Utilizing Web Soil Survey for Delineating Soils, Surveying and Land Usage

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The *Utilizing Web Soil Survey for Delineating Soils, Surveying and Land Usage* laboratory activity will introduce students to the practical application of using online databases for scientific investigations. The online web soil survey tool allows students to engage in a virtual, online lab where they can access data and information related to soil and land use. This interactive lab teaches students how to use the online tool while going through specific step by step tasks at a given geographic location. Various skill checks are embedded into the activity, including delineating an area on a map and gathering specific soil or surface information. This lab can be modified for different geographic areas and be used as a two part lab; students identify an area and collect data through the database, follow by a field visit to the site. The lab can be used either synchronously or asynchronously with a brief introduction. This lab activity is ideal for ecology, geology, or environmental science classes.

Keywords: soil structure, environmental science, land use, inquiry-based learning

Introduction

As a pedagogical method, inquiry- based learning (IBL) is widely accepted and implemented throughout higher education. But its usefulness has been strengthened by the calls for reform in the undergraduate sciences, particularly calls to engage students in the scientific process by providing opportunities for authentic research experiences. In response to these recent calls, educators have been implementing undergraduate research experiences into their science curricula (Auchincloss et al., 2014). These course-based undergraduate research experiences (CUREs) "offer a refreshing alternative to cookbook labs since they are more authentic research experiences," (Brownell and Kloser, 2015). CUREs provide a form of "authentic learning," utilizing the concepts of inquiry-based learning, while engaging students in exploring complex, real-life applications. As described by Trautmann and McLinn (2012), if students have the opportunity to design and conduct their own investigations and data collection, the result will produce more profound learning outcomes.

Recent research of inquiry- based learning (IBL) and course-based undergraduate research experiences (CUREs) also suggests positive learning outcomes in students' understanding, skills, and professional development. Using CUREs, Brownell et al. (2015) found improved students' conceptions, ability to interpret data, and practice of scientific thinking. Additionally, CUREs led to positive changes in career choices and attitudes, with students reporting an increased interest in pursuing postgraduate education in research and science in general (Harrison et al., 2011) and improved graduation rates (Jones et al., 2010).

Embedding CUREs into science curricula, however, presents some challenges due to distance/ remote learning options, larger class sizes, and inaccessible or unavailable lab or field resources. But online data sets provide opportunities for students to organize and carry out unique research studies and investigations despite such challenges (Trautmann and McLinn, 2012). Further support for the use of online data stems directly from the AAAS's *Vision & Change: Call to Action*, highlighting the importance of providing experiences for student learning using large, real-life, real-time online data sources as they have become an essential component in professional contexts.

Therefore, the purpose of this lab activity is to use an online database, the Web Soil Survey (WSS), for scientific investigations. The guided, inquiry-based learning activity, will introduce students to the online database to practice accessing, collecting, and analyzing open data from online sites. Exploring the digital landscape environments, students will design and execute a multi-step experiment using online sources for data collection and apply their investigations to complex, real-world questions and issues. By engaging in CUREs using online data sources like the Web Soil Survey, students will have more opportunities to practice scientific investigations leading to overall improvements in student learning (Sit and Brudzinski, 2017).

Laboratory Goals & Learning Outcomes

The Web Soil Survey lab activity follows the framework of the Structure of the Observed Learning Outcomes (SOLO) taxonomy (Biggs & Collins, 1989). Students will answer questions throughout the guided activity to reinforce skills and concepts learned as part of the process of analyzing information at identified locations. Examples include;
1. Identify: "Identify the four major ingredients that make up soil"
2. Describe/ list/ calculate: "How many acres is your Area of Interest (AOI)?"
3. Analyze/ compare: "Analyze the differences between the two AOI's you studied."
4. Investigate: "Design a research question using data from WSS"

Applying the (SOLO) taxonomy to the Web Soil Survey activity, students develop skills from the unistructural to the relational levels of understanding, identifying and following basic instructions to analyzing and comparing soil composition in different locations. The workflow- style data visualization tools implemented in this lab activity provide a built- in framework for students to model each step in their own independent investigations using online data in CUREs (Trautmann and McLinn, 2012). Using online data sources for guided IBL laboratory activities can provide more opportunities to actively engage students in CUREs and improve student learning outcomes.

