

Soil and Water Conservation Laboratory Manual

SOIL AND WATER CONSERVATION LABORATORY MANUAL

COLBY J MOORBERG

New Prairie Press
Manhattan, Kansas



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EPIGRAPH

Out of the long list of nature's gifts to man, none is perhaps so utterly essential to human life as soil.

-Hugh Hammond Bennett-

When the well's dry, we know the worth of water.

-Benjamin Franklin-

ON THE COVER

Rows of trees and shrubs, as well as a native grass strip, combine in a riparian buffer to protect Bear Creek in Story County, Iowa. The buffer is a nationally designated demonstration area for riparian buffers. Photograph by Lynn Betts, courtesy of the USDA-NRCS.

PREFACE

Draft Status

This is an unpublished, publicly-available draft of *Soil and Water Conservation Laboratory Manual*, an open-access textbook. Final publication is expected by the end of 2023. It will be licensed with a [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License](#). This unpublished edition was made publicly available for use by instructors that have already adopted the manual for use in their courses. If you notice anything that needs attention prior to publication, please contact [Colby Moorberg](#).

Overview

This laboratory manual was developed for graduate and upper-level undergraduate students in soil and water conservation classes who have previously taken a course on introductory soil science. It is designed with a “scaffolding” approach in which each laboratory builds on the previous ones on the way to developing a conservation plan for a single study site. The manual begins with a section on site characterization with laboratory activities covering evaluation of onsite conditions such as ground cover, slope, soils as mapped in SSURGO, ecological sites, and soil health assessment. This is followed by sections on specific soil and water conservation practices and virtual field trips. Following that is a section on predicting water and wind erosion using soil erosion models. The final section is focused on developing a conservation plan in which students will summarize their site characterization, erosion modeling, and evaluation of potential conservation practices relevant to their study site.

Each laboratory exercise begins with a recommended reading in a purple textbox that describes and links to freely-available resources related to the laboratory exercise topic. This is followed by learning objectives in a green textbox that outlines expected learning outcomes. Next is a list of materials required for the laboratory in an orange textbox. These material lists generally include several options based on materials available to students and instructors. These textboxes are followed by an introduction that provides relevant context for the laboratory activities. The laboratory activities are described in step-by-step detail and, when possible, include embedded videos that demonstrate how to perform the activity. Each laboratory is concluded with a blue textbox containing questions relevant to the laboratory followed by references. The questions should be answered in the laboratory report. A default format for laboratory reports is provided in the beginning of this laboratory manual.

Accessibility

This laboratory manual was designed with accessibility in mind. Alternative text is included with each image. Aria-labels have been added to HTML code for URLs in all reference sections as needed to prevent each character from being spelled out by screen readers. If you find an image that is missing alternative text, or a URL that is missing a functional aria-label, please [inform Colby Moorberg](#).

Acknowledgements

Financial support for the development of this laboratory manual was provided by a new course development grant from [K-State Global Campus](#) and funds from the K-State Open Textbook Fee. In addition, the [Ecological Site Descriptions](#) laboratory was funded by the USDA-NRCS, agreement number NR183A750025C016. Each of these funding sources are greatly appreciated.

This laboratory manual, in particular the Site Evaluation section, highlights the use of two excellent resources. The first is the Cropland In-Field Soil Health Assessment developed by the USDA-NRCS. The second is the LandPKS app, which facilitates the use of technology for collecting site data including observations from the Cropland In-Field Soil Health Assessment. In addition, the USDA-NRCS and the creators of LandPKS have developed a wealth of YouTube videos that concisely describe how to conduct these and other site assessments. These resources were instrumental in the development of this manual. Links to those resources are provided as needed.

Logan Simon, a former student of the AGRON 635 – Soil and Water Conservation Course at Kansas State University led the development of the Soil and Water Management Chapter.

The face-to-face and online students of the Kansas State University AGRON 635 – Soil and Water Conservation course during the Fall 2022 semester were gracious in their use of early editions of this laboratory manual and helped provide constructive criticism for its improvement.

Associated Resources

This open-access laboratory manual was developed as a companion to the open-access book, *Soil and Water Conservation: An Annotated Bibliography* (Moorberg, 2019), which is available through [New Prairie Press](#) and as a [Pressbooks web book](#). The YouTube channel, [ColbyDigsSoil](#) contains content in support of this laboratory manual that was produced by the same author.

ABOUT THE AUTHOR

[Colby Moorberg, PhD, CPSS, PWS](#), is an associate professor of soil science in the Kansas State University, [Department of Agronomy](#) in Manhattan, Kansas. There, he oversees the Hydropedology and Root Ecology Laboratory which conducts research on hydric soils and soil-and-root interactions in wetland, riparian, and agricultural ecosystems. He teaches AGRON 305 – Soils, AGRON 306 – Soils Laboratory, and AGRON 635 – Soil and Water Conservation. He is also a coach for the Kansas State University Soil Judging Team and serves as the faculty advisor to the Kansas State University Soil and Water Conservation Society. Before joining Kansas State University, Moorberg earned his BS in Environmental Science from Iowa State University. He later completed his MS and PhD in Soil Science at North Carolina State University. Following graduate school, he was a postdoctoral researcher in the University of Washington Civil and Environmental Engineering Department. Moorberg advocates open textbooks and develops open education resources for soil science courses, including the [Soils Laboratory Manual](#) by Colby Moorberg and David Crouse, which was published by New Prairie Press in (2017, 2019, 2021) and [Soil and Water Conservation: An Annotated Bibliography](#) (Moorberg, ed., 2019). He is an Open Education Group OER Research Fellow. He is a member of the National Technical Committee for Hydric Soils, a member of the Soil Science Society of America Soils Certification Committee for the Certified Professional Soil Scientist professional credential, and is an associate editor for *Natural Sciences Education*. Selected awards include the Soil and Water Conservation Society Outstanding Service Award, the Soil Science Society of America Early Career Award, and the Soil Science Society of America Emil Truog Soil Science Award.



[Colby Moorberg, PhD, CPSS](#)

LABORATORY REPORTS

Rationale

For some laboratories you will be submitting a laboratory report. These reports help reinforce the course goals and the specific learning objectives for each laboratory activity. The reports also provide an opportunity for feedback and helps develop communication skills. The format and contents of laboratory reports is described below. Note that for laboratories in [Site Evaluation and Soil Health Assessment](#) you will complete a single report, [Site Evaluation and Soil Health Assessment Report](#). Also note that [Virtual Field Trips and Interviews](#) each have an associated discussion for an assessment rather than laboratory reports.

Laboratory Report Components

Each laboratory report should include the following components unless otherwise specified. Points allocated to each component may vary as necessary.

Name

Include your first and last name.

Laboratory Number and Title

List the laboratory number and title. For example: “Laboratory 4 – Soil Health Assessment 2: Infiltration, Surface Crusts, Soil Structure, and Water Stable Aggregates”.

Date the Exercise was Conducted

Identify the day you conducted the laboratory exercise. Note, this is likely different than the date you submit the report. Do not include the date of submission, as that will be identified in the learning management system.

Introduction

Provide a brief (one to two paragraph) introduction to the laboratory exercise. Explain the importance or significance of the procedure(s) being performed.

Methods

Write a concise yet detailed summary of the methods used for the laboratory exercise written in your own words. The methods should contain enough detail that you could use it to perform the same activity again using only your written summary of the methods.

Results

Present your raw data in one or more organized tables. You may use the data sheets provided in the laboratory manual. You are also welcome to format or organize your data in a logical way that is more useful to you and is able to be appropriately interpreted by your instructor.

Responses to Questions

In lieu of a traditional results section you will instead respond to a series of questions posed at the end of each laboratory exercise. In some cases these questions will require data analysis, presentation of data in summary tables and/or well-designed figures, or exploration of additional resources and scientific literature. Answer the questions to the best of your ability. Contact the instructor with any questions.

References

Provide a list of all references that were cited within the text of your report. Citations should follow the [*Journal of Soil and Water Conservation Style Guide*](#) (Soil and Water Conservation Society 2023) which is based on the [*Chicago Manual of Style*](#) (University of Chicago Press 2017). References cited in this laboratory manual are cited according to the *Journal of Soil and Water Conservation Style Guide*.

Supplemental Information

Include additional resources that may be relevant to your report as needed. One example is pictures taken

during the laboratory exercise. Another example is noting any recent weather or site conditions that may influence the results.

References

Soil and Water Conservation Society. 2023. Journal of Soil and Water Conservation Style Guide. Soil and Water Conservation Society. https://www.jswconline.org/sites/default/files/additional-assets/Author%20Info/Style_Guide-2021.pdf.

University of Chicago Press. 2017. The Chicago Manual of Style, 17th Edition. <https://www.chicagomanualofstyle.org>.

TEXTBOOK ADOPTION FOR INSTRUCTORS

If you would like to adopt the *Soil and Water Conservation Laboratory Manual* for use in your course, please fill out [this optional textbook adoption online form](#). The information will help us measure the impact of the *Soil and Water Conservation Laboratory Manual*, and will help guide future improvements.

PART I

SITE EVALUATION AND SOIL HEALTH ASSESSMENT

1.

IDENTIFYING A SITE

This laboratory manual is designed around the premise that you, the student, have access to a field site for most of the academic term. The goal is for you to develop a conservation plan that could potentially be implemented on the site for the purposes of conserving soil and maintaining or improving water quality. Your assignment is to identify this site and show the instructor that you will have access to the site as needed.

You will need to be able to walk around the field site to take measurements as well as excavate small holes or extract soil cores. In addition, you are highly encouraged to [call 811 or contact the appropriate local authorities](#) in order to have locations of underground utilities marked ahead of any excavation work.

The site should be currently managed in a scenario in which implementation of soil and water conservation practices would be beneficial and possible. For example, good potential sites include active farmland, grazed rangeland, production forest, or an active or soon-to-be active construction site.

Also, ask the land manager to complete the Management History form on page 13 and 14 of the Cropland In-Field Soil Health Assessment Guide ([USDA-NRCS 2021](#)), or interview them yourself and complete the form on their behalf.

Note: the landowner or land manager is welcome to contact the instructor of this course if they have any questions about the activities. They are also welcome to read this laboratory manual to see the specific activities that will likely take place on their land.

Assignment: Identify a Site

Identify a site based on the description above. Then submit proof that you have access to this land.

If you own or manage the land being used:

1) Write a brief summary with the course instructor as the primary audience that details the following:

- Your relationship to this piece of land

- The location, including the latitude and longitude
- Contextual information about the location (number of acres, current land use, etc.)
- Historical land use, if known

2) Complete the Management History Interview form from the Cropland In-Field Soil Health Assessment.

If you do not own or manage the land being used:

1) Provide the same summary described above, AND

2) Provide a dated letter or email from the landowner or manager that

- Identifies the location of the site
- Explicitly gives you permission to access the site, take measurements and collect data, and conduct small excavations

3) Complete the Management History Interview form from the Cropland In-Field Soil Health Assessment.

References

USDA-NRCS. 2021. Cropland In-Field Soil Health Assessment Guide. USDA-NRCS. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/soils/health/?cid=nrcs142p2_053869.

2.

USEFUL APPLICATIONS FOR SITE ASSESSMENT

Introduction

There are many applications (apps) that are useful for site assessment. A selection of these apps are summarized below in alphabetical order, along with links to where those apps can be accessed or downloaded.

Google Earth

Google Earth ([Google 2023](#)) is a free mapping app from Google (Alphabet Inc., Mountain View, California, US) that encompasses several apps available on multiple platforms, including a web app accessible through an internet browser, Android and iPhone apps, and a desktop App called Google Earth Pro. Google Earth is novel in that it superimposes satellite imagery on a three-dimensional globe. Features that are particularly useful for site evaluation include the ability to change the satellite imagery to previous dates, which allows users to see potential land use changes or changes due to stream or gully erosion. Users can also drop pins to save locations, as well as use a measuring tool to estimate distances between two points.



