Lab 2. Land Use and Soils

This week's lab will again be conducted at two sites, located near the campus. Soil pits have been dug to facilitate soil profile descriptions. The soils exposed in these pits have been subject to different types of land use history. *Your task will be to identify and describe the soil horizons, the parent material, and the landscape in which the soils are found and relate these features to the land use history of the sites and potential uses.*

Objectives

- Reinforce skills learned in Lab 1
- Learn how to recognize differences in soil strength and degree of mottling
- Distinguish master horizons features and suffix nomenclature used to identify them
- Recognize how land use history has affected soils
- Recognize how soils have affected historical and future use

Reading

2.18 The Soil Profile
2.13 Climate
2.14 Biota: Living Organisms
4.5   Soil Density

Land Use History

In the first laboratory, you explored the impact of parent material on soil properties and horizons. Vegetation and land use history can also cause soils to develop different properties. Most of the eastern USA has undergone drastic land use changes in the last 200 to 300 years. Tompkins County is no exception. Land survey records, aerial photographs, and field studies indicate that in 1790 the entire county was forested (Marks and Smith 1989, Smith et al. 1993). In 1789, this area was covered with trees, swamp, and only 50 acres of Indian maize gardens at the base of East Hill (Roseberry 1977). As more people settled in Ithaca, forests were cleared for agricultural production. By 1900, Tompkins County forested land decreased to 19 percent. Some of this cleared land has reverted back to forest during this past century. By 1980, forest cover in the county had increased to 50 percent.

For this week's lab we will visit the Mt Pleasant Research farm, east of the Cornell campus at an elevation of 541 meters. As a reference, the elevation of the Cayuga Lake is 117 meters and campus is between 255 and 265 meters. This higher elevation results in colder temperatures and a shorter growing season. There are two soils pits at Site 2. One pit is in soil that has been cultivated in years passed and now is covered with grass vegetation. Another pit is in soil that has never been cultivated and contains secondary mixed forest following a heavy cutting around the turn of the century. The parent material of both pits is glacial till.

Relationship of Soil Properties to Land Use History

Soils developed under grassland, where deep fibrous root systems of perennial grasses are present, usually have a deep A horizon. In comparison, in forest soils much of the organic matter input occurs at the surface where leaves and woody material accumulate. These soils tend to have most organic matter in the surface O horizon with a thin A horizon underneath. The location of organic matter under these two types of vegetation is both influenced by and influences where live organisms are found in the soil. In forest soils, meso and micro fauna and flora are found in the O horizons and many roots are found at the interface of the O and A horizons, whereas grassland vegetation has root distribution throughout the A horizon. In deciduous forests such as these, about 3 metric ton of leaf litter are returned each year to the forest floor. This leaf litter, as well as branches, wood and roots, is an energy source for decomposing organisms living in the soil. As you will observe, most of the leaf fall is consumed by the following summer. Soil fauna are responsible for the initial incorporation of leaf litter into soil. A census of fauna in McGowan's woods made in 1942 indicated that there were approximately 1 million earthworms, 38 million mites, and 12 million springtails per acre. Notice the earthworm casts on the soil surface.

Forestland that has never been under cultivation will have mounds and pits in contrast to a leveled surface. Mounds and pits result from trees uprooting as they fall, concentrating dead roots and soil near the base (mound) and creating a pit underneath the roots. A leveled surface indicates tillage has occurred at some time in the past, soils under cultivation often have an Ap horizon indicating a plow layer. The plow layer represents the top 15 to 20 centimeters of the profile that has been mixed and organically enriched due to plowing. Decomposing tree litter is acidic, so usually the O horizon has a lower pH than the mineral soil beneath it.

Due to the high organic matter content at the surface, forest soils also have porous surface layers. Trees are particularly sensitive to compacted soils so this natural environment also facilitates root growth in the surface horizon.

Soil compaction differs between and within sites, depending on the texture and land use history. Fragipans are formed under forest vegetation and are usually found on flat to gently rolling landscapes (Fanning and Fanning 1989). Also fields that have been cultivated sometimes develop a hard pan from plowing or other tillage operations. These plow layers can be distinguished from fragipans because they are found at the plow level, usually 15 to 20 centimeters below soil surface. Regardless of the pan type, trees can be sensitive to these sorts of compactions. Penetrometers are field instruments used to measure soil compaction.

