USDA AGRICULTURAL RESEARCH SERVICE
PASTURE SYSTEMS AND WATERSHED MANAGEMENT RESEARCH UNIT
FACT SHEET

GIS-BASED APPROACH IMPROVES ACCURACY OF PLACING PASTURE BEST MANAGEMENT PRACTICES

The **Managing Forage and Grazing Lands for Multiple Ecosystem Services** Project is one of three major projects in the Pasture Systems and Watershed Management Research Unit at University Park, Pennsylvania. The mission of this unit is to conduct research leading to the development of land, water, plant, and animal management systems, which ensure the profitability and sustainability of northeastern farms while maintaining water quality.

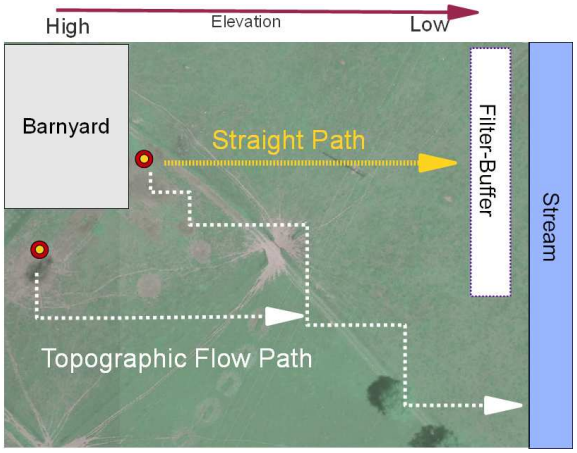
Background

Best Management Practices (BMPs) protect water quality and aquatic life by intercepting animal waste runoff before draining into streams and waterways. BMPs can keep animals out of streams and can reduce impact of animal waste and sediments before runoff reaches the stream and waterways. Common BMPs are:

- Stream-bank fencing that excludes livestock
- Vegetated buffer strips that filter runoff
- Placing feeding/watering animals away from streams

Placing buffer strips to intercept flow from a barnyard is a challenge because water moves downhill. Changes in elevation can be dramatic, but can also be subtle. On-site visits provide needed facts to judge BMP selection and implementation based on the farm layout. But on the ground it can be hard to predict where water leaving barnyards will enter the stream, or to identify the areas not protected by existing buffers. Water flow direction may change many times before reaching the stream, and these changes may not be obvious. Placing a filter strip or buffer along the straight path from the barnyard to the stream, "as the crow flies", may be ineffective. This problem is solved by using elevation data to find the topographic flow paths, the paths that water will actually follow, and to locate those areas uphill of buffered and unprotected streambanks.

Geographic Information Systems software (GIS) is a tool that links all of the information about a place: aerial photography, elevation data, and farm use or management information provided by the owner. Planners can use this GIS technology on farms to make tailored BMP placement decisions. For example, GIS shows the topography of each pasture and can indicate where filter strips should be placed to intercept flow from barnyards. The same tool can also show which areas drain directly into the stream, and should not be used as feeding and watering stations. We compared straight paths and topographic flow paths using GIS software. The methods we developed can be used by planners to locate overland flow paths and improve BMP performance and placement.



Study Site

We tested this GIS approach on three sub-watersheds of the Spring Creek Watershed (Centre County, Pennsylvania). The Spring Creek Watershed drains into the Susquehanna River and ultimately into the Chesapeake Bay. Agriculture makes up ~30% of the land use within 100m of the stream. The remaining land is roughly equally divided into residential and commercial uses.