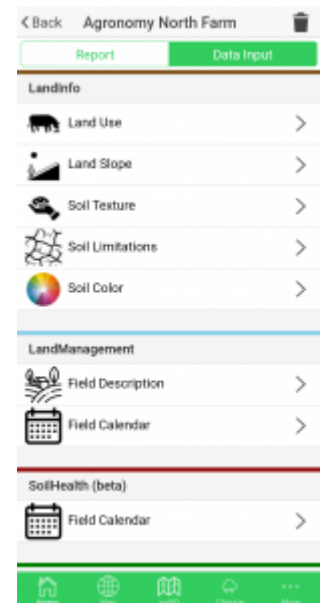
Google Earth icon.
Image courtesy of
Google Inc., Public
domain, via Wikimedia
Commons.

LandPKS

LandPKS ([LandPKS 2024b](#)), which is short for “Land Potential Knowledge System”, is a free mobile app developed by researchers at the Jornada Experimental Range. The developers state on the LandPKS website that the app features are to identify soil and land types, monitor soil health, monitor vegetation, and track land management. Within the US the LandPKS app heavily leverages Soil Survey Geographic Database (SSURGO) ([USDA-NRCS Soil Survey Staff. n.d.](#)) data to assist with identifying soil and land types. A notable feature is a slope meter that uses accelerometers in mobile devices to determine hillslope based on how much a phone is tilted when it is visually aligned with a hillslope. The data input portion of the app includes detailed and easy-to-follow directions on how to determine slope, soil texture, soil limitations, soil color, and more. Several calendars are available to track land management practices and soil health data over time. The soil health assessment within the app corresponds to the Cropland In-Field Soil Health Assessment from the US Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), which is used heavily in this laboratory manual. There is also a data portal ([LandPKS 2024a](#)) available through the LandPKS website to allow access to data through a computer.

Note: The LandPKS app is currently undergoing a redesign. It is a somewhat unstable app at the moment, and may necessitate being force-closed occasionally. Version 3 of the app is expected soon.

Breakout boxes such as the one below will be included in laboratory activities where data we are collecting directly corresponds to a feature in LandPKS.



The data input screen in the LandPKS Android app. Image courtesy of Colby Moorberg.

LANDPKS – KNOWLEDGE FOR SUSTAINABLE LAND MANAGEMENT IN YOUR HANDS

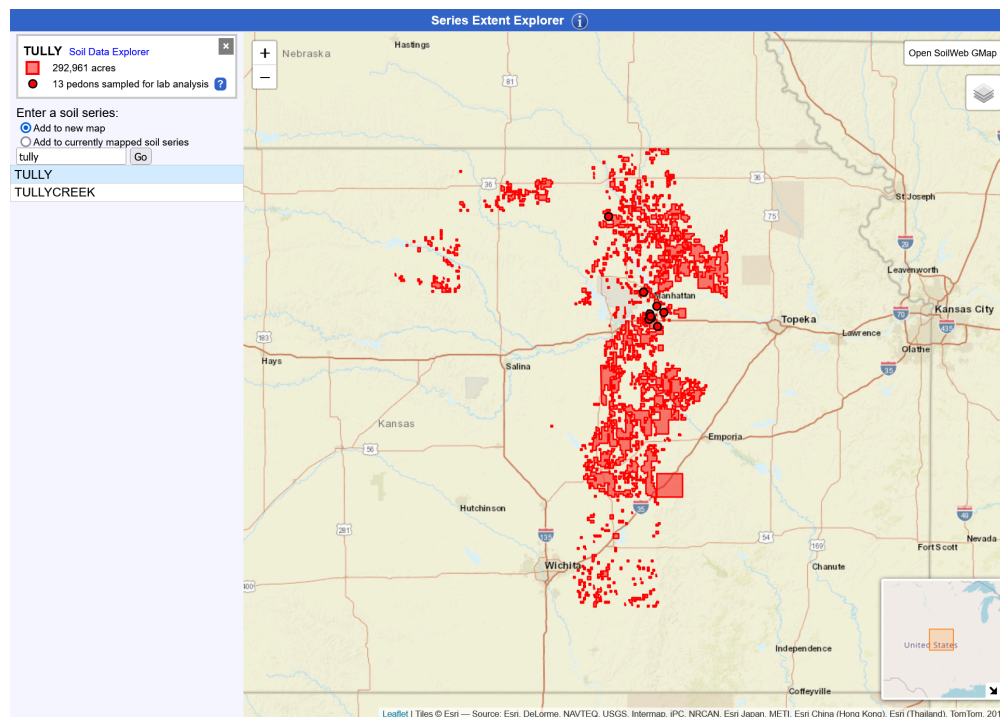
Breakout boxes will include embedded videos and other useful tips for executing the specific task. Watch the video below for further introduction to the LandPKS app.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=91#oembed-1>

Series Extent Explorer

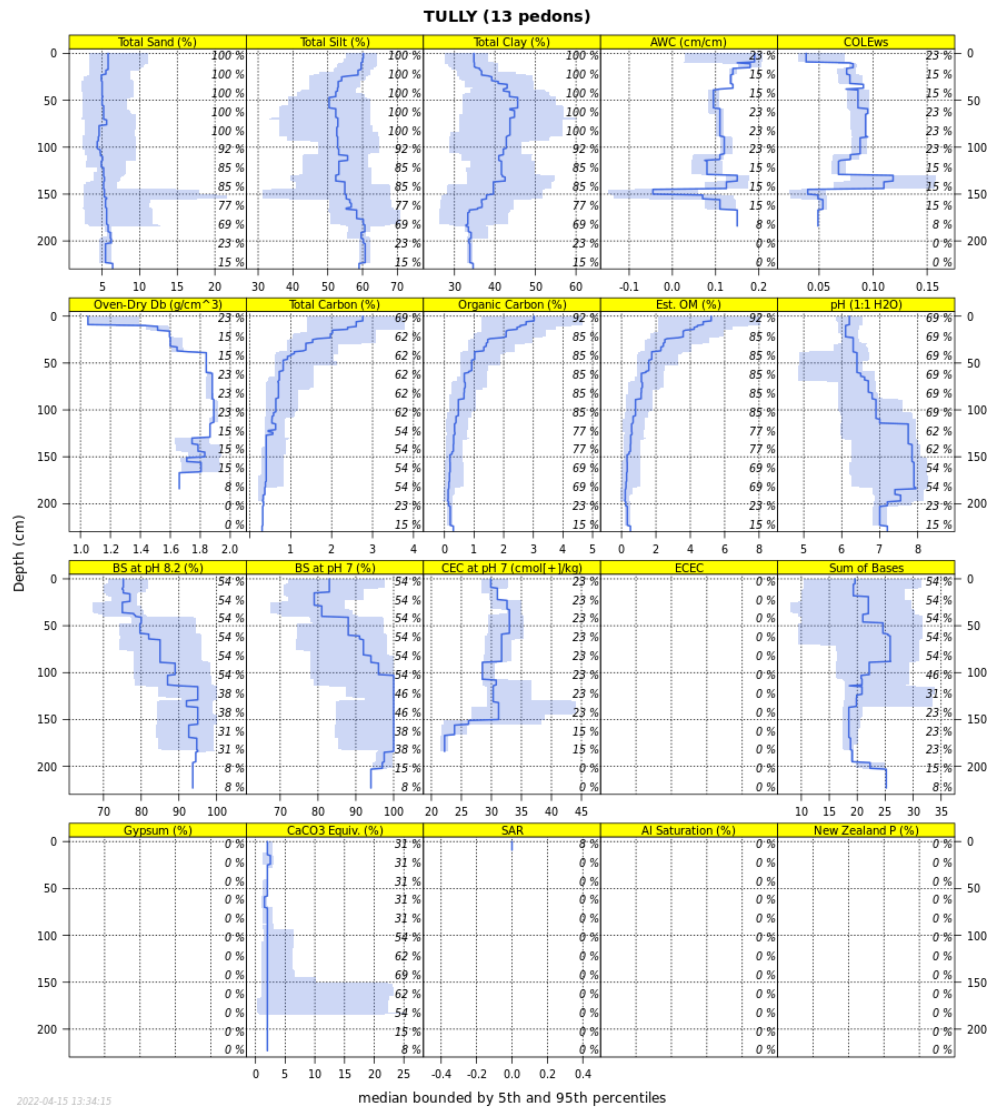
Series Extent Explorer ([California Soil Resource Lab 2018a](#)) is a web app that provides a map displaying the approximate geographic distribution of a specified soil series. The app was developed by the California Soil Resource Lab at University of California-Davis University of California Agriculture and Natural Resources in collaboration with the USDA-NRCS.



A screen capture of the Soil Series Extent web app depicting where the Tully series occurs within the Flint Hills in eastern Kansas. Image courtesy of Colby Moorberg.

Soil Data Explorer

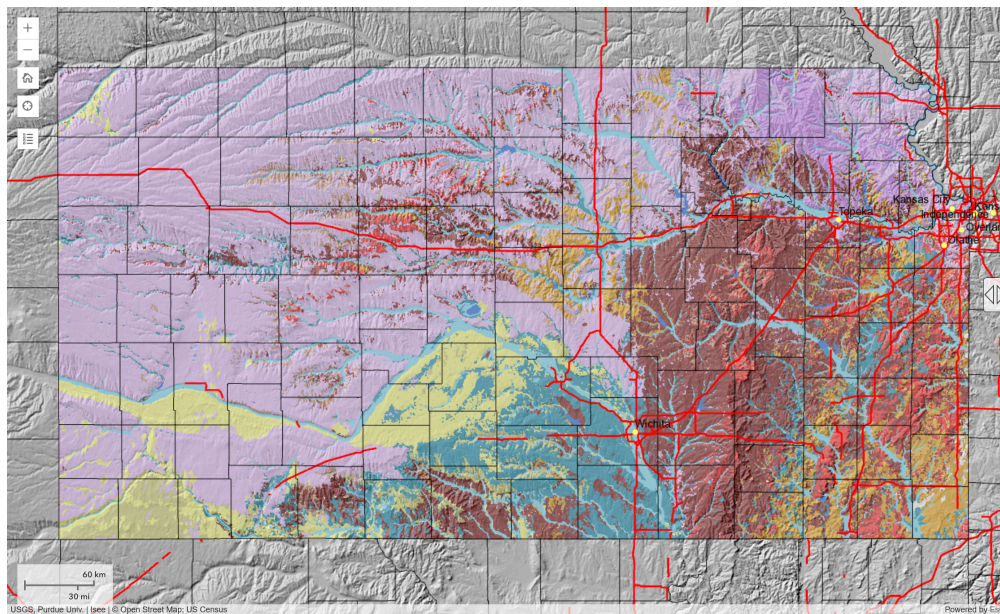
Soil Data Explorer ([California Soil Resource Lab 2018b](#)) is a web app that provides detailed information about soil series. Once a soil series name is entered it opens up a web page that displays the official series description. Other available tabs and information include Lab Data, Water Balance, Sibling Summary, Competing Series, Shared Subgroup, Block Diagrams, Map Units, and Extent. The app was developed by the California Soil Resource Lab at University of California-Davis University of California Agriculture and Natural Resources in collaboration with the USDA-NRCS.



Lab data for the Tully Series from the Soil Data Explorer web app. Image courtesy of Colby Moorberg.