Student Outline

Objectives
Practice accessing, collecting and analyzing open data from online sites
Design and execute a multi- step experiment
Conceptualize digital landscapes environments to practical applications

Introduction
The composition of soil in a specific area can provide useful information. Much like how comparing similar ecosystems can provide insight into differences and help monitor a changing habitat, knowledge of soil composition can provide a deeper understanding of the dynamic soil influences of a particular area (Kluthe and Mortellaro, 2019). Information on parent material, soil mineral composition, and soil structure influence land use decisions from sectors spanning land preservation to land development. A wide variety of disciplines, including geology, civil engineering, biology and environmental science benefit from using the Web Soil Survey for accessing and mining information needed to answer specific research questions.

Methods and Data Collection
You will engage with an online soil database to become familiar with both accessing digital data and the discipline and terminology associated with soil science. The laboratory provides step by step instructions (Appendix A) with associated pictures to guide you through learning the components of the Web Soil Survey (WSS). The task driven instructions will provide you the opportunity to engage with the various tools in the database.

Data Analysis
The data collected throughout this laboratory experience spans two different park systems. The step-by-step instructions will guide you through various data sets to access information about the identified area of interest (AOI). You will answer questions throughout the guided activity to reinforce skills and concepts learned as part of the process of analyzing information at identified locations.

Discussion
Through this lab you have learned that there is free public access to the nation's soil resource data through the interactive tool, Web Soil Survey and you have identified various characteristics of soil in two distinctly different locations, including parent material, soil forming factors, suitability and limitation for use, and land capability classes. Using what you have learned about the soil composition in the two different park systems you explored, discuss the soil influences of each and how they differ from one another. To apply what you have learned, choose an area of interest (AOI) and write a research question relating to the impacts of the soil influences in your AOI. Then, use the Web Soil Survey tool to collect and analyze the soil influences in your AOI needed to answer your specific research question.

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Materials

Students will need access to a computer and the internet. The benefit of this lab is that students will not need to download anything onto the computer; everything is accessed through the web page.

Follow up activities might require some field sampling materials but that is optional. You might also consider follow up field activities that might influence selection of the area of interest for this lab.

Notes for the Instructor

Students will answer questions throughout the activity to reinforce skills and concepts learned as part of the process of analyzing an identified location. For the purpose of this lab, a public park near the authors home campus is the starting point. This lab can be modified to select a starting location that is familiar to the students and potentially a location to hold additional labs in the future, such as looking at diversity in areas based on soil composition.

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About the Authors

John Kluthe has a Bachelor of Science in agronomy from Missouri State University and Master of Science from the University of Missouri. In addition to providing technical education to the students at Saint Peter's University, he helps farmers and land/livestock owners keep soil and nutrients in place so that they can use the land without causing damage to the effected resources. He has worked in federal conservation program delivery and is now offering conservation assistance by private practice, KES LLC, to farmers with agriculture and natural resource problems.

Dr. Christina Mortellaro is an Assistant Professor at Saint Peter's University Biology Department. Dr. Mortellaro primarily teaches anatomy & physiology and research focuses on pedagogy in the biological and health sciences to improve student learning outcomes. Additional experience includes serving as the Director of the Core Curriculum and the Student Learning Outcomes Director for the University, implementing new techniques and modeling best practices for assessment and evaluation.

Dr. Brandy Garrett Kluthe is an Assistant Professor at Saint Peter's University Biology Department and the Director of the Environmental Studies program. Dr. Kluthe primarily teach ecology courses and maintains an active research program with students. Additional experience includes interpretive education in both the private and public sector, strategic planning in environmental science/sustainability for public and nonprofit entities and environmental education work as both a Peace Corps and AmeriCorps Volunteer.

Appendix A: Student Handout for Web Soil Survey activity

Working with the WebSoilSurvey.gov

First, before we get started, it is important to read the words in this lab. I understand that it is tempting to simply jump from picture to picture but that won't cut it. The pictures are there to assist the words just a little bit.