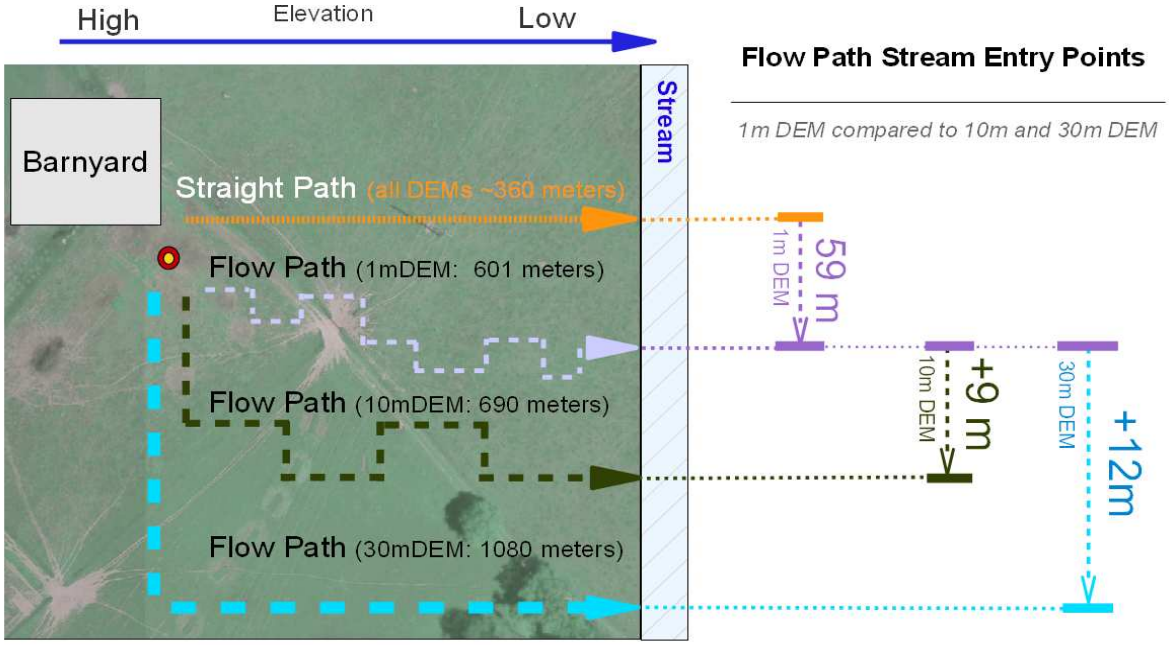
Methods

High resolution aerial photography clearly shows the presence of barnyards and animal concentration areas such as trees, feeding stations, and waterers. We searched for heavy use areas within 100m of Spring Creek, and found 471.

Prepared by the ARS Pasture Systems and Watershed Management Research Unit. For additional information contact Dr. Sarah Goslee(814-863-0887; Sarah.Goslee@ars.usda.gov; http://www.ars.usda.gov/naa/pswmru)

Elevation data for the watershed came from digital elevation models (DEMs). These are gridded maps of the landscape that show the elevation data for each grid cell, much like laying a piece of graph paper over the landscape and recording the average elevation in each cell. Like graph paper, the grid cells can be of different sizes. Finer cells show changes in elevation more accurately, but are more computer-intensive to work with. Coarser cell sizes are more readily available and easier to work with, but potentially less accurate because they average over a larger area. We used three grid cell sizes: 30m, 10m, and 1m. The 30m and 10m DEMs are freely available nationwide. The 1m DEMs are available for Pennsylvania, but not all other states.

Each DEM was used to investigate water movement from the heavy use areas to the stream. We compared the distance to the stream taken by the topographic flow path and by the straight paths. The stream offset, or the distance between the stream entry points of the straight and flow path were also compared.



Results and Conclusions

- **Topographic flow path lengths were much longer than the straight line distances.** The median straight path distance was 360m. All the topographic distances were longer: 601m and 690m for the finer-resolution DEMs, and 1080m for the coarsest DEM. Flow length can affect erosion and nutrient transport.
- **Apparent stream entry points varied widely depending on DEM used.** The 1m DEM is the most accurate available, but is hard to work with. The 10m DEM placed flows from concentration areas entering the stream within 10m of where the 1m DEM showed them, but the coarsest DEM put them farther away.

The 30m DEM grid cell size was too inaccurate for on-farm planning, but the 10m DEM is good enough to help planners place BMPs. The 10m DEMs are widely available on the internet.

This GIS-based tool can help planners place BMPs where they will be most effective at filtering and capturing run-off from animal concentration areas. New concentration areas can be located where runoff will pass through existing buffers instead of flowing straight into the stream.