Soil Explorer

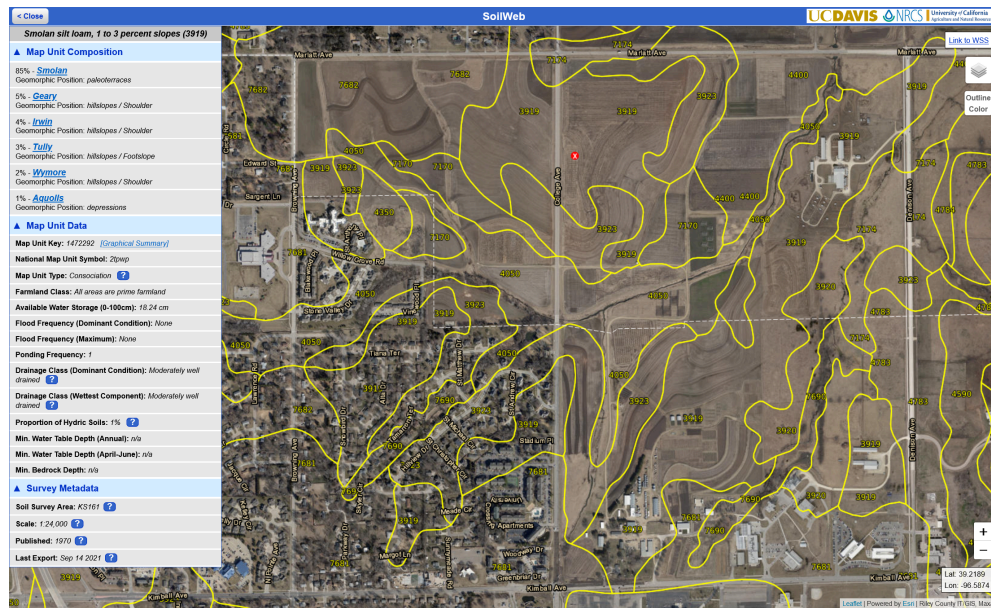
Soil Explorer ([Isee Network. 2015, 2023](#)) is available as a web app or Android and iPhone mobile apps that was developed by the Integrating Spatial Educational Experiences (ISEE) Network. The app is designed to demonstrate soil taxonomy and soil properties using maps. Users must select a region, as different data sets are available for different regions.



Screen capture of the Soil Explorer web app depicting the dominant soil orders of the state of Kansas. Image courtesy of Colby Moorberg.

SoilWeb

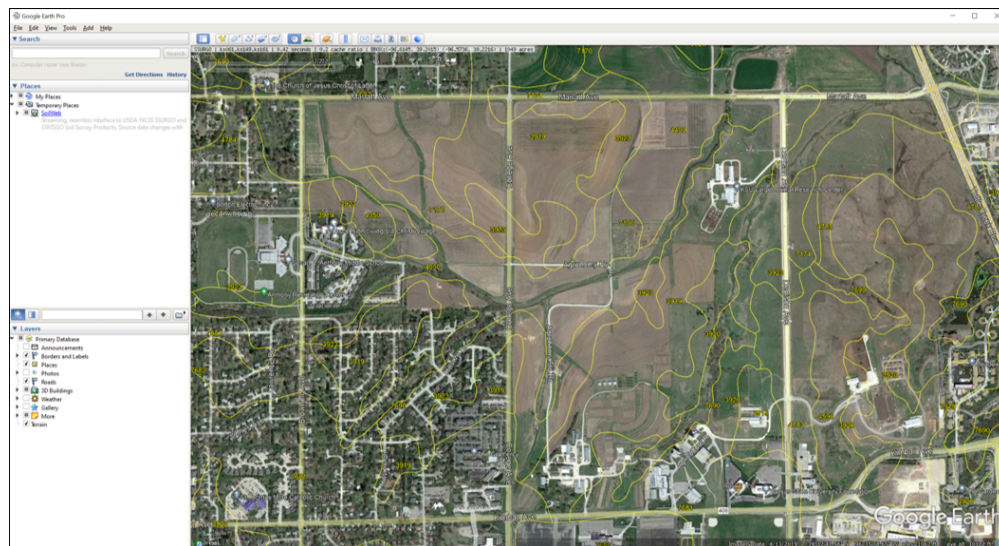
SoilWeb ([California Soil Resource Lab 2018c](#)) is a web app that allows users to explore National Cooperative Soil Survey (NCSS) data for locations in much of the US. Within the app users can navigate to a location and view mapping unit boundaries projected over current satellite imagery. Once a point location is selected the app displays the mapping unit composition, and allows users to explore the data associated with each of the soil series included within that map unit composition. Map unit data is also presented, which includes the map unit symbol, map unit type, farmland class, available water storage to a depth of 100 cm, flooding data, drainage class, and more. The SoilWeb web app is reliably available, while the Android and iPhone apps are available based on the availability of funding. The app was developed by the California Soil Resource Lab at UC Davis and UC-ANR in collaboration with the USDA-NRCS.



Screen capture of the SoilWeb web app showing the Smolan silt loam, 1 to 3 percent slopes (3919) mapping unit. Image courtesy of Colby Moorberg.

SoilWeb Earth

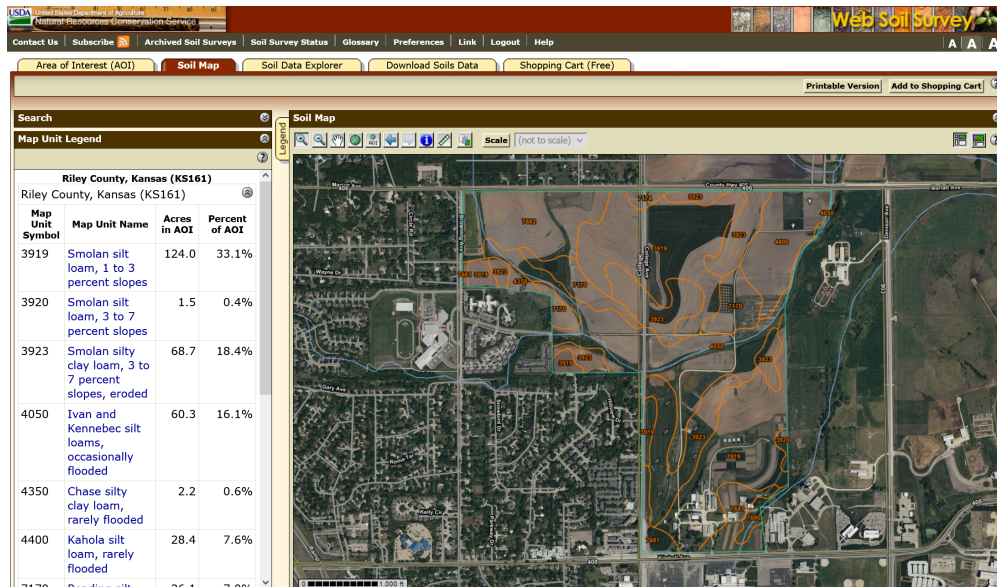
SoilWeb Earth ([California Soil Resource Lab 2018d](#)) allows soil data to be displayed within Google Earth in a [KML file](#) with interactivity and function similar to SoilWeb accessed through a browser. The SoilWeb Earth KML file was developed by the California Soil Resource Lab at University of California-Davis University of California Agriculture and Natural Resources in collaboration with the USDA-NRCS.



The SoilWeb Earth KML file loaded in the Google Earth Pro app. Image courtesy of Colby Moorberg.

Web Soil Survey

Web Soil Survey ([USDA-NRCS 2019](#)) is a web app from the USDA-NRCS that provides soil data and information in SSURGO ([USDA-NRCS Soil Survey Staff. n.d.](#)) from the NCSS. Once an area of interest (AOI) has been designated, users can explore the Soil Map and then use the Soil Data Explorer to explore Suitability and Limitations for Use, Soil Properties and Qualities, Ecological Sites, and more. Soils data for the AOI can be downloaded, or a PDF report can be generated for download.



A soil map of the Kansas State University Agronomy North Farm depicted in the Web Soil Survey web app. Image courtesy of Colby Moorberg.

References

- California Soil Resource Lab. 2018a. Series Extent Explorer. <https://casoilresource.lawr.ucdavis.edu/see/>.
- California Soil Resource Lab. 2018b. Soil Data Explorer. <https://casoilresource.lawr.ucdavis.edu/sde/>.
- California Soil Resource Lab. 2018c. SoilWeb. Davis, CA: California Soil Resource Lab. <https://casoilresource.lawr.ucdavis.edu/gmap/>.
- California Soil Resource Lab. 2018d. SoilWeb Earth. Davis, CA: California Soil Resource Lab. http://casoilresource.lawr.ucdavis.edu/soil_web/kml/SoilWeb.kmz.
- Google. 2023. Google Earth. <https://earth.google.com/web/>.
- Isee Network. 2015, 2023. Soil Explorer. <http://SoilExplorer.net>.
- LandPKS. 2024a. Data Portal. <https://landpotential.org/data-portal/>.
- LandPKS. 2024b. LandPKS. <https://landpotential.org/>.
- LandPKS. 2020. Knowledge for Sustainable Land Management In Your Hands. YouTube.

<https://www.youtube.com/watch?v=QZAZBdSuitA>.

USDA-NRCS. 2019. Web Soil Survey. <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>.

USDA-NRCS Soil Survey Staff. n.d. Description of SSURGO Database. <https://www.nrcs.usda.gov/resources/data-and-reports/soil-survey-geographic-database-ssurgo>.

3.

SOIL HEALTH ASSESSMENT PART I: SOIL COVER, SLOPE, AND RESIDUE BREAKDOWN

Soil Cover, Slope, and Residue Breakdown

Acknowledgement and Recommended Reading

The methods for determining soil cover and assessing residue breakdown were based on the Cropland In-Field Soil Health Assessment Guide from the USDA-NRCS ([2021](#)). The LandPKS app is useful for recording soil health assessment data and uses the same methods described in the Cropland In-Field Soil Health Assessment ([LandPKS 2023](#)). An introduction video to soil health measurements using the LandPKS app is provided in the introduction to this laboratory activity. How-to videos are also provided in breakout boxes.

Learning Objectives

By the end of this laboratory you will:

1. Conduct a field assessment to determine percent residue cover (also known as soil cover), percent slope, and residue decomposition
2. Be prepared to determine need for conservation practices to address resource concerns associated with these soil health indicators

Materials

Materials necessary to complete this laboratory activity include:

- Meter stick or 100' roll-up tape measure
- Clinometer or the [LandPKS app](#) on a mobile device
- [Ground Cover and Percent Slope Data Sheet](#) (Excel file)

Introduction

Plant residue, mulch, and other soil covers are important because cover helps protect the soil from the impact of raindrops. The three components of soil erosion are detachment, transport, and deposition. Soil erosion rates can be greatly reduced when detachment of soil particles from soil aggregates is prevented. When assessing the existing erosion risk of a site it is important to accurately quantify the amount of soil cover present as well as predict the fate of residue during subsequent decomposition or field operations. This laboratory exercise is the first of a four-part activity to conduct a cropland in-field soil health assessment based on the USDA-NRCS Technical Note No. 450-06 ([USDA-NRCS 2021](#)).



Figure 3.1. Conservation tillage system that leaves at least 30 percent of the soil covered after planting with last year's crop residue. North-central Iowa. Photo by Lynn Betts, USDA-NRCS.

The risk of soil erosion is also influenced by the slope. As slope increases the velocity of water flowing in sheets, rills, and gullies increases, making the water more erosive. In addition to percent cover, you will be determining percent slope, which will be used in estimations of erosion rates in later laboratories.

Introduction to Soil Health and the LandPKS App

The LandPKS app uses the same soil health assessment protocols as the Cropland In-Field Soil Health Assessment from the USDA, and is very useful for recording soil health data. Watch the video below for an introduction to soil health assessment using the LandPKS app.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=26#oembed-1>

Determining Percent Slope and Length of Slope

Determining Percent Slope with a Clinometer

You will now measure the slope and length of slope for hill slopes at the site, or for individual terraces if the field has already been terraced. This can be done with a clinometer in two ways. If you have a partner of approximately the same height you can aim the clinometer at their eyes, or a facial feature about the same height as your eyes as you use the clinometer. If you do not have a partner, then drive two stakes or shovels into the ground at the top and bottom of the slope to be measured. The tops of each shovel or stake should be at an equal distance above the soil surface. Using the clinometer, measure the slope from the top of one stake/shovel to the other. Most clinometers display two numbers – the slope angle and the sloper percent. The percent slope should be the higher number, and is typically the number on the right of the scale inside the clinometer. You can check this by looking at a 45° angle. The slope percent should be 100% while the slope angle should be 45°. Alternatively, a unit should be visible when looking directly upward or downward through the clinometer. Record the percent slope of each major hill at your site.

