Research Report
Department of Environmental Science, Dickinson College
5/12/08

Title: Elevation and Soil Hydrology at the Dickinson College Farm

Principal Investigators:

Brendan Hughes
bhughes44@gmail.com
973-207-3514

Dr. Jeffrey Niemitz
niemitz@dickinson.edu
717-245-1285

Collaborators:

Dr. Peter Sak
sakp@dickinson.edu
717-235-1423

Rob Dean
deanr@dickinson.edu
717-245-1109

Abstract: The Dickinson College Farm is transitioning from a traditionally run farm to an organic farm. This is a three year process and changes have already been made to begin this process. My research consisted of developing an independent elevation map of a portion of the farm using laser rangefinder equipment. Based on this data, I developed a series of Geographical Information Systems (GIS) maps of the farm examining the following: infrastructure (buildings, parcel boundaries, location), elevation, and hydrology related to soil series type. The hydrology map was in turn developed based on my elevation data as well as the Pennsylvania State elevation data.

Duration of Research: August 2007 – May 2008

Location: Dickinson College Farm
Contact: Jenn Halpin, Director
halpinj@dickinson.edu
717-245-1251

INTRODUCTION

The Dickinson College Farm, originally part of a larger traditionally run dairy farm, is now in the process of becoming a certified organic farm. In order to best assist the future efforts of the organic farm, my research project aims to provide a clearer picture of the elevation at the farm and how that affects the hydrology related to soil series type. Each different soil series designation provided by the National Cooperative Soil Survery (NCSS) organization (National Resources Conservation Service, 2008). Each of these series has physical and chemical properties. My research was concerned with the physical properties and how each of these affected the hydrology at the farm. The property saturated hydraulic conductivity, or Ksat, is particularly important because it describes the ease with which water can move through the pore spaces in the soil when it is saturated (NRCS, 2008).

This property is important because the farm owners are concerned with how easily pesticides/fertilizers will move through groundwater and also with surface runoff. Not only are they concerned about their own use of these substances, but also about the possibility of neighboring properties transmitting them on the college farm.

MATERIALS/METHODS

I used a Laser Technology Impulse LR laser rangefinder attached to an Electronic Compass Module II and TDS Recon Pocket PC running Windows Mobile to collect elevation data points at the farm. This was a two person process whereby one person would operate the rangefinder and shoot to the other person who was holding a reflective black plate. Each of these data points contained x, y data and elevation based off an original origin point. Essentially all of these points then existed by themselves; they weren't connected to any real elevation data at the farm.

I then used a Garmin GPSmap 60CSx unit to collect longitude, latitude, and elevation data for three points that corresponded to points in the rangerfinder data. Using these three points, I was able to georeference the points in my GIS map using ArcGIS 9.2.

Developing the GIS map was key to the eventual analysis of the data. I based these maps off of maps that a previous student in the Dickinson College GIS class, Lisa Biddle, had developed for a class project. She had developed basic maps showing farm infrastructure, farm fields, and soil series type. The only map from her project that I used was the infrastructure map. Since her original project had been completed, there has been a great deal of construction at the farm. An addition was put onto the barn, an irrigation pond was installed, an electric solar panel was installed, a solar water heater was installed, and a greenhouse was constructed. A second greenhouse is currently in the process of being constructed as well.

I updated the infrastructure map by collecting GPS points corresponding to the four corners of each of these structures and then adding the new polygons to the map. I also added a polygon for the well house and points for each of the wells in the well field.

Based on the elevation map that I developed, I was able to interpolate a hillshade layer that could be analyzed for hydrology flow patterns. This determines the flow direction and accumulation of the water and develops a raster layer to add to the map. I added this map layer on top of a soil series map layer provided by the NRCS. Finally, since my elevation map was constrained to a little over half of the area of the farm, I also developed a separate hydrology layer that was interpolated from elevation data provided by the state.

DISCUSSION

Since I collected over 600 data points for over half of the farm, the hydrology layer developed from my data was more detailed than the accompanying layer based on the state elevation data. When lined up, the two layers match fairly well, indicating that my elevation survey was fairly accurate.

When looking the two hydrology flow maps together it becomes clear that there three main paths for water to flow away from the farm: one to the east, one to the west, and one to the south directly into the Yellow Breeches Creek which is very near the farm, on the opposite side of Park Drive. These paths are obvious locations to examine when looking for locations that the water can travel due to surface runoff. These are also locations where water would tend to seep through the vadose zone and into the groundwater table.

There appears to be no major paths where water is traveling into the farm from neighboring properties. Therefore my major concern was the three outward flowing paths. When these three paths are overlain on top of the soil series layer, two series are present at the locations of the paths: HuA (Huntington Silt Loam) and DuB (Duffield Silt Loam).

HuA exists in 0-5% slopes. It is composed of 7% sand, 69% silt, and 24% clay. It has an erosion factor Kf of .28, meaning its fine earth fractions are moderately susceptible to forms of erosion such as wind and water runoff. The Ksat factor for HuA is 0.60 to 2.00 in/hr, which means that its most limiting layer has a moderately high to high capacity to transmit water (Custom Soil Report, 2008).

DuB exists in 3-8% slopes. It is composed of 26.3% sand, 52.7% silt, and 21% clay. It has an erosion factor Kf of .37, meaning its fine earth fractions are moderately susceptible to erosion much like HuA. The Ksat factor for DuB is also 0.60 to 2.00 in/hr (Custom, 2008).

Ultimately the differences between these two series in terms of erosion and hydraulic conductivity are not significant. We do know that the can both easily erode and transport water and thus, contaminants as well. Thus the three paths identified on the GIS map should be carefully considered when using any kind of contaminant.

Lastly, a pond was recently installed in the farm to collect rainwater and provide a source for irrigation. Like two of the runoff paths, the pond is located mostly within the HuA series. According to the NRCS, this series is “somewhat limited” for ponds because it has high rates of seepage (Custom, 2008). Since the pond has already been installed, this information may not be useful, but it would explain high seepage rates and might mean the pond has to be thoroughly lined to prevent this.

CONCLUSION

The three drainage paths identified by the GIS analysis are all moderately susceptible to wind erosion, surface runoff, and seepage into the groundwater table. This makes them prime locations to focus on if concerned about paths for contaminants to flow, especially the southern drainage path that leads into the Yellow Breeches.

Windbreakers on the edges of fields or the property could protect against wind erosion, but only careful use and application on fertilizers, pesticides, herbicides, etc will prevent runoff and seepage.

Further studies could finish the detailed elevation survey of the farm and perform a more detailed soil survey to gain more accurate information about the soil physical properties than the data the state of PA already has available.

REFERENCES

Custom Soil Resource Report for Cumberland County, PA. National Resources Conservation Association. United States Dept. of Agriculture, 2008. 1-90. <http://websoilsurvey.nrcs.usda.gov/app/>.

Natural Resources Conservation Services. 12 May 2008 <http://soils.usda.gov/technical/handbook/contents/part601.html#00>.