially problematic in the future. There exists a considerable potential for soil erosion in the watershed; however, based on recent studies the projected life of the reservoir has been increased by 100 to 200 years (a positive that needs to be understood and accentuated).

Management Practices

1. drainage water management (554)
2. filter strips (393)
3. subsurface drainage (606)
4. nutrient management (590)
5. pesticide management (595)
6. waste utilization (633)

Research Objectives

*General: D*etermine the watershed scale impact of voluntary, practical, and scientifically based conservation practices.

Specific:

1. Evaluate the impact of specific conservation practices (CORE4, water table

management, soil amendments, point source/structural filters, etc.) on source water quantity and quality.

Hypotheses:

a. Installation of a specified conservation practice will have a significant impact on hydrology and pollutant loading.

b. Subsurface drainage is a significant component of the hydrologic balance and pollutant transport.

c. The impact of a conservation management practice is inversely proportional to the scale at which the impact is measured.

d. The physical and cropping characteristics (slope, time of concentration, cropping rotation, etc.) of the landscape significantly affect the impact of a conservation management practice.

e. The benefit of implementing conservation practices within a defined area is proportional to the percentage of treated area.

2. Quantify the influence of differing landscapes, land uses, and land conversion on water quantity and quality.

Hypotheses:

a. Conversion of agricultural lands to urban/suburban land use significantly alters the hydrology and water quality of a watershed.

b. Commercial turfgrass systems significantly increase the amount of nutrients and pesticides transported to surface water.

3. Assess the impact of land management practices on aquatic and terrestrial habitat.

Hypotheses:

a. A conservation management practice will increase the diversity of the terrestrial and aquatic habitat.

b. Significant increases in aquatic and terrestrial wildlife populations occur along riparian corridors.

4. Determine the impact of conservation management practices on soil quality.

Hypothesis:

a. Conservation management practices will impact the physical and chemical properties of the soil.

Approaches

This research program will be conducted in the Upper Big Walnut Creek Watershed in Ohio. The research approach includes field measurements from plots and nested, paired watersheds and incorporates model predictions. Three primary spatial scales will be investigated: edge-of-field (acres), small watershed (100s of acres), and large watershed (1000s of acres). Hydrology and water quality field data will be collected using automated samplers with and without control volumes. In each study area, storm event and base flow samples will be collected and analyzed, using standard methods, for pesticides, nutrients, and sediments. Each sampler will be programmed to record continuous 10-minute flow readings. Water quality samples including storm and base flow will be collected using a flow-proportional technique.

Water samples will be collected from March 1st to November 30th using a frequency interval equivalent to 1 mm volumetric depth. During January, February, and December, grab samples will be collected weekly when the streams are not frozen. Hydrology measurements will be collected throughout the year. The modeling approach will be carried out using the SWAT (Soil and Water Assessment Tool) model.

Hypothesis 1a: Field and modeling approaches will be used to assess the impact of a specific practice on hydrology and water quality. The field portion of this research will primarily be conducted on individual plots and fields. Baseline data on hydrology and water quality will be collected for a period of at least one year prior to the change in or installation of a specific management practice. After installation, hydrology and water quality data will be collected for a period equivalent to the life of the practice. The modeling portion of the assessment will be completed using the SWAT model. Different practices will be tested to identify those that potentially offer the most benefit once installed.

Hypothesis 1b: This hypothesis will be tested using field measurements. Hydrologic and water quality data will be collected at strategic points within the small watersheds. The strategic points will include tile outlets, with and without surface inlets as well as the watershed outlet. This will permit the partitioning of excess water and chemical transport between surface runoff and subsurface drainage.

Hypothesis 1c: This research will be accomplished by collecting hydrology and water quality data at three different scales: edge-of-field (acres), small watershed (100s of acres), and large watershed (1000s of acres). Hydrologic and water quality instruments will be installed at the three different scales. A specific practice or combination of practices will be implemented at the field level. After installation, the hydrology and water quality impacts of that practice or practices will be measured at the three identified points. The resulting data will permit the cascading impact of the practice(s) to be determined.

Hypothesis 1d: This research will be conducted using individual fields and small watersheds. Four small watersheds (2-pair), with a target drainage area of 1000 acres each, have been instrumented with automated hydrologic and water quality sampling equipment. Each pair of watersheds is characterized by different physical properties. The impact of crop rotation will be tested using an individual pair of watersheds. The impact of characteristics such as slope and time of concentration will be tested by implementing identical conservation practices on contrasting watersheds. In each case, water quality and hydrology will be measured over time to document different responses.

Hypothesis 1e: This research will be conducted at the small watershed (approximately 1000 acres) scale and will include both field and modeling efforts. The field assessment will take advantage of the paired design. In each watershed pair, one watershed will be designated a control and one a treatment. In the control watershed, implementation of conservation practices will be held to a minimum. In the remaining watershed, conservation practices will be promoted. The selected practices will be agreed upon and implemented by NRCS and operators. In addition to the small watershed scale assessment, watershed water quality models and long term climatic data will be used to generate probability estimates of the water quality benefits achievable through comprehensive implementation of specific conservation practices throughout these watersheds.

Hypothesis 2a: Two similar watersheds within the larger UBWC watershed have been selected for this assessment. Agriculture accounts for 75-80% of the land use in each watershed. One watershed will be designated a treatment watershed and the second will serve as a reference watershed. The treatment watershed is scheduled to undergo significant development (2000 plus single unit dwellings) over the next 5-10 years. Baseline data will be collected for as long as possible. Comparisons of the hydrologic and water quality data will be made to the baseline data as well as data collected from the reference watershed. Samples will be analyzed for a suite of chemicals commonly found in agriculture and urban areas.

Hypothesis 2b: This hypothesis will be tested on a commercial turfgrass/golf course facility within the larger UBWC watershed. The facility is approximately 200 acres in size and is managed at a moderately intense level. Surface water from the adjacent agricultural areas enters the course at two locations. The two inputs converge on the course and exit through one outlet. Inflow and outflow data will be collected and compared.

Hypothesis 3a: To be determined.

Hypothesis 3b: To be determined.

Hypothesis 4a: This hypothesis will be tested at the small watershed (approximately 1000 acres) scale. Four small watersheds have been instrumented for hydrologic and water quality measurements. In each of these watersheds, detailed management data is also being gathered. Each watershed contains three primary soil types and three primary operators. Soils samples will be collected from three depths (0-6", 6-12", and >12") at two different locations for each soil type and operator, resulting in a total of 216 soil samples across the four watersheds. Soil samples will be taken from the same locations every three years. The physical and chemical properties of the samples will be related to the management over time.

Collaborators and Cooperating Agencies and Groups

Local landowners and operators, UBWC water quality partnership, Delaware County Soil and Water Conservation District, The Ohio Environmental Council, Ohio State Extension Service, Ohio EPA , Ohio Dept. of Natural Resources, City of Columbus, Ohio State University, NRCS, Farm Service Agency