Exercise A Profile Descriptions

Materials

- spatula
- measuring tape
- water bottle
- muffin tin
- Munsell color chart
- pH field kit
- penetrometer
- GPS unit

Steps

1. Describe topography, parent material and locate your positions on the map.

2. Determine horizons (O,A,E,B,C) and measure depth (cm) for each horizon. If applicable, record appropriate suffix designation for the O horizon (Oi,Oe,Oa), the A horizon (Ap), the B horizon (Bw,Bt,Bx).

3. Record in Table 1.

4. Record any mottling

5. Record effective rooting depth.

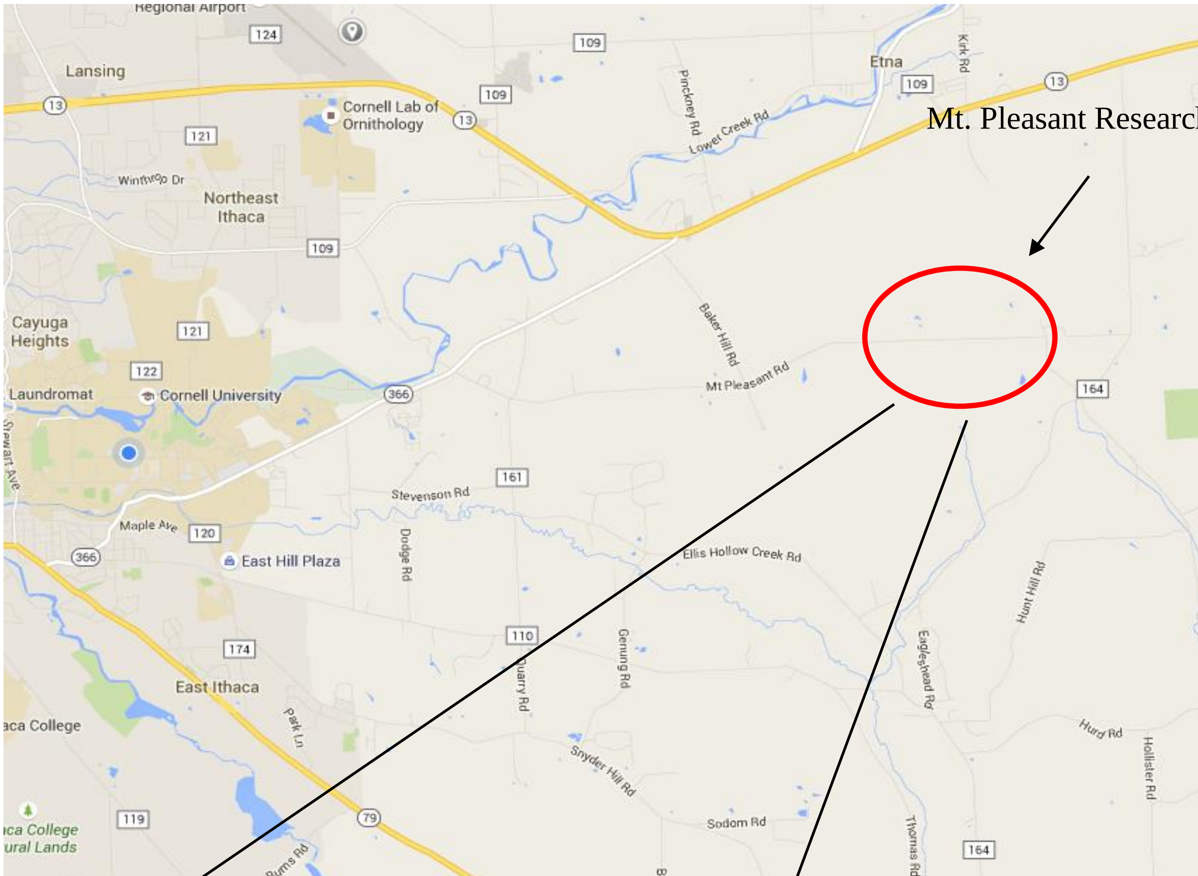
6. Measure soil strength with penetrometer for each horizon and record.