Determining Percent Slope with LandPKS

If you do not have a clinometer, use the LandPKS application on a mobile device. You will first need to create a “site” on the app. Open the app on a mobile device, then click on the plus sign to add a new site. Enter a site name, use the latitude and longitude recorded by the device, and click “save”. Next, click on “Data Input”, then “Land Slope”, then “Use Slope Meter”. Position yourself a certain distance to the side of the hill slope you desire to measure, then face that slope. While facing the slope, align the side of your mobile device so it lines up with the slope of the land, notice both the slope angle (noted by a degree sign, °) and the slope percent (%) change as you rotate the mobile device. Once the device is aligned with the slope, click “lock”. This will save the slope percent for that location within the app. Report this value in the data sheet.

Watch the video below for an overview of creating a site, measuring slope, and recording that data in the app.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=26#oembed-2>

Note About Terraces

When determining the slope of a terrace: the slope of a broad-based terrace is measured from the top of a terrace to the channel behind the next terrace downslope. The slope of step-back terraces are measured from the bottom of one terrace to the edge of the next terrace downslope.

Measuring Length of Slope

You will now measure the length of slope using a long measuring tape, or if you know the length of your gate you can measure the length of slope using the number of steps it takes to walk along the slope. Alternatively you can measure the length of slope using the Google Earth app. Navigate to your location in the Google Earth app, click on the ruler icon near the top-right of the screen. Click on the “Add Point” button to add a point at the bottom or top of the slope, then repeat for the opposite end of the slope. Once the second point is added the length of that slope will be reported on screen in the units selected at the bottom-left of the screen.

Report the length of slope in the data sheet, and save this data for future erosion modeling labs.

Determining Percent Cover

There are two primary methods that can be used to determine percent cover. Choose a method based on the materials available to you, and report the method used in your data sheet.

Meter stick Method

This method utilizes a meter stick (or yard stick) and its graduations as an easy, quick method of determining

ground cover, and is completed entirely in the field. Place a meter stick perpendicular to the rows of the field. Add up the number of centimeter marks (or inch marks) along the length of the stick that are underlain by ground cover. Also, add up the number of total marks on the stick. Calculate the ground cover according to the following equation:

$$\text{Ground cover}(\%) = \frac{\text{marks underlain by ground cover}}{\text{total number of marks}} \times 100 \%$$

Repeat this measurement at least five times for each section of the field. If this is for a terraced slope, repeat this measurement five times for each terrace. Report the measured values and the average percent cover for each section of the field in the data sheet.

Line-Transect Method

The line-transect method is essentially the same as the meter stick method, but uses either a roll-up tape measure, or a rope/string specifically designed for this method.

With a partner, stretch out the length of a tape measure and align it so that the tape is perpendicular to the rows. Walk the length of the tape, and record the number of graduation marks (meter, yard, or foot marks) that are underlain by ground cover. Also record the total number of graduation marks. Calculate the ground cover using the same equation as above. This method captures a larger sampling area, so repeated measurements are not needed. However, you are welcome to repeat it if field conditions are variable.

A variation of this method is sometimes used in which a rope or string is used instead of a tape measure. In those cases, a knot, or similar marker, is used in place of the graduation marks on a tape measure.

Determining Cover with LandPKS

The LandPKS app uses a slightly different method for quickly determining ground cover. Watch the video below for an overview of that method and how to record your data in the LandPKS app.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=26#oembed-3>

Watch the next video to learn how to conduct the vegetation and land cover assessment in LandPKS.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=26#oembed-4>

If you desire more detailed vegetation and ground cover data you can use the protocol in the video below. This is optional for this laboratory, but may be useful, particularly if you are conducting this assessment on rangeland.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=26#oembed-5>

Assessing Residue Breakdown and Predicting Residue Loss

Crop residue and ground cover is broken down by soil organisms through shredding, fragmentation, cycling, and decomposition. The rate at which this occurs can be an indicator of biological activity. This process is also influenced by soil moisture, soil and air temperature, C:N ratio of residues, and more. Assess residue breakdown by examining residue for signs of decomposition, shredding, and incorporation by soil organisms. In addition, note the condition, color, and depth of the residue most recently deposited. If possible, discuss management of the field with the land manager to determine residue age and types of plants. Note that this indicator can be assessed at any time, but may be influenced by full-width tillage.

Based on your observations at the site, is the natural decomposition of crop residues or ground cover as expected with crop and conditions? Report your response as yes or no in the data sheet.

Assessing Residue Breakdown with LandPKS

Watch the video below for an overview of assessing residue breakdown and how to record that data in the LandPKS app.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=26#oembed-6>

Questions

The following questions directly relate to this lab activity and will be answered as part of the [Site Evaluation and Soil Health Assessment Report](#).

1. Describe the site conditions and recent operations (tillage, tillage implements used, planting, etc.)
2. What field operations are planned for this site between now and the next time it is planted?
3. What was the average percent ground cover for each location?
4. Based on your responses to the questions above, estimate the remaining plant residue at the time of planting the next crop using [this extension publication from the University of Nebraska, Lincoln](#).

References

- LandPKS. 2020a. Vegetation & LandCover Training, Part 1. https://youtu.be/R5_TmcA8HyU.
- LandPKS. 2020b. Vegetation & LandCover Training, Part 2. <https://youtu.be/qJHPY15iaSI>.
- LandPKS. 2021a. SoilHealth Trainings 1: Introduction to the Indicators. <https://youtu.be/CO2pYxWi2yo>.
- LandPKS. 2021b. SoilHealth Trainings 2: Set-up & Soil Cover. <https://youtu.be/Rogcmd8-fYg>.
- LandPKS. 2021c. SoilHealth Trainings 3: Residue Breakdown. https://youtu.be/puIND54_uPk.
- LandPKS. 2023. LandPKS. <https://landpotential.org/>.
- Shelton, D. P., J. Smith, P. Jasa, and R. Kanable. 1995. Estimating Percent Residue Cover Using the Calculation Method. Lincoln, NE: University of Nebraska, Lincoln. <https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1782&context=extensionhist>.
- USDA-NRCS. 2021. Cropland In-Field Soil Health Assessment Guide. USDA-NRCS. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/soils/health/?cid=nrcs142p2_053869.
- USDA-NRCS. 2022. Conservation Practices. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/?cid=nrcs143_026849.

4.

SOIL HEALTH ASSESSMENT PART II: INFILTRATION, SURFACE CRUSTS, SOIL STRUCTURE, AND WATER STABLE AGGREGATES

Infiltration, Surface Crusts, Soil Structure, and Water Stable
Aggregates

Acknowledgement and Recommended Reading

This laboratory was designed to conduct in-field assessments of soil health and is based on the Cropland In-Field Soil Health Assessment Guide from the USDA-NRCS ([2021](#)). Additional information is available in USDA-NRCS Soil Quality Indicator Sheets from the USDA-NRCS for infiltration, slaking and soil crusts, and structure ([2008a](#), [2008b](#), [2008c](#), [2008d](#)) and the Field Guide for Describing and Sampling Soils ([Shoeneberger et al. 2012](#)). Methods and videos for the LandPKS app are provided for each activity. More information is available at the LandPKS website ([2023](#)).

Learning Objectives

By the end of the laboratory you will:

1. Conduct a field assessment to characterize the infiltration rate, soil crusts, soil structure, and water stable aggregates
2. Be prepared to determine need for conservation practices to address resource concerns associated with these soil health indicators

Materials

Materials required to complete this laboratory activity include the following:

- Thin-walled cylinder approximately 15 cm in diameter and 15 cm tall (6 in x 6 in)
- Block of wood and a mallet
- Water container approximately 4 L in volume (1 gal) filled with water
- Permanent marker or brightly colored tape
- Ruler or tape measure
- Stop watch or smart phone stop watch app
- Colander or wire mesh for suspending soil peds and aggregates in water
- Bowl or tall cylinder
- Water to fill the bowl or cylinder

Introduction

Soil physical properties can be used to assess soil health and to prescribe conservation practices that can improve soil function over time. In this lab you will learn how measure infiltration rate, observe the presence of surface crusts, evaluate soil color of the topsoil, and determine the type of soil structure in the topsoil.

Observing Ponding or Measuring Infiltration Rate

Standing water can be an indicator of poor infiltration, which may be caused by soil properties impacted by soil management including compaction, poor soil structure, poor aggregate stability, lack of ground cover, or soil crusting; or by natural soil conditions such as clayey soils, fragipans, duripans, and more. Surface ponding and prolonged saturation can cause runoff and erosion, damage to crops, problems with nutrient cycling, production of greenhouse gases and more.

The presence of ponded conditions can be observed directly within 24 hours of a typical rainfall or irrigation event. Determine if the ponded condition occurs throughout the field, or only in select locations.

Alternatively, conduct an infiltration test. Refer to the [Soil Quality Test Kit Guide \(SQTKG\)](#) for instructions on how to conduct this test. Select a location for the test that avoids areas likely to be compacted (headlands/turning rows, traffic lanes, and wheel tracks). Most soils should infiltrate within 30 minutes.

Assessing Ponding or Infiltration with LandPKS

Watch the video below for an overview of assessing ponding or infiltration and recording data in the LandPKS app.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=32#oembed-1>

Identifying Surface Crusts

Soils that are poorly aggregated are prone to surface crusting, especially when left uncovered and exposed to rainfall. Crusting can also occur in soils with salinity (high salt content) and/or sodicity (high sodium content) problems. Crusts limit aeration, infiltration, and seedling emergence causing problems for plant health, soil organisms, and nutrient management.

Assess the site for the presence of soil crusts by examining the field for crusts. Crusts will remain intact when picked up. This is best done after irrigation or rain. Recent full-width tillage may temporarily eliminate soil crusts. Further investigation may be warranted if saline, sodic, or saline-sodic conditions are expected or observed.

Assessing Surface Crusts with LandPKS

Watch the video below for an overview of assessing surface crusts and recording your observations using the LandPKS app.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=32#oembed-2>

Describing Soil Structure

Soil structure impacts many biological, chemical, and physical soil properties. Soil structure can be negatively impacted by loss of soil organic matter, compaction, and soil management practices such as crop rotation, residue removal, tillage, and more.

Assess the soil structure by looking for the presence of granular structure, platy structure, or structureless massive conditions (Figure 4.1) within the top 30 cm of soil profile. This assessment can be conducted at any time, but may be impacted by recent full-width tillage operations. Comparison to the OSD, which can be accessed as described above, provides context for the potential of the soil.

