Analyzing Soil Properties and Developing Erosional and Water Management Practices on the Proposed Sustainable Student Farm

Mark Keck, Amanda Murphy, Julian Subick, Audrey Davis, Julie Schubert

Introduction

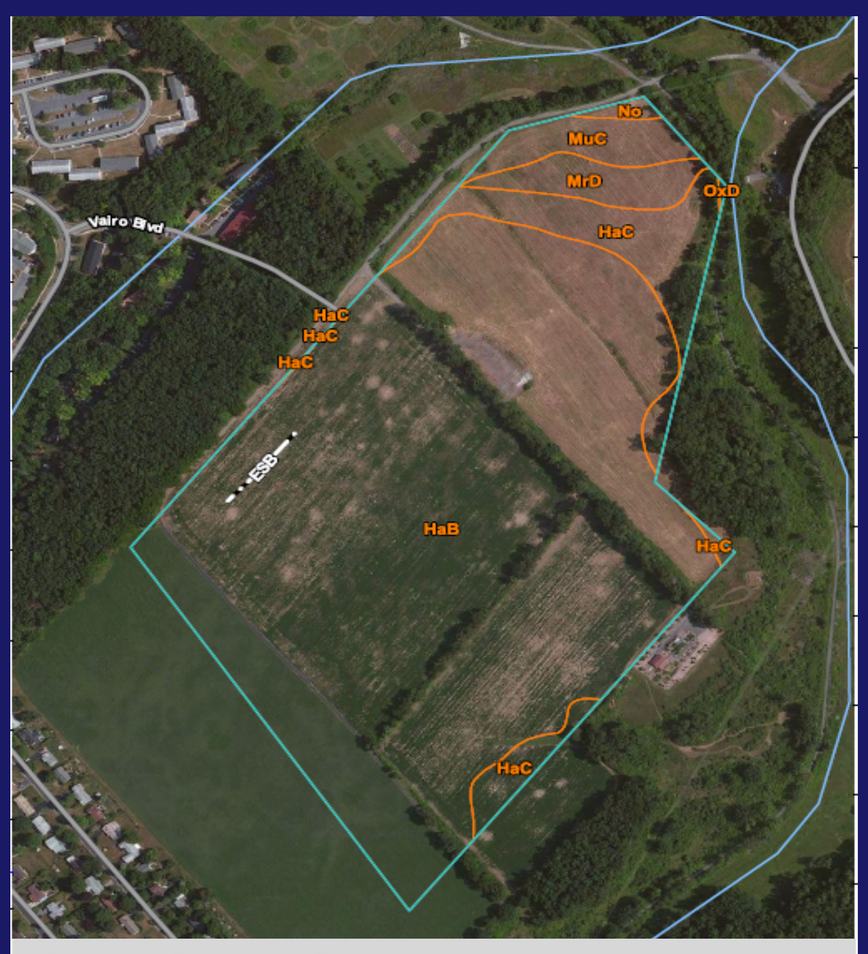
This project was completed in conjunction with Soils 401: Soil Composition and Physical Properties. The goal of this project was to work in an interdisciplinary team to develop solutions to a problem that involved soils and their characteristic properties. At the suggestion of group members the site investigated was the area for the proposed Sustainable Student Farm that is located north of Penn State's University Park campus. The site has the potential to grow fresh fruits and vegetables for Penn State students but the site's geography and soil needed to be investigated to determine how to best manage concerns such as excess water and soil runoff. This project analyzes the properties of the proposed site's soil and potential water and sediment management solutions based on its unique characteristics. It also gave students from backgrounds such as plant science and engineering the opportunity to work together and develop a plan that would be practical and useful moving forward with the Sustainable Student Farm.

Soil Characteristics

Map symbol and soil name	Depth	Saturated hydraulic conductivity	Organic matter	Erosion factor
	In	*µm/s*	*Pct*	*Kw*
HaB-Hagerstown silt loam, 3 to 8 percent slopes				
Hagerstown	0-10	4.23-14.11	1.6-7.0	0.37
	10-21	4.23-14.12	0.2-1.5	0.28
HaC-Hagerstown silt loam, 8 to 15 percent slopes				
Hagerstown	0-8	4.23-14.11	1.0-5.0	0.37
	8-19	4.23-14.12	0.2-1.5	0.28

The soils investigated in detail were Hagerstown B and C due to their prevalence on the site. Although the two soils have similar properties, it is important to note how quickly water moves through the soils, the soils' organic contents and how susceptible they are to erosion. It was determined that the hydraulic conductivity was typical for a silt loam and the organic content was also typical as most soils contain 1-10% organic content. The erosion factors were moderately high as 0.4 is considered high for erosion susceptibility.