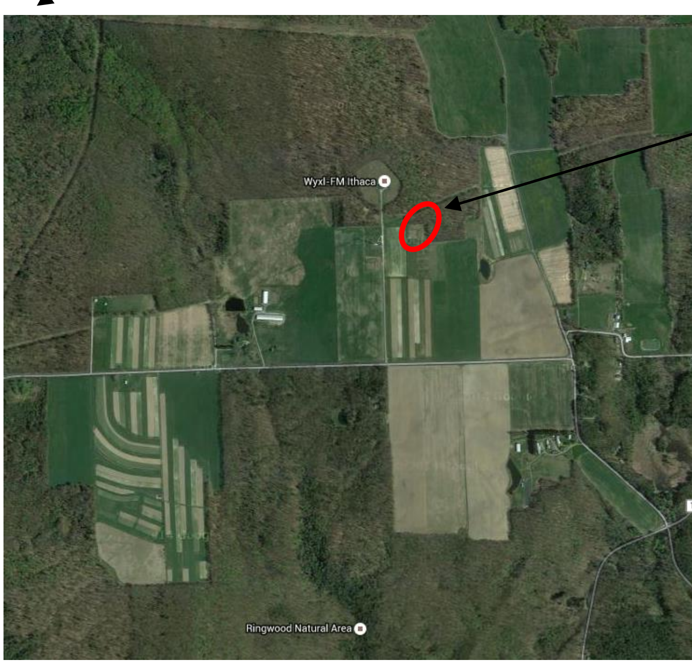
7. Take soil sample from each horizon and place in soil cans or muffin tins. Use these samples to determine soil pH, wet soil color, and soil texture.

8. Repeat for other soil pits.

Locational References

Mt. Pleasant Research Farm





Approximate soil pit locations

Table 1 Profile Description for field site:

Horizon	Depth (cm)	Texture	Structure	Matrix (1°) Color	Mottles (2°) Colors	pH	Penetrometer	Roots (+/-)

Table 2 Profile Description for wooded site:

Horizon	Depth (cm)	Texture	Structure	Matrix (1°) Color	Mottles (2°) Colors	pH	Penetrometer	Roots (+/-)

Exercise B Map Unit and Suitability Determination

Materials

Using Web Soil Survey

Steps

1. Locate and select the location of the soil pits on the Web Soil Survey Area of Interest (AOI) tab.
2. Select the “Soil Map” tab and determine the Map Unit code for the pit locations. You may have to use the zoom in tool on the map to be able to determine the location and code.
3. Select the “Soil Data Explorer” tab open the “Land Classification” legend.
4. Determine the farmland classification for the soils you have described.
5. Open the “Land Management” tab and determine the suitability of the soil for septic systems instillation.
6. Open the “Water Management” tab and determine the suitability of the soil for storm water management.
7.

Assignment

Assignment

Answer the following questions:

1. What is the name of the Soil Series and Map Unit(s)?

2. A profile description (Table 1 & 2) including depth of horizons, colors (1° and 2°), texture, structure, density, pH and presence of roots.

3. A description (similarities and differences) of the nature and properties of the soils.

4. Based on these properties and what you learned from the Web Soil Survey ratings (Land Classification, Land Management and Water Management) discuss the implications for land use. Again you will be graded on your completeness, not the length… your description need not be longer than 500 words and will be viewed based on your insight.

Appendix A MARDIN SERIES

The Mardin series consists of very deep, moderately well drained soils on glaciated uplands, mostly on broad hilltops, shoulder slopes and backslopes. These soils formed in loamy till, and have a dense fragipan that starts at a depth of 36 to 66 cm (14 to 26 in) below the soil surface. Slope ranges from 0 to 50 percent. Saturated hydraulic conductivity is moderately high or high in the mineral surface layer, subsurface layer, and upper part of the subsoil; and low or moderately low in the lower part of the subsoil and the substratum. Mean annual temperature is 8 degrees C (46 degrees F), and mean annual precipitation is 1080 cm (42 in).

TAXONOMIC CLASS: Coarse-loamy, mixed, active, mesic Typic Fragiudepts

TYPICAL PEDON: Mardin channery silt loam, on a 5 percent slope in a meadow at an elevation of 317 meters (1,040 feet). (Colors are for moist soil.)