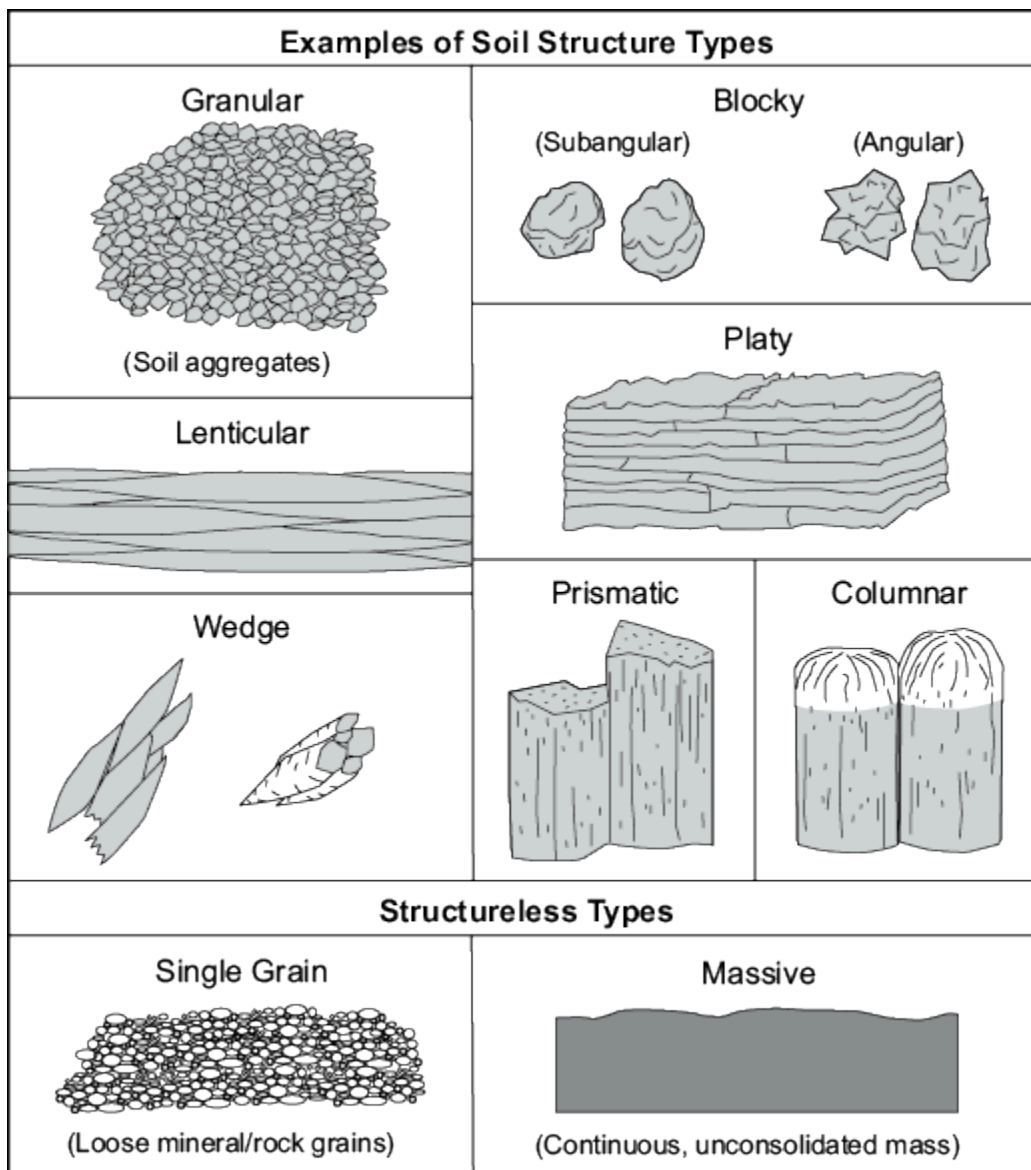


Figure 4.1. Examples of soil structure types. Diagram courtesy of the USDA-NRCS.

Assessing Soil Structure with LandPKS

Watch the video below for an overview of how to record the soil structure in the LandPKS app.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=32#oembed-3>

Water Stable Aggregates

Soil properties and functions such as water infiltration, water storage, nutrient cycling, root growth, plant health, soil organism habitat, protection of soil organic matter, and more are all dependent on the stability of soil aggregates in water. Two methods of assessing water stable aggregates are presented here.

Cylinder Method

Collect a soil ped from the site just below any surface residue. The ped should be approximately the size of a golf ball. Allow the ped to air dry. Place the ped in a strainer basket and submerge it in a container. Observe the water after the ped has been submerged for 5 minutes. Is the clear or cloudy? Cloudiness caused by the soil slaking apart is caused by internal pressure or air inside the ped that is being forced out by water. The roots, root hairs, polysaccharides, and other “glues” that promote aggregation will help stable aggregates from breaking apart under this strain, while a lack of those “glues” will allow the ped to slake apart. Record your observations in the data sheet.

Strainer Method

Collect a sample of soil and break apart any large peds until aggregates are the the size of a BB or slightly larger. Place the soil in a stainer or fine mesh colander. Immerse the the colander in a water-filled bowl and allow the aggregates to saturate for approximately 1 minute. Dump the aggregates onto a flat surface and observe the stability of the aggregates. Water stable aggregates will maintain structure, while aggregates with poor aggregates will break apart and appear similar to pudding. This method does not require the aggregates to be air dry, and can be performed at various soil moisture contents.

Soil Quality Test Kit Guide Method

If you have access to the [USDA-NRCS Soil Quality Test Kit and Guide](#) you can use the method presented in Chapter 9 of that guide. The USDA-NRCS states this is the easiest method to perform in the field.

Assessing Aggregate Stability with LandPKS

Watch the video below for an overview of the three methods above and how to record aggregate stability data in the LandPKS app.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=32#oembed-4>

Questions

The following questions directly relate to this lab activity and will be answered as part of the [Site Evaluation and Soil Health Assessment Report](#).

1. Did any of the soil health indicators above not meet the soil health assessment criteria? Explain why.
2. Where there any recent operations or site conditions that may have influenced any of the soil health assessments? Explain how the assessments may have been impacted.

References

- LandPKS. 2021a. SoilHealth Trainings 4: Surface Crusts (Surface Crusting). <https://youtu.be/U6aOei0xaEg>.
- LandPKS. 2021b. SoilHealth Trainings 5: Ponding (Ponding/Infiltration). <https://youtu.be/VzYlW385s5g>.
- LandPKS. 2021c. SoilHealth Trainings 7: Aggregate Stability (Water-Stable Aggregates). https://youtu.be/N_lIu3YEHSc.
- LandPKS. 2021d. SoilHealth Trainings 8: Soil Structure. <https://youtu.be/pHPZWtBXGZs>.
- LandPKS. 2023. LandPKS. <https://landpotential.org/>.
- Schoeneberger, P. J., D. A. Wysocki, E. C. Benham, and Soil Survey Staff. 2012. Field Book for Describing and Sampling Soils, Version 3.0. Lincoln, NE: USDA-NRCS. <https://www.nrcs.usda.gov/resources/guides-and-instructions/field-book-for-describing-and-sampling-soils>.
- USDA-NRCS. 2001. Soil Quality Test Kit Guide. USDA-NRCS Soil Quality Institute. <https://www.nrcs.usda.gov/sites/default/files/2022-10/Soil%20Quality%20Test%20Kit%20Guide.pdf>.
- USDA-NRCS. 2008a, June. Soil Quality Indicators: Infiltration. USDA-NRCS. <https://www.nrcs.usda.gov/sites/default/files/2022-10/Infiltration.pdf>.
- USDA-NRCS. 2008b, June. Soil Quality Indicators: Slaking. USDA-NRCS. <https://www.nrcs.usda.gov/sites/default/files/2022-10/Slaking.pdf>.
- USDA-NRCS. 2008c, June. Soil Quality Indicators: Soil Crusts. USDA-NRCS. <https://www.nrcs.usda.gov/sites/default/files/2022-10/Soil%20Crusts.pdf>.
- USDA-NRCS. 2008d, June. Soil Quality Indicators: Soil Structure & Macropores. USDA-NRCS. <https://www.nrcs.usda.gov/sites/default/files/2022-10/Soil%20Structure%20and%20Macropores.pdf>.
- USDA-NRCS. 2021. Cropland In-Field Soil Health Assessment Guide. USDA-NRCS. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/soils/health/?cid=nrcs142p2_053869.
- USDA-NRCS. 2022. Conservation Practices. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/?cid=nrcs143_026849.

5.

SOIL HEALTH ASSESSMENT PART III: SOIL COLOR, BIOLOGICAL DIVERSITY, AND BIOPORES

Soil Color, Biological Diversity, and Biopores

Acknowledgement and Recommended Reading

This laboratory was designed to conduct in-field assessments of soil health and is based on the Cropland In-Field Soil Health Assessment Guide from the USDA-NRCS ([2021](#)). Additional information is available in the Field Guide for Describing and Sampling Soils ([Shoeneberger et al. 2012](#)). Methods and videos for the LandPKS app are provided for each activity. More information is available at the LandPKS website ([2023](#)).

Learning Objectives

By the end of the laboratory you will:

1. Conduct a field assessment to characterize soil color, stability of soil aggregates in water,

- biological diversity of soil organisms, and presence of biopores
2. Be prepared to determine need for conservation practices to address resource concerns associated with these soil health indicators

Materials

Materials required to complete this laboratory activity include the following:

- A Munsell soil color chart
 - OR, cell phone camera and 3M Canary Yellow Post-It Notes
- Hand lens
 - OR, cell phone camera with a zoom feature
 - OR, magnifying glass

Introduction

The foundation of soil biological activity is soil organic matter. The source of that organic matter is plant residue, roots, and root exudates. Healthy soils that have been minimally disturbed and have sufficient additions of organic materials will maintain the soil organic matter, resulting in dark colors and lots of biological activity. Soils that experience regular disturbance or do not have sufficient additions of organic materials will lose soil organic matter over time, and as a result will exhibit lighter colors and less biological activity. In this lab you will be assessing the color of the topsoil as an indicator of high amounts of soil organic matter. You will also assess levels of biological activity as evidenced by direct observation of soil organisms and the presence of biopores that are created by these organisms.

Describing Soil Color

Dark top soil color is attributed to soil organic matter. As organic matter is lost from soil the topsoil will become less dark in color. In contrast, increases in organic matter result in darker soil color.

Assess the site for topsoil color by comparing colors determined using a Munsell soil color chart or the LandPKS app and the Official Series Description (OSD) or by comparing soil from the site to a nearby fencerow with the same soil type.

Soil Color Chart Method

Use a Munsell Soil Color Chart to determine the hue, value, and chroma of the surface horizon. Compare this color to that of the Official Series Description (OSD) for that specific soil series. Use the [SoilWeb web app](#) to identify the soil mapping unit for the location. Click on the map to bring up the soil mapping unit composition (*Note: Further site investigation may be needed to confirm what soil series exists at that location*). Click on the appropriate soil series name for the site. This opens an animated description of the soil profile. Click on the “Description” option towards the top-right of the web page. This will open the OSD for that soil series. Compare the color of the soil at the surface to the color of the surface horizon in the OSD. Record the results in the data sheet.

Determining Soil Color with LandPKS

If you do not have a Munsell soil color chart available, reliable soil colors can be determined with the LandPKS app with a calibrated cell phone camera. Determine the soil color using the LandPKS app based on the video below. You will need a color reference for your cell phone camera. Canary yellow 3M Post-It notes serve as a great color reference.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=132#oembed-1>

Field versus Fencerow Comparison Method

At several locations for field compare field topsoil to that of nearby fencerows or other undisturbed perennially-vegetated location. Ensure both soils are at similar moisture by moistening the sample before comparison as would be done for measuring soil color with a soil color chart. Do not use this method for irrigated fields where irrigation and fertility management of the field may lead to organic matter concentrations greater than the fencerow. Record the results in the data sheet.

Biological Diversity

Soil organisms can have a significant influence on soil properties and function, including pest suppression, nutrient cycling, aggregation, and water dynamics.

Assess biological diversity by observing soil organisms in the soil surface. Do this by taking a shovel full of soil and examining it for organisms. Look for meso- and micro-fauna such as earthworms, springtails, beetles, ants, millipedes, roundworms, etc. Also look for active nodules on the roots of legumes, or fungal hyphae that appear as thin, white threads or masses. The Soil Macrofauna Field Manual from the FAO ([Ruiz et al. 2008](#)) includes images of soil organisms you may possibly see. Page 10 of the Cropland In-Field Soil Health Assessment Guide also includes 12 photos of possible soil organisms ([USDA-NRCS 2021](#)).

Assessing Biological Diversity with LandPKS

Watch the video below to learn about observing soil biota and recording your observations in the LandPKS app.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=132#oembed-2>

Biopores

Large pores (macropores) in the soil that are created by earthworms or roots are called “biopores”. These biopores facilitate rapid movement of air and water, allow plants to access nutrients and water, and provide pathways for soil organisms to navigate the soil.

Assess the presence of biopores by taking a shovel full of soil and examine it for intact biopores. These biopores can appear darker than surrounding soil due to enrichment of organic matter. These pores may also connect to the soil surface. This indicator is easiest to assess in moist soils, but can also be assessed when the soil is dry.

Assessing Biopores with LandPKS

Watch the video below to learn about identifying biopores and recording their presence in the LandPKS app.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=132#oembed-3>

Questions

The following questions directly relate to this lab activity and will be answered as part of the [Site Evaluation and Soil Health Assessment Report](#).

1. Did any of the soil health indicators above not meet the soil health assessment criteria? Explain why.
2. Were there any recent operations or site conditions that may have influenced any of the soil health assessments? Explain how the assessments may have been impacted.