The Web Soil Survey (WSS) is the United States government's official soils maps and public data source for information about soils. It is chalked FULL of more information than anyone will ever need about a given soil. That said, you will likely need some of the information in this source, so it is important to know how to use it. Let's get started. Go to https://websoilsurvey.sc.egov.usda.gov/ and click the START WSS button…

Notice the tabs across the top of the screen. We start by using the first tab, Area of Interest (AOI).

Let's start by entering a location to find. Under Quick Navigation open the Address tab. Saint Peter's University is a great place to start. You can enter the address or simply enter "saint peters university"; it takes you right there! In addition to entering the address, you can Import a file that gives WSS the boundary of the area you want to locate (that option is beyond the scope of this lab). What other Quick Navigation options are there? List three of the nine.

1) _____

2) _____

3) _____

Soon it will be time to define an area of interest (AOI) - but first take a minute to familiarize yourself with the definitions of these icons by hovering your cursor over the images.

You can also click the "?" in the corner of the map to better understand the functions that each of the tools performs. Actually, any time you want to know more about a topic on Web Soil Survey click the "?" to find out more!

What is the difference between these two icons? If hovering over the icon doesn't give you enough information, click on the question mark icon.

4) _____

Use the zoom and pan buttons to find Lincoln Park. Define the boundary of the park by using the polygon AOI. (It's totally fine to simply define the whole city block as your AOI - don't make it harder than it is.)
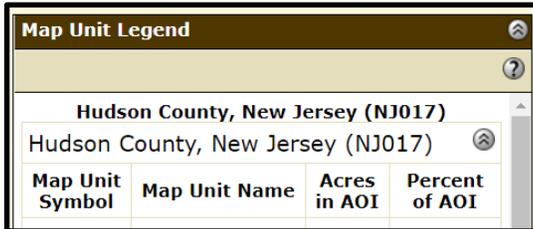

How many acres are your AOI? (listed in the left panel under Area of Interest>AOI Properties>AOI Information)

5) _____

Next, you will be moving to the tab <u>Soil Map</u> to the right of the <u>Area of Interest</u> tab at the top of the screen.

The panel on the left shows the <u>Map Unit Legend</u>.

In the Map Unit Legend notice that it lists the Map Unit Symbol, Map Unit Name, Acres in AOI and Percent of AOI.

Also, notice that when you click on the Map Unit Name, such as <u>Greenbelt loam, 0 to 3 percent slopes</u>, the <u>Map Unit Description</u> box appears.
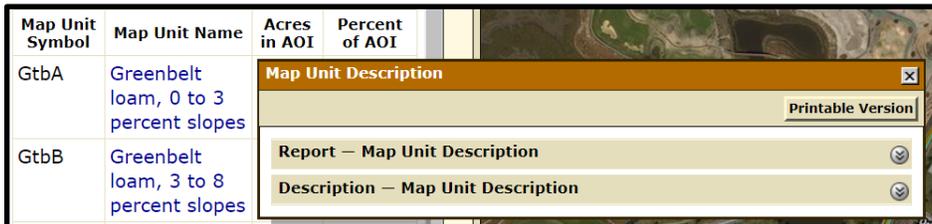

Open the <u>Description - Map Unit Description</u> and read the text for understanding. Scroll to the bottom of the popup page, click on the arrow icon to the right of the map unit description. Just so that I know that you have found it, enter the missing word in the following paragraph. Note that you are being asked to read the whole thing.

> "The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit 6) _____
> in this report, along with the maps, can be used to determine the 7) _____
> and 8) _____ of a unit."

The next tab across the top is <u>Soil Data Explorer</u>. When you click on that tab other tabs appear just below it; the default tab is <u>Suitabilities and Limitations for Use</u>. Before we explore that tab let's take a look at <u>Intro to Soils</u>.