Site Description



Centre County, Pennsylvania

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
HaB	Hagerstown silt loam, 3 to 8 percent slopes	56.4	75.0%
HaC	Hagerstown silt loam, 8 to 15 percent slopes	11.4	15.2%
MrC	Morrison sandy loam, 8 to 15 percent slopes	0.3	0.4%
MrD	Morrison sandy loam, 15 to 25 percent slopes	2.2	2.9%
MsD	Morrison very stony sandy loam, 8 to 25 percent slopes	0.5	0.6%
MuC	Murrill channery silt loam, 8 to 15 percent slopes	3.1	4.1%
No	Nolin silt loam, local alluvium, 0 to 5 percent slopes	1.3	1.8%
Totals for Area of Interest		**75.2**	**100.0%**

Investigated Solutions and Rationale

Drainage Ditches - Drainage ditches are a way to manage surface and sub-surface water. By constructing sloped channels in the ground, it has the ability to divert water runoff to locations that may need it while removing water from areas that do not.

Plant Buffers - Plant buffers are strips of vegetated areas that serve to protect sensitive areas. They promote infiltration of water and intercept sediment and nutrients that would run off into undesired wooded areas or waterways.

Mulch - Mulch is a layer of material that is applied to the soil particularly around certain plants. Mulch promotes water infiltration, locks in sediments, conserves moisture, and reduces weed growth.

Tillage/Crop Residue - The tillage of the soil for crops and remaining plant residue can influence water runoff rates as well as the amount of sediment and nutrients transported based on infiltration or inhibition of water movement.

Investigation Results

Based on the soils present at the farm site and researching case studies, conclusions were made about each method.

- Drainage ditches are not necessary because the slopes of the areas are not steep enough to require them and no specific water source is being drained. Minor land modifications could be useful and beneficial in some specific cases.
- Plant buffers would significantly reduce water runoff rates and absorb nutrients such as nitrogen and phosphorus which can protect sensitive wooded areas and waterways.
- Mulch would be extremely beneficial for its physical and biological uses. It would protect plants from weeds and also from intense water and sediment runoff.
- Maintaining no-tilled soil with high crop residue remaining would significantly lower water and sediment runoff rates than conventionally tilled soil with all residue removed.

Recommendations

We recommend utilizing many of the discussed methods in conjunction with one another to best manage water runoff and erosion. Providing plant buffers between cropland and surrounding areas would not only protect adjacent areas from undesired nutrients and sediment but also disperse water in a safe and natural way. The use of mulch such as straw or grass clippings would be very beneficial for the health of the crops planted and physically reduce water runoff intensity experienced by the plant through infiltration. For larger crops such as corn, no-till should be considered to reduce excess sediment movement and leaving crop residue will reduce water movement rates and provide organic material back to the soil. When no particular crops are being planted, the utilization of cover crops such as hairy vetch or wheat can prevent water and wind erosion while providing nitrogen back into the Hagerstown soil.

Acknowledgements

Thank you to Leslie Pillen for suggesting this project and moving forward with the Sustainable Student Farm Initiative. Thank you to Dr. Jack Watson who oversaw the development of this project and its research.

Additional acknowledgments to the following references:

Beniston, J. W., M. J. Shipitalo, R. Lal, E. A. Dayton, D. W. Hopkins, F. Jones, A. Joynes and J. A. J. Dungait. 2014. Carbon and macronutrient losses during accelerated erosion under different tillage and residue management. European Journal of Soil Science 66:218-225.

Gholami, L., Homaee, M., Sadeghi, S. H. 2012. Straw Mulching Effect on Splash Erosion, Runoff, and Sediment Yield from Eroded Plots. Soil Science Society of America Journal 77:268–278.

Kleinman P.J., Needelman, B. A., Rabenhorst, M. C., Vaughan, R.E. 2008. Morphology and characterization of ditch soils at an Atlantic coastal plain farm. Soil Science Society of America Journal 72:660-669.

United States Department of Agriculture: Web Soil Survey