References

- LandPKS. 2021a. SoilHealth Trainings 9: Soil Color. https://youtu.be/_MX4XBZAuI.
- LandPKS. 2021b. SoilHealth Trainings 11: Biological Diversity. https://youtu.be/L_u44M7LriE.
- LandPKS. 2021c. SoilHealth Trainings 12: Biopores. https://youtu.be/0XBiloO7_rQ.
- LandPKS. 2023. LandPKS. <https://landpotential.org/>.
- Ruiz, N., P. Lavelle, and J. Jiménez. 2008. Soil Macrofauna Field Manual. Rome: Food and Agriculture Organization of the United Nations and Intergovernmental Technical Panel on Soils. <http://www.fao.org/3/a-i0211e.pdf>.
- Schoeneberger, P. J., D. A. Wysocki, E. C. Benham, and Soil Survey Staff. 2012. Field Book for Describing and Sampling Soils, Version 3.0. Lincoln, NE: USDA-NRCS. <https://www.nrcs.usda.gov/resources/guides-and-instructions/field-book-for-describing-and-sampling-soils>.
- USDA-NRCS. 2021. Cropland In-Field Soil Health Assessment Guide. USDA-NRCS. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/soils/health/?cid=nrcs142p2_053869.
- USDA-NRCS. 2022. Conservation Practices. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/?cid=nrcs143_026849.

6.

SOIL HEALTH ASSESSMENT PART IV: SOIL PENETRATION RESISTANCE AND PLANT ROOTS

Soil Penetration Resistance and Plant Roots

Acknowledgement and Recommended Reading

This laboratory was designed to conduct in-field assessments of soil health and is based on the Cropland In-Field Soil Health Assessment Guide from the USDA-NRCS (2021), and on the Pennsylvania State University extension publication, Diagnosing Soil Compaction Using a Soil Compaction (Soil Compaction Tester) by Duiker (2002). The video below from the University of Wisconsin Integrated Pest and Crop Management (2015) provides a demonstration on how to use a penetrometer. Methods and videos for the LandPKS app are provided for each activity below. More information is available at the LandPKS website (2023).



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=44#oembed-1>

Learning Objectives

By the end of the laboratory you will:

1. Conduct a field assessment to characterize soil penetration resistance and plant roots
2. Determine need for conservation practices to address resource concerns associated with these soil health indicators

Materials

Materials required to complete this laboratory activity include the following:

- Wire flag, or
- Penetrometer
- Shovel or spade
- Hand lens

Introduction

Soil compaction can be caused by machinery or vehicle traffic, hoof traffic, or tillage. Soil compaction results in the loss of pore space, which limits aeration and water movement. Compaction can also inhibit or hinder root growth or interfere with soil organism habitat and nutrient cycling. Compaction can be indicated by increased soil penetration resistance as well as irregular root growth.

Penetration Resistance

Penetration resistance should be measured at field capacity if possible, due to the increase in soil strength as soil dries. Penetration resistance should be measured at 8-10 locations at the site, or 8-10 locations for each soil type or management system.

Wire Flag Method

Hold a wire flag near the flag and insert the wire to a depth of 30 cm (12 in) in an area known to not be compacted, such as a nearby fence row. Repeat this within the assessment area and determine if greater force was required to insert the wire. Record your observations in the data sheet.

Penetrometer Method

Penetrometers (Figure 6.1) are hand-powered instruments that measure the force exerted on a cone at the tip of a rod which is inserted into the soil.

Assess soil compaction by applying consistent, downward force at a rate of 2.5 cm (1 in) per second while observing readings on the pressure gauge. Cones should be used as follows: 0.5 in cones for silty, clayey, or loamy soils; 0.75 in cones for sandy soils. Note the depth of restrictive layers and resistance pressure. A layer of soil is considered restrictive to roots when penetration resistance exceeds 104 N/cm^2 (1035 kPa, 150 PSI) in the top 15 cm (6 in) of soil and 207 N/cm^2 (2070 kPa, 300 PSI) at 15-45 cm (6-18 in) of soil. Using Table 6.1, determine the compaction rating and whether subsoiling or an alternative practice is recommended based on the percent of observations where penetration resistance would be root limiting in the top 45 cm. Record your the results.



Figure 6.1. A handheld penetrometer being used in the field (left), associated equipment (top right), power meter (center right), and cones (bottom right). Photograph courtesy of HPsy.

Table 1. Compaction rating determination based on observations of root-restrictive layers.

Percent of Observations With a Root-Restrictive Layer Within Top 45 cm	Compaction Rating	Subsoiling or Alternative Practice Recommended
<30%	Light-none	No
30-50%	Slight	No
50-75%	Moderate	Yes
>75%	Severe	Yes

Table adapted from (Murdock et al. 1995) and (Duiker 2002).

Assessing Penetration Resistance with LandPKS

Watch the following video for an overview of assessing soil penetration resistance using several methods and how to record penetration resistance data in LandPKS.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=44#oembed-2>

Plant Roots

Plants are the primary producers of terrestrial ecosystems, and plant roots are the primary means of carbon additions into the soil. This is done via root exudates from living plants, or decomposition of plant roots once a plant dies or sheds roots. These exudates and root-derived carbon feed soil microbes. The roots also promote soil aggregation and create biopores, thus influencing soil porosity, aeration, water movement, nutrient cycling, and soil organism habitat.

To assess plant roots as a soil health indicator observe rooting patterns in the top 20 cm (8 in) or deeper depending on the plants present and soil conditions. Roots should be abundant and be deeply rooted, and not be impeded by compacted layers as indicated by kinked or irregular root growth or roots growing horizontally above a compacted layer. Healthy roots should have root hairs, whereas a lack of root hairs may indicate anaerobic soil conditions. Roots should be intermingled with soil aggregates that stick to the roots, indicating roots and root hairs are supporting soil structure. Some plant species may form rhizosheaths, which can indicate beneficial soil microbe colonization. Record your observations in the data sheet.

Assessing Plant Roots with LandPKS

Watch the following video for an overview of assessing soil roots and recording data in the LandPKS app.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=44#oembed-3>

Questions

The following questions directly relate to this lab activity and will be answered as part of the [Site Evaluation and Soil Health Assessment Report](#).

1. Did any of the soil health indicators above not meet the soil health assessment criteria? Explain why.

2. Where there any recent operations or site conditions that may have influenced any of the soil health assessments? Explain how the assessments may have been impacted.

References

Duiker, S. W. 2002. Diagnosing Soil Compaction Using a Penetrometer (Soil Compaction Tester). Pennsylvania State University. <https://extension.psu.edu/diagnosing-soil-compaction-using-a-penetrometer-soil-compaction-tester>.

LandPKS. 2021a. SoilHealth Trainings 6: Root Restriction (Penetration Resistance). <https://youtu.be/EouDj8P7a4U>.

LandPKS. 2021b. SoilHealth Trainings 10: Plant Roots. <https://youtu.be/YAbmhJ1VZaY>.

LandPKS. 2023. LandPKS. <https://landpotential.org/>.

Schoeneberger, P. J., D. A. Wysocki, E. C. Benham, and Soil Survey Staff. 2012. Field Book for Describing and Sampling Soils, Version 3.0. Lincoln, NE: USDA-NRCS. <https://www.nrcs.usda.gov/resources/guides-and-instructions/field-book-for-describing-and-sampling-soils>.

University of Wisconsin Integrated Pest and Crop Management. 2015. Using a penetrometer to detect soil compaction. Arlington, Wisconsin. https://youtu.be/Zq_785JqRq8.

USDA-NRCS. 2021. Cropland In-Field Soil Health Assessment Guide. USDA-NRCS. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/soils/health/?cid=nrcs142p2_053869.

USDA-NRCS. 2022. Conservation Practices. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/?cid=nrcs143_026849.

7.

DESCRIBING SOIL MORPHOLOGY AND IDENTIFYING SOILS

Acknowledgement and Recommended Reading

This laboratory was designed to help you correlate the soils on your site to known soil series based on data for the site in the SSURGO data set. This will be done with the assistance of the the Field Book for Describing and Sampling Soils ([Schoeneberger et al. 2012](#)), the SoilWeb web app ([California Soil Resource Lab 2018](#)), and/or the LandPKS app ([LandPKS 2022](#)). Videos are provided below to guide you through describing soil morphology, SoilWeb, and the Web Soil Survey. A series of videos are also provided if you prefer to use the Land Info module of the LandPKS app to complete this laboratory activity.

Learning Objectives

By the end of the laboratory you will:

1. Describe the soil morphology at your site
2. Correlate the soil morphology to a known soil series

Materials

Materials required to complete this laboratory activity include the following:

- Shovel, spade, soil probe, or soil auger
- Water in a spray or squirt bottle
- Soil knife
- *Field Book for Describing and Sampling Soils* or the LandPKS app
- Munsell Soil Color Chart or the LandPKS app and a 3M canary yellow Post-It note or other color reference
- Pedon description form (available on page 2-93 and 2-94 of the *Field Book for Describing and Sampling Soils*) or the LandPKS app
- Optional items
 - 10% hydrochloric acid
 - 2 mm sieve

Introduction

Identifying the specific soil series on site is useful for providing context for soil management decisions. In the US the USDA-NRCS and the National Cooperative Soil Survey (NCSS) have extensive soils data that covers most of the country. Most map units used by the soil survey include one or two dominant soil series and often include several other soil series as map unit components or inclusions. By describing basic soil morphology, such as soil color and texture, combined with the soils expected to be present based on work by the soil survey, the soil series that are present can be accurately determined.

Two methods are presented below. The first uses a traditional soil pedon description card followed by manually correlating your soil description to the properties of soil series mapped at the site within the SSURGO database and accessed via the SoilWeb app. The second method uses a similar approach, but has you record your soil color and texture within the LandPKS app which also helps you identify the soil series present.

Identifying the Soil Onsite Using a Pedon Description and SoilWeb

Identify the soil on site by digging a soil pit as deep as you are able. For safety it's recommended to keep the pit shallower than 1.4 m (4.5 ft). Alternatively, you can use a soil probe, an auger, or even a fence post digger to collect a core to use for describing the soil. Identify the horizon breaks then describe the soil texture, color, and structure of each horizon. Refer to the *Field Book for Describing and Sampling Soils, Version 3.0* ([Schoeneberger et al. 2012](#)) for information about describing soil morphology, or watch the videos below for step-by-step directions. Record your results in the soil profile description sheet provided in Schoeneberger et al. ([2012](#)).

Describing Soil Profiles

Watch the following four videos to learn how to describe a soil profile; identify horizons; and describe soil texture, color, and structure.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=156#oembed-1>



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=156#oembed-2>



One or more interactive elements has been excluded from this version of the text. You can view

them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=156#oembed-3>



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=156#oembed-4>

Once you've described the soil texture, color, and structure, compare the description to the data available for soil series listed for the mapping unit at that location as described in SoilWeb. *Note: this information is also available in Web Soil Survey, but SoilWeb is preferred for field use due to the ease of use in a mobile browser.* Each mapping unit will likely contain a list of soil series likely to be present, and a percentage of the area within the mapping unit represented by each series. The soils that have the highest percentages are the soils most likely to correspond to the soil you described, so review those soils first. Once you find a soil series with similar soil textures, colors, and structure by depth to your soil record the name of the soil series and the taxonomic classification on the pedon description sheet. Also, make a note of the land capability classification and the limitation listed with the land capability classification.

Overview of SoilWeb

Watch the video below for an overview of SoilWeb, including how to review data for each of the soil series present within a soil mapping unit.





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Identifying the Soil Onsite Using LandPKS

The LandPKS app LandInfo module is targeted specifically towards identifying the soil series that most closely corresponds to the soil you have a your site. Describe and record the soil texture and color using the LandPKS app. Then use the app to identify the soil series that most closely match what you observed. From the report portion of the app note the land capability classification and the potential land capability classification limitations. Generate a PDF of the report by clicking on the green “Generate PDF Report” button within the LandInfo tab and submit that report with your laboratory report. Watch the LandPKS videos below for further directions.