Click on the Introduction to Soils check box then View Selected Topics.
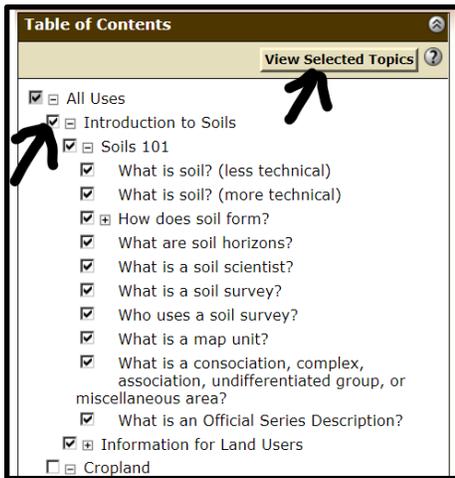
What are the two main components of the mixture that makes up soil?

9) _____

and 10) _____

What are the minerals produced from?

11) _____

In addition to parent material, what are the other four soil forming factors?

12) _____, 13) _____,

14) _____, and 15) _____.

Next, read What are soil horizons? and any of the other paragraphs for your own understanding (you are students, right? So be studious).

Next, return to the Suitabilities and Limitations for Use tab. The purpose of this portion of the lab is to understand thematic maps, ratings, and rating reasons.

> The Suitabilities and Limitations for Use tab includes various soil interpretations displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each interpretation.

> The ratings are both verbal and numerical. The hazard is described as "slight," "moderate," or "severe." A rating of "slight" indicates that little or no erosion is likely; "moderate" indicates that some erosion is likely, that the roads or trails may require occasional maintenance, and that simple erosion-control measures are needed; and "severe" indicates that significant erosion is

expected, that the roads or trails require frequent maintenance, and that costly erosion-control measures are needed.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified aspect of [a given] management (1.00) and the point at which the soil feature is not a limitation (0.00).

Under the Suitability and Limitations for Use tab open Land Management and Erosion Hazard (Road, Trail); click view rating.
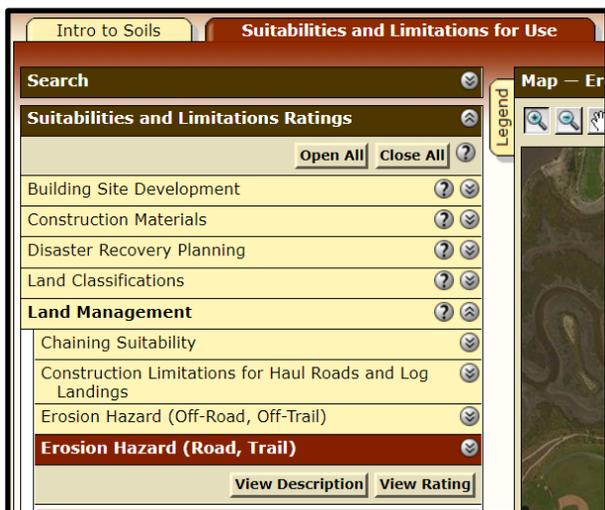
What is the verbal rating for Greenbelt loam, 0 to 3 percent slopes?

(scroll down to find this info)

> 16) _____

What is the verbal rating for Greenbelt loam, 3 to 8 percent slopes?

> 17) _____

For the Greenbelt component what is the numeric rating and reason?

> 18) _____,

> 19) _____

So, this explains that the Greenbelt series on a 3-8% slope gets a moderate rating because of slope and erodibility. That makes   sense, right? That trails on a steeper slope would have limitations?   The "take away" that you should glean from this is that limitations are things that should be closely considered and managed for. They aren't necessarily things that cannot be overcome.

To demonstrate that you understand the concept, what are things that you might do to mitigate slope/erosion on a trail that you are designing?

20) _____

Next, you will be learning a little about <u>Soil Properties and Qualities</u>. The soils in Lincoln Park are not very exciting so I would like you to re-create your AOI with the boundary of Central Park in New York City.

Return to the AOI tab.

- Click <u>Clear AOI</u> under Area of Interest>AOI Properties.
- Then enter "central park, new york city".
- Notice that WSS wants to know if you mean Central Park (neighborhood) or Central Park (park). Choose the park, please.