Ap--0 to 20 cm (0 to 8 in); brown (10YR 4/3) channery silt loam; pale brown (10YR 6/3) dry; moderate fine granular structure; very friable, nonsticky, slightly plastic; 20 percent channers; neutral, pH 7.0; abrupt smooth boundary. (15 to 30 cm thick) (6 to 12 in thick)

BE--20 to 30 cm (8 to 12 in); light olive brown (2.5Y 5/4) channery silt loam; weak fine subangular blocky structure; very friable, nonsticky, slightly plastic; 15 percent channers; slightly acid, pH 6.3; clear wavy boundary. (0 to 18 cm thick) (0 to 7 in thick)

Bw1--30 to 41 cm (12 to 16 in); yellowish brown (10YR 5/4) channery silt loam; moderate medium subangular blocky structure; friable, nonsticky, slightly plastic; 20 percent channers; moderately acid, pH 5.8; clear wavy boundary.

Bw2--41 to 51 cm (16 to 20 in); brown (10YR 4/3) channery silt loam; weak medium subangular blocky structure; friable, nonsticky, slightly plastic; 15 percent fine faint pale brown (10YR 6/3) and light brownish gray (10YR 6/2) iron depletions and 15 percent fine faint brown (7.5YR 4/4) masses of oxidized iron; 20 percent channers; strongly acid, pH 5.3; abrupt irregular boundary. (Combined thickness of the Bw horizons is 10 to 46 cm (4 to 18 in).)

Bx1--51 to 91 cm (20 to 36 in); dark yellowish brown (10YR 4/4) channery silt loam; strong very coarse prismatic structure parts to weak very thick platy structure; very firm, slightly sticky, slightly plastic; brittle; many fine pores; clay films on surfaces along pores; 15 percent fine distinct light brownish gray (10YR 6/2) iron depletions; 30 percent channers; strongly acid, pH 5.3; gradual wavy boundary.

Bx2--91 to 145 cm (36 to 57 in); olive brown (2.5Y 4/4) channery silt loam; strong very coarse prismatic structure parts to weak coarse angular blocky structure; very firm, slightly sticky, moderately plastic; brittle; many fine pores; 20 percent clay films on all faces of peds and 20 percent clay films on surfaces along pores; 15 percent fine distinct light brownish gray (2.5Y 6/2) iron depletions and 15 percent fine distinct brown (7.5YR 4/4) masses of oxidized iron; 35 percent channers; very strongly acid, pH 4.8; diffuse wavy boundary. (Combined thickness of the Bx horizons is 38 to 142 cm (15 to 56 in).)

C--145 to 183 cm (57 to 72 in); olive brown (2.5Y 4/4) channery silt loam; massive structure; firm, nonsticky, slightly plastic; 15 percent fine distinct brown (7.5YR 4/4) masses of oxidized iron and 15 percent fine distinct light olive gray (5Y 6/2) iron depletions; 35 percent channers; strongly acid, pH 5.3.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 97 through 183 cm (38 through 72 inches). Depth to the top of the fragipan ranges from 36 through 66 cm (14 through 26 inches). Depth to bedrock ranges from 152 cm (60 inches) through 6 meters (20 feet) or more. There is 60 percent or more silt plus very fine sand in the fine-earth fraction above the fragipan. Rock fragments are dominantly channers, flagstones, or gravel, and range from 5 to 35 percent in the horizons above the fragipan, and commonly from 15 to 60 percent in the Bx and C horizons. Some pedons do not have rock fragments in layers below a depth of 152 cm (60 inches).

The Ap horizon has hue of 7.5YR to 2.5Y, value of 3 or 4, and chroma of 2 to 4. Texture of the fine-earth fraction is silt loam. Structure is weak or moderate granular. Consistence is friable or very friable. Some pedons in uncultivated areas have a dark A horizon that is 3 to 13 cm (1 to 5 inches) thick. Reaction ranges from extremely acid to moderately acid, unless limed.

The BE horizon, where present, has colors and textures similar to B and E horizons.

The Bw horizon has hue of 7.5YR to 2.5Y, value of 4 to 6, and chroma of 3 to 8. Texture of the fine-earth fraction is loam or silt loam. Structure is very fine through medium subangular blocky or granular. Consistence is very friable through firm. Reaction ranges from extremely acid through moderately acid, unless limed.