Using the LandPKS LandInfo Module

Watch the five videos below to learn how to use the Land Info module within LandPKS to identify soil series that are the closest match to the soils onsite.



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One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=156#oembed-7>



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=156#oembed-8>



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=156#oembed-9>



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=156#oembed-10>

Questions

The following questions directly relate to this lab activity and will be answered as part of the [Site Evaluation and Soil Health Assessment Report](#).

1. What soil series was the closest match to the soil(s) at your site? Explain why you thought that series was the best fit.
2. Was the soil series you identified one of the primary map unit components or was it a minor map unit component?
3. What was the land capability classification limitation(s), and how can that limitation(s) be addressed through your conservation plan for this site?
4. Based on the surface textures you observed, are water or wind erosion a concern at this site? Explain why or why not.

References

- California Soil Resource Lab. 2018. SoilWeb. <https://casoilresource.lawr.ucdavis.edu/gmap/>.
- KStateAgronomy. 2017. Soil Horizons. <https://www.youtube.com/watch?v=b1VcCc0co78>.
- K-State Research and Extension. 2010. Eye on Agriculture Today: Soil Texture By Feel. <https://www.youtube.com/watch?v=IOyaBxj767s>.
- K-State Research and Extension. 2011a. Soil Profiling: Color. https://www.youtube.com/watch?v=2cmJa8dQ5_I.
- K-State Research and Extension. 2011b. Soil Profiling: Structure. <https://www.youtube.com/watch?v=UKT9RBIkeKc>.
- LandPKS. 2020. LandInfo Training, Part 1: Introduction and General Site Classification. <https://www.youtube.com/watch?v=YD49kck6dpI>.
- LandPKS. 2020. LandInfo Training, Part 2: Soil Texture. <https://www.youtube.com/watch?v=OgYZMsFkoEc>.
- LandPKS. 2020. LandInfo Training, Part 3: Soil Color. <https://www.youtube.com/watch?v=OwfkMXWP1Ls>.

LandPKS. 2020. LandInfo Training, Part 4: Soil Limitations. <https://www.youtube.com/watch?v=1G7gd8epGlA>.

LandPKS. 2020. LandInfo Training, Part 5: Interpreting Your Reports. <https://www.youtube.com/watch?v=bYpiZyrbdRI>.

LandPKS. 2022. LandPKS. <https://landpotential.org/>.

Schoeneberger, P. J., D. A. Wysocki, E. C. Benham, and Soil Survey Staff. 2012. Field Book for Describing and Sampling Soils, Version 3.0. Lincoln, NE: USDA-NRCS. <https://www.nrcs.usda.gov/resources/guides-and-instructions/field-book-for-describing-and-sampling-soils>.

USDA-NRCS. 2021. Cropland In-Field Soil Health Assessment Guide. USDA-NRCS. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/soils/health/?cid=nrcs142p2_053869.

8.

ECOLOGICAL SITE DESCRIPTIONS

Recommended Reading

This Ecological Site Description (ESD) web page from the USDA-NRCS ([2022](#)) provides an excellent overview of ESDs and provides links to webinars, the Ecosystem Dynamics Interpretive Tool (EDIT), and Web Soil Survey. The Jornada Rangeland Research Program Ecological Site Descriptions web page ([Perez 2022](#)) also provides an excellent overview of ESDs and links to useful resources.

Learning Objectives

By the end of the laboratory you will:

1. Identify the Major Land Resource Area (MLRA) where your site is located
2. Identify the Ecological Site Description (ESD) that best represents your site using ESD keys
3. Identify the state of the ESD that best represents your site using a state-and-transition model (STM)
4. Consider land management decisions given the context provided by an ESD

Materials

Materials required to complete this laboratory activity include the following:

- Computer and/or mobile device with internet access
- Printed ESD keys for the appropriate MLRA
- Equipment for describing soil morphology
 - Shovel or spade
 - Soil knife
 - Tape measure
 - Water bottle for soil texture by feel
 - Munsell soil color chart or the LandPKS app for determining soil color
 - Clinometer or the LandPKS app for determining slope
 - 10% hydrochloric acid for identifying carbonates
 - Field Book for Describing and Sampling Soils ([Schoeneberger et al. 2012](#)), or PDF
 - *Note: if you do not have equipment or experience to describe soil morphology you can instead use a soil profile description from your site or use an Official Series Description (OSD) of one of the dominant soils for a soil mapping unit from your site*

Introduction

The Interagency Ecological Site Handbook for Rangelands ([Caudle et al 2013](#)) states that Ecological Site Descriptions (ESDs):

“... provide a consistent framework for stratifying and describing rangelands and their soil, vegetation, and abiotic features; thereby delineating units that share similar capabilities to respond to management activities or disturbance processes.”

These ESDs provide land managers important information and context for making land use decisions, determining the suitability of land for specific land uses, evaluating how the land will respond to significant disturbances, and developing plans to facilitate long-term productivity. ESDs include site characteristics, plant communities, site interpretations, and supporting information.

There are two types of ecological sites – forestland and rangeland. Forestland site types have an overstory canopy of at least 25% or more, while trees are not significant in rangeland reference plant communities. Reference plant communities are the plant community that was present at the time of the arrival of European immigrants to the location of interest. These plant communities are assumed to be best adapted to the soils, climate, and other environmental factors that influence the local area, and thus be the most resilient when exposed to natural disturbances such as fire, grazing, drought, and native fauna.

The reference plant community can be shifted towards other plant communities and conditions, which are referred to as “states”. The changes between states are termed “transitions”. A state-and-transition model (STM) is used to characterize the known states and transitions for a specific ESD, and can be used as a framework for making management decisions.

Interagency Ecological Site



Handbook for Rangelands

January 2013



Figure 8.1. Cover of the Interagency Ecological Site Handbook for Rangelands

Identify the MLRA

Ecological Site Descriptions are developed within boundaries of MLRAs. If you do not know the MLRA on which your site is located you can use the interactive map on Ecosystems Dynamics Interpretative Tool (EDIT) ESD Catalog to determine the MLRA ([USDA-ARS Jornada Experimental Range, USDA-NRCS, and New Mexico State University 2022](#)). Using the MLRA interactive map in EDIT, click on the appropriate MLRA to determine the name and number of the MLRA, then click on the MLRA name. This will open a “Quick View” of the MLRA with some basic statistics. Using the side menu on the left side of the EDIT website, click on “MLRA List”. Scroll to find the appropriate MLRA, or use the search function. Click on MLRA name to open the web page for that MLRA. Make a note of the MLRA name and number, then move on to the next step.



Figure 8.2. A screen capture of the interactive MLRA map in EDIT ([USDA-ARS Jornada Experimental Range, USDA-NRCS, and New Mexico State University 2022](#)).

Use Keys to Identify the ESD

Once the appropriate EDIT web page for the MLRA is open, click on the “Ecological Site Keys” menu item on the left-side menu. This will open a list of ecological site keys. Download the appropriate key, which will be a PDF (note, you will need a PDF viewing application on your device to read the keys). Use the keys to identify the most appropriate ESD for your site.

Ecological site keys will use soils data, slope and landform information, and indicator plant species to identify the most appropriate ESD for the site.

Using the keys may require you to perform a soil profile description to characterize the soil depth, texture, structure, presence of carbonates or other salts, etc. You are encouraged to do this on your own. However, if you do not have experience in describing soil morphology you may differ to the official series description (OSD) of the dominant soil(s) for the mapping unit that has been described for the site. Note that some mapping units may include multiple components

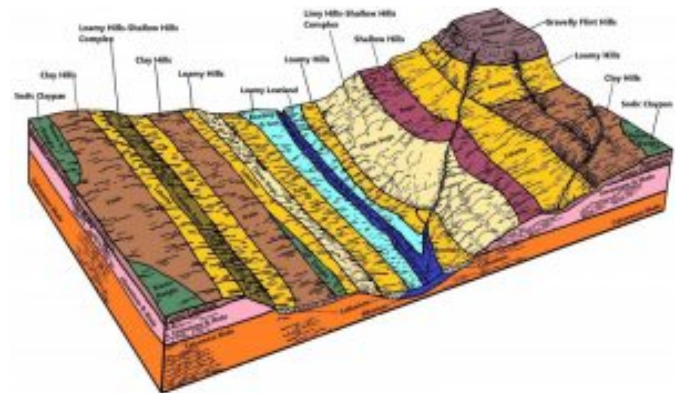


Figure 8.3. ESD Block Diagram for MLRA 76 ([USDA-NRCS 2019a](#)).

which may be associated with different ESDs. Use your best judgment when differing to OSDs and soil survey information.



Figure 8.4. A ponded bison wallow near Manhattan, KS which is categorized as the “Sodic Claypan” ESD in MLRA 76. Image courtesy of Colby Moorberg.

Once you have identified the most appropriate ESD using the keys, access the appropriate ESD by navigating to the “Ecological Site List” using the side menu within EDIT. You can scroll to the appropriate ESD or use the search feature. Click on the appropriate ESD to open it. This will open a new web page for that specific ESD. The web page defaults to General Information, which provides a brief description of the MLRA and its associated ESDs. *Note: there is an option to download the ESD in its entirety as a single PDF at the bottom of the MLRA Notes page.* Review the physiographic, climatic, water, soil, and plant features to confirm you have selected the appropriate ESD using the keys. Download a copy of the ESD PDF and save it to your device. You will submit

this as part of the laboratory report later.

Identify the Representative ESD State

The state-and-transition model of the ESD is located in the “Ecological Dynamics” section. Each state is represented by numbered squares (boxes) representing the states. Arrows going from one state to another indicate transitions between states. A concise summary of the transitions are listed immediately below the state-and-transition model.

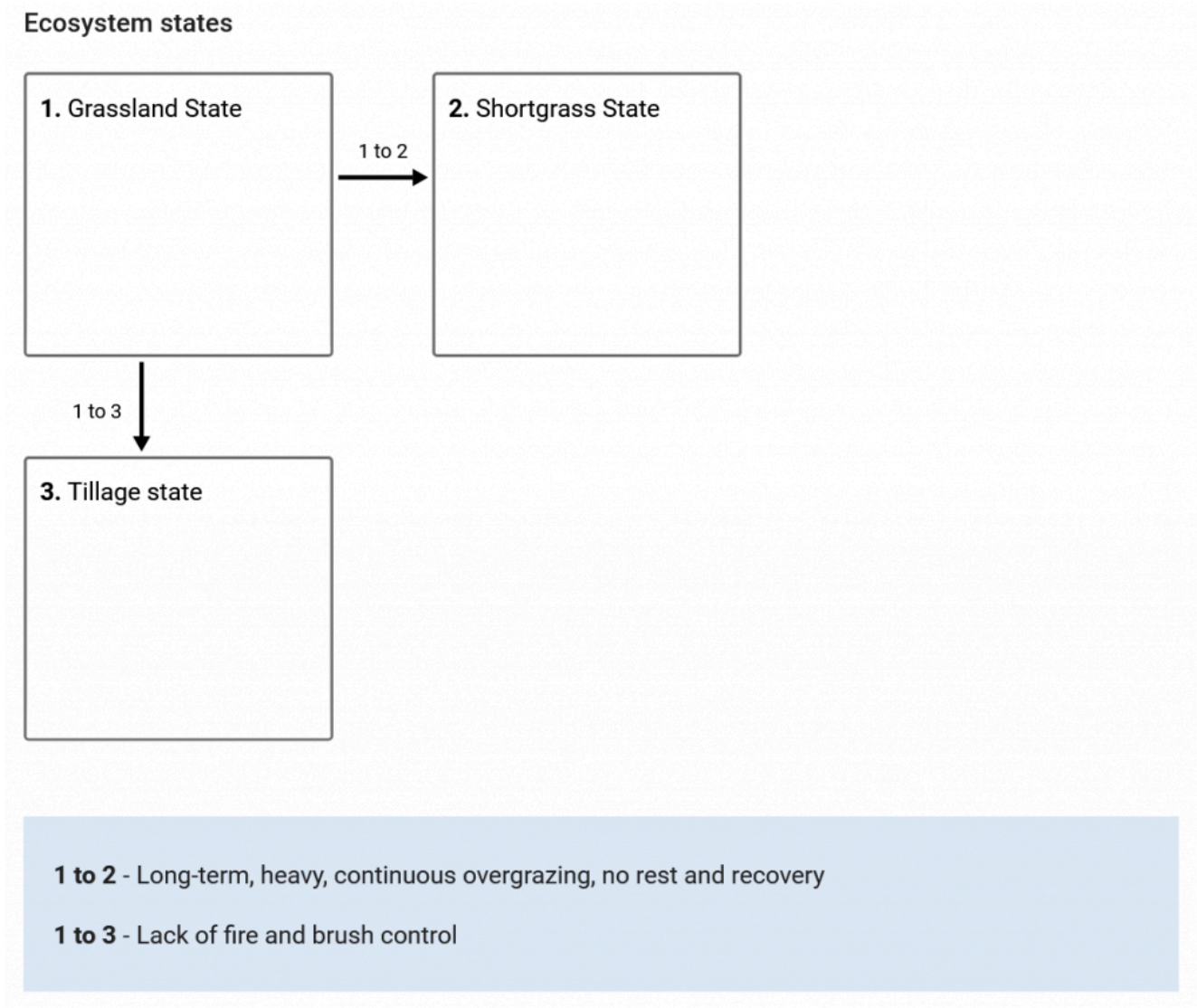


Figure 8.5. State-and-transition model for the Sodic Claypan ESD in MLRA 76 ([USDA-NRCS 2019a](#)).