Now you are ready for <u>Soil Properties and Qualities</u> under the <u>Soil Data Explorer</u> tab. Under the <u>Properties and Qualities Ratings</u>><u>Soil Qualities and Features</u> go to <u>Parent Material Name</u>.
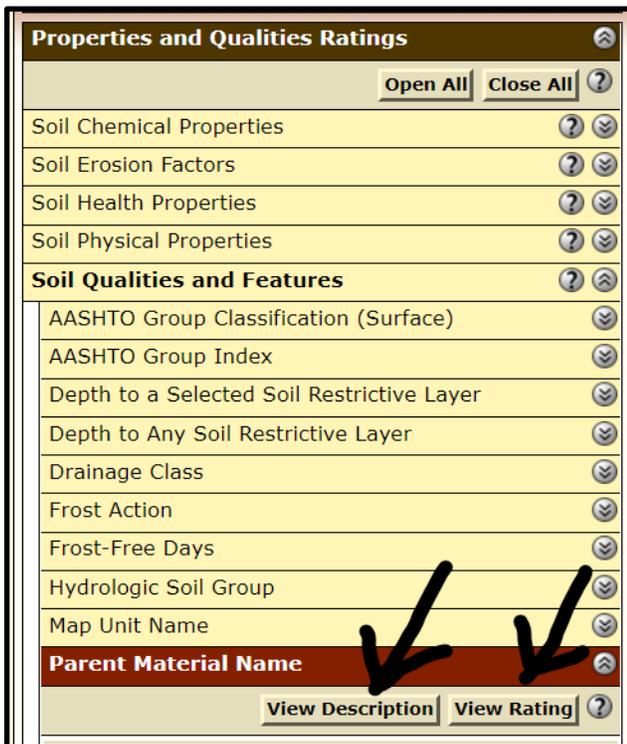
Click on View Description. What does the parent material name refer to?

21) _____

_____

What two characteristics may be implied by the name?

22) _____,

23) _____

Next click View Rating. Peruse the map unit names and ratings. Notice that the soils in the Greenbelt series are found in Central Park, just like Lincoln Park. Also notice that Greenbelt is a "loamy human-transported material". What does that mean in your own words?

24) _____

_____

Native soils can also be found in Central Park. That is pretty exciting to me given the long history that New York City and Manhattan Island have endured. I'll leave it to your own interest and internet search to answer what schist, gneiss and granite are.

Next, let's look at the options under Soil Reports.
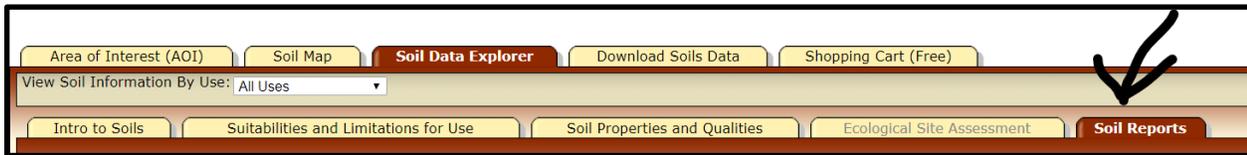
On the left-hand panel go to Land Classifications > Land Capability Classifications and View Soil Report.

Scroll down to the report (below the map). On the right side of the report you will see Land Capability Subclass. The capability class is the number that is listed while the subclass is the letter that sometimes accompanies the number. Numbers 1-7 indicate the range of uses you might expect from each particular component name. "One" indicates that the "soils have slight limitations that restrict their use" while "seven" indicates "very severe limitations." These soils are rated with an agricultural context in mind. Class 8 soils "have limitations that preclude commercial plant production and that restrict their use to recreational purposes, wildlife habitat, watershed, or esthetic purposes."

At the bottom of the report, you will find a description of the Land Capability Classification. What do the subclass letters *e, w, s,* and *c* mean?

25) e - _____

*26) w -*_____

*27) s -*_____

*28) c -*_____

The final cool thing that I would like to show you in this lab is that you can identify the extent of a soil series throughout the United States. The process I am about to show you works for any soil series, but I would like you to focus on one in particular for this exercise.