The E horizon, where present, has hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 2 or 3. Texture of the fine-earth fraction is loam or silt loam. Structure is subangular blocky or platy. Consistence is friable or firm. Reaction commonly ranges from extremely acid to moderately acid but the range includes slightly acid in limed areas. The E, Bw or BE horizons have redoximorphic features in some part above 51 cm (20 in), but are not distinct or prominent within 30 cm (12 in).

The Bx horizon has hue of 7.5YR to 5Y, value of 3 to 5, and chroma of 2 to 4 with faint to prominent redoximorphic features. Texture of the fine-earth fraction is loam or silt loam. The Bx horizon has weak to strong very coarse prismatic structure. Consistence is firm or very firm. Reaction ranges from very strongly acid to slightly acid. Some pedons have a BC or a CB horizon.

The C horizon has hue of 7.5YR to 5Y, value of 3 to 5, and chroma of 2 to 4. Textures are similar to the Bx horizon except silty layers that do not have rock fragments are in some pedons below a depth of 102 cm (40 in). The C horizon is massive, or has weak plate-like divisions. Consistence is firm or very firm. Reaction ranges from strongly acid to neutral in the upper part, but can range to slightly alkaline below a depth of 152 cm (60 in) in some pedons. Some pedons lack C horizons.

GEOGRAPHIC SETTING: Mardin soils are nearly level to very steep with slopes ranging from 0 through 50 percent. These soils developed in till, and are on slightly convex parts of dissected glaciated uplands. Mean annual temperature ranges 6 to 11 degrees C (43 through 52 degrees F). Mean annual precipitation ranges from 795 through 1725 millimeters (31 through 68 inches), and mean annual frost-free season ranges from 105 through 180 days. These soils generally occur at elevations between 100 and 670 meters (328 and 2,198 feet), but have been mapped as high as 750 meters (2,460 feet) in some areas.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Moderately well drained. A seasonal water table typically occurs at depths of 36 to 61 cm (14 to 24 in) below the soil surface. The potential for surface runoff is medium to high. Saturated hydraulic conductivity is moderately high or high in the mineral surface layer, subsurface layer, and upper part of the subsoil; and low or moderately low in the lower part of the subsoil (fragipan) and the substratum.

REMARKS: Diagnostic horizons and other features recognized in the typical pedon include:
1. Ochric epipedon - the zone from 0 to 20 cm (0 to 8 in) (Ap horizon).
2. Cambic horizon - the zone from 20 to 51 cm (8 to 20 in) (BE and Bw horizons).
3. Fragipan - the zone from 51 to 145 cm (20 to 57 in) (Bx1 and Bx2 horizons).
4. Udic soil moisture regime.
5. Estimated CEC activity class to be active, but of 6 pedons sampled in NY from 1982 to 1991: 3 were superactive, 2 were semiactive, & 1 was active.

References

Brady, N.C., and Well, R.R. (1999). *The nature and properties of soil,*
Simon & Schuster, Upper Saddle Brook, New Jersey.

Cline, M.G., and Marshall, R.L. (1977). "Soils of New York landscapes",
Cornell University, Ithaca, New York

Fanning, D.S., and Fanning, M.C.B. (1989). *Soil morphology, genesis, and classification,*
John Wiley & Son, New York

Helms, J.A. (1998). "The dictionary of forestry".
Society of American Foresters, Bethesda, MD.

Marks, P.L., and Smith, B.E. (1989). "Changes in the landscape: a 200-year history of forest clearing in Tompkins County"
New York's Food & Life Sciences Quarterly, 19(2), 11-14

Neeley, J.A. (1965). *Soil survey, Tompkins County, New York.*
U.S. Dept. of Agriculture, Soil Conservation Service, Washington D.C.

Roseberry, C.R. (1977). "Before Cayuga",
New York State College of Agriculture at Cornell University, Ithaca.

Smith, B.E., Marks, P.L., and Gardescu, S. (1993). "Two hundred years of forest cover changes in Tompkins County, New York"
Bulletin of the Torrey Botanical Club, 120(3), 229-247.

Stone, E. (1977) "Field trip notes for Agronomy 404", Cornell, Ithaca

Von Engeln, O.D. (1961). *The Finger Lakes Region Its origin and nature,*
Cornell University Press, Ithaca, NY

Wenger, K.F. (1984). "Forestry handbook",
John Wiley & Sons, New York xviii + 1335.