Can you find the Charlton series in the northern part of Central Park? In the figure below I have pointed out the map unit symbol ChB which indicates Charlton loam, 3-8 percent slopes and ChD (Charlton loam, 15-25 percent slopes). You will also be able to see some complexes (areas too mixed up to name it after just one series) of soil map units that contain the Charlton series. Find some yourself on WSS by panning and zooming.

Use this link https://soilseries.sc.egov.usda.gov/osdlist.aspx to get an idea about the extent of the Charlton series.

- Type "Charlton" in the text box then click the submit button.
- Under the report tab, to the right side, click the link "View CHARLTON Extent Map"

How many acres nationwide are there of the Charlton series?

29) _____

(hint; keep it simple - the answer is listed in the legend)

All the soils data is kept in a database which is operated by the USDA-NRCS. Find the database by following this url; https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/class/data/
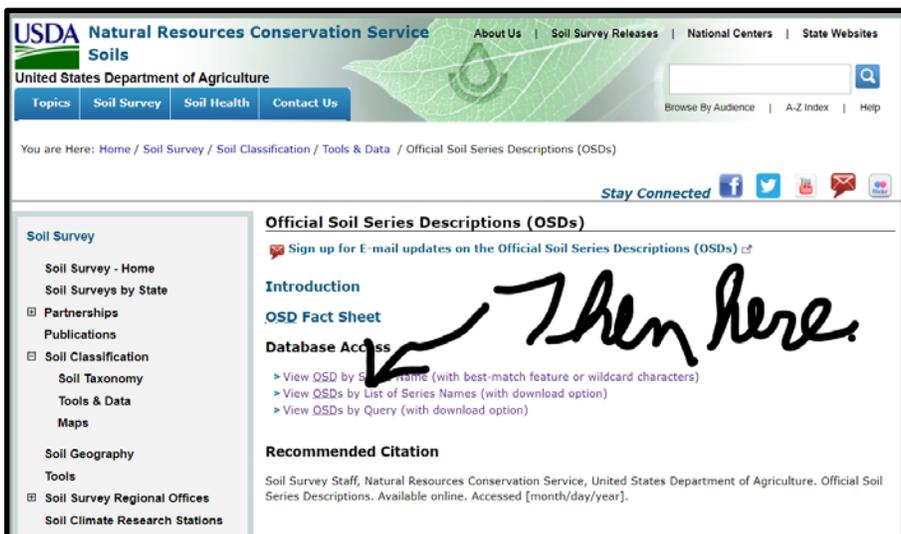
Or by searching for "Official Soil Series Descriptions" in your search engine. You should see something like this…
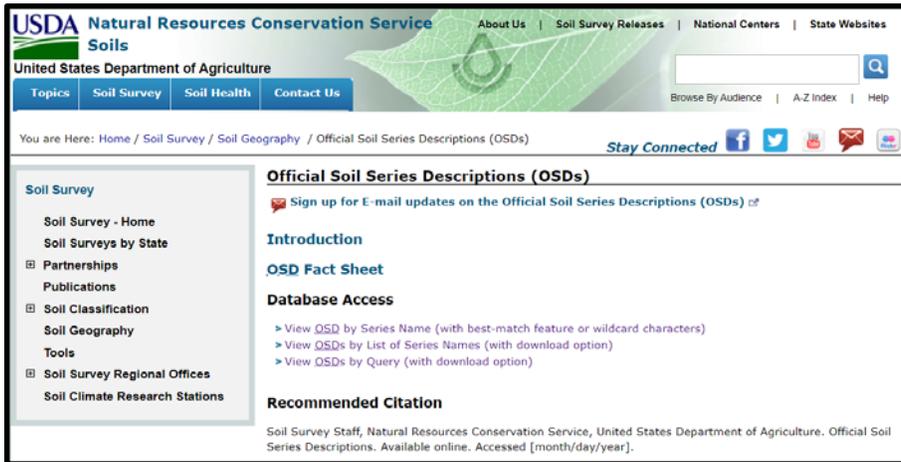
Take note of <u>View OSDs by List of Series</u> under <u>Database Access</u>.

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