The state-and-transition model is followed by submodel diagrams indicating various plant communities that may be present within a given state. There can be one or several different plant communities present within each state. Transitions between each plant community may also be described.

As you scroll down the Ecological Dynamics section of the ESD you will find a detailed description of the states and plant communities. These include pictures of the reference state and plant communities as well as information and data about disturbances, resilience management, dominant plant species, and annual production by plant type (grass/grasslike, forb, shrub/vine).

Determine the state that best categorizes your site using the state-and-transition models, submodels, and associated information. Make a note of the state, then move on to the next step.

Confirming ESD Using Web Soil Survey or SoilWeb

The SSURGO database associates each soil mapping unit component (soil series) with specific ESDs. These can be viewed in both the Web Soil Survey and SoilWeb web apps. Using either Web Soil Survey or SoilWeb determine the ESD associated with the soil series present at your site and compare that ESD to what you identified previously using the ESD keys. Note that SoilWeb works well in a mobile device browser, and can be accessed from the field when cellular signal is available.

ESDs in Web Soil Survey

Open Web Soil Survey in your internet browser, then navigate to the location of your site. Define your Area of Interest (AOI), then switch to the “Soil Data Explorer” tab. Within the Soil Data Explorer navigate to the “Ecological Sites” tab and click on the “View All Ecological Site Info” button. This will load a map of the AOI with the ESD of the dominant mapping unit component displayed for each mapping unit. Scroll down to view the ESDs listed for each mapping unit component. Identify the mapping unit and mapping unit component of interest to determine the ESD for the site. You may need to explore information each of the mapping unit components (soil series) to confirm that it corresponds to what you observed at your site. Note the name of the ESD is a hyperlink to the ESD web page within EDIT. Make a note of the ESD name and compare that to what you identified using the ESD keys previously.

ESDs in SoilWeb

Open SoilWeb in your browser and navigate to your site. Click on the map at the location of interest. This will open a window on the left side of the screen which depicts the mapping unit components for that location. Explore the soil properties to confirm which soil series best correlates to what you observe at the site. Once the most relevant soil series is identified, click on the soil series name and expand the “Land Classification” tab. Note the name of the ESD listed under the “Ecological Site Description:” heading. The name of the ESD is a hyperlink to the ESD web page in EDIT. Make a note of the ESD name and compare that to what you identified using the ESD keys previously.

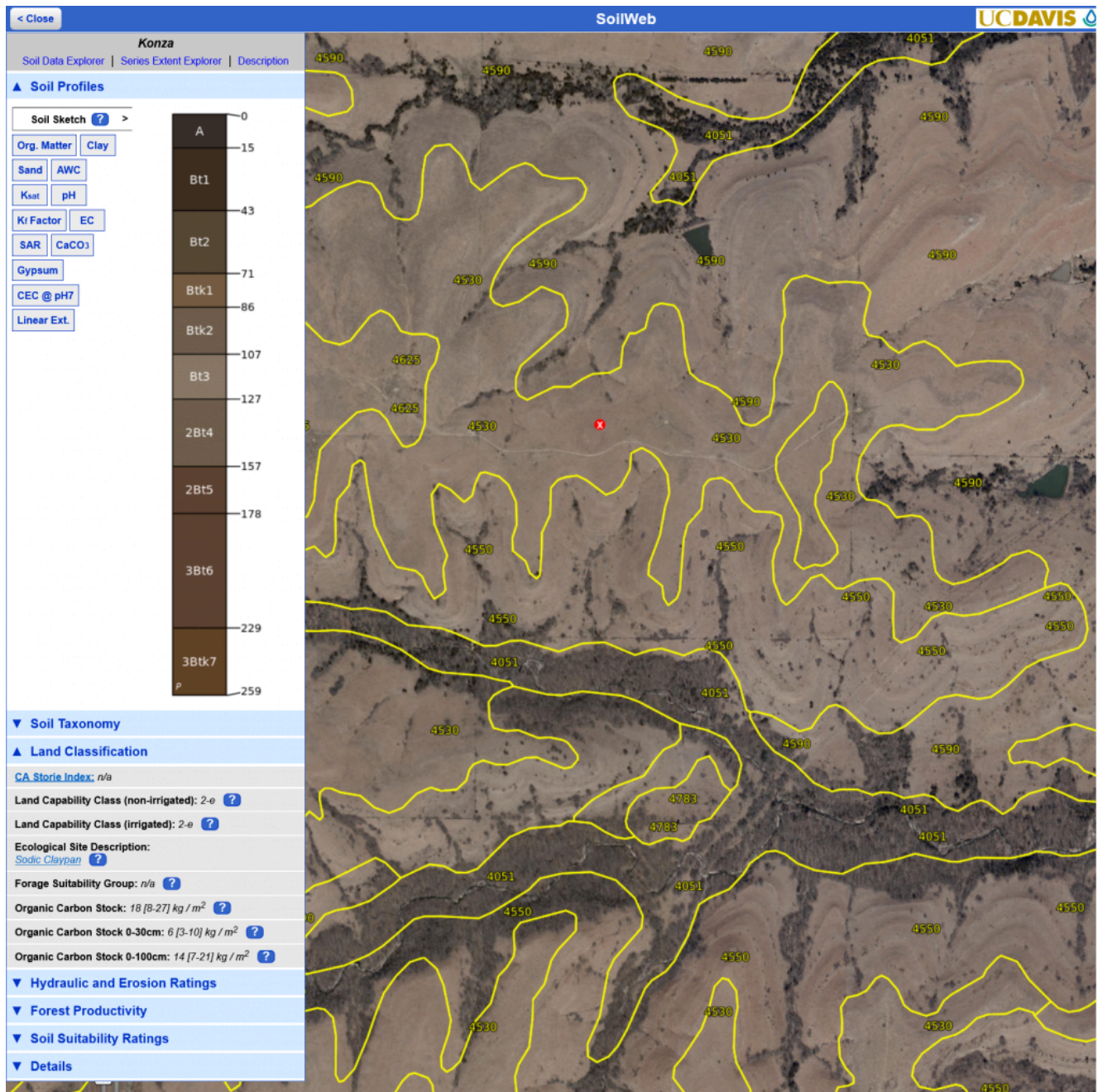


Figure 8.6. Screen capture of the SoilWeb web app with the land classification information for Konza soil series displayed. The ESD for the Konza Series is “Sodic Claypan”.

Using ESDs for Land Management Decisions

Ecological Site Descriptions are particularly useful as context for making land management decisions. For example, if the site is being used for range, the descriptions of transitions between states and/or plant communities can be helpful for making decisions about prescribed burning regimes, stocking, or invasive

species management. Likewise, the ESD can contain useful information about species to use when seeding to restore farmland to prairie, or when allowing land to “go-back” to prairie without reseeding. From a row crop agriculture perspective ESDs can provide important context for what might be possible regarding improvements to soil health or carbon sequestration potential. Answer the questions below in order to gain a better understanding of how ESDs can be used for land management decisions.

Questions

The following questions directly relate to this lab activity and will be answered as part of the [Site Evaluation and Soil Health Assessment Report](#).

1. In what MLRA (name and number) is your site located?
2. Describe the decisions you made using the ESD key to determine the most appropriate ESD for your site. Provide data or observations from your site that was used to make decisions as needed.
3. Identify the representative ESD state that best represents your site. Describe how you came to that conclusion based on the state-and-transition model and supporting information in the “Ecosystem Dynamics” section of the ESD.
4. How did the ESD you identified using the ESD keys compare to the ESD identified using Web Soil Survey or SoilWeb? It is alright if they differed. If they did differ, explain what may have caused a difference.
5. Recall the responses to the interview questions from the land manager who oversees the site. What are their goals for the site, and how does that differ from the current ESD state?
6. Based on the potential transitions described in the ESD, how could your site be managed differently to transition it to a different state? If the current state and the land managers desired state are different, how could the site be managed to achieve that transition?
7. If you had access to locations that represent reference plant communities as well as other states and had permission to sample those locations, describe what you would do to determine the “potential” of your site for improvements to soil health or carbon sequestration. Also, describe the limitations of such comparisons.
8. Save the PDF of the ESD you identified for your site for future submission as part of the [Site](#)

Evaluation and Soil Health Assessment Report.

References

Caudle, D., H. Sanchez, J. DiBenedetto, C. Talbot, and M. Karl. 2013. The Interagency Ecological Site Handbook for Rangelands. 110. Washington, DC: The US Department of Agriculture's Natural Resources Conservation Service and Forest Service, and the US Department of the Interior's Bureau of Land Management. <https://jornada.nmsu.edu/files/InteragencyEcolSiteHandbook.pdf>.

Perez, J. 2022. Ecological Site Descriptions. <https://archive.jornada.nmsu.edu/esd>.

Schoeneberger, P. J., D. A. Wysocki, E. C. Benham, and Soil Survey Staff. 2012. Field Book for Describing and Sampling Soils, Version 3.0. Lincoln, NE: USDA-NRCS.

University of California, Davis, California Soil Resource Lab, University of California, Division of Agriculture and Natural Resources, and USDA-NRCS. 2019. SoilWeb. <https://casoilresource.lawr.ucdavis.edu/gmap/>.

USDA-ARS Jornada Experimental Range, USDA-NRCS, and New Mexico State University. 2022. Ecological Site Descriptions. <https://edit.jornada.nmsu.edu/catalogs/esd>.

USDA-NRCS. 2019a. Ecological site HX076XY103 Sodic Claypan. MLRA 76X – Bluestem Hills: USDA-NRCS. <https://edit.jornada.nmsu.edu/catalogs/esd/076X/HX076XY103>.

USDA-NRCS. 2019b. Web Soil Survey. <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>.

USDA-NRCS. 2022a. Ecological Site Descriptions. <https://www.nrcs.usda.gov/getting-assistance/technical-assistance/ecological-sciences/ecological-site-descriptions>.

9.

SITE EVALUATION AND SOIL HEALTH ASSESSMENT REPORT

Acknowledgement and Recommended Reading

This laboratory was designed to conduct in-field assessments of soil health and is based on the Cropland In-Field Soil Health Assessment Guide from the USDA-NRCS ([2021](#)). The LandPKS app ([LandPKS 2023](#)) also uses the same criteria as the NRCS assessment guide, but within the LandPKS app.

Learning Objectives

By the end of the laboratory you will:

1. Complete a field assessment to characterize soil health
2. Identify soil health resource concerns
3. Determine need for conservation practices to address soil health resource concerns
4. Prescribe conservation practices that address resource concerns

Materials

Materials required to complete this laboratory activity include the following:

- Responses from the land manager to the [Management History Interview](#) (page 13 and 14 from the [assessment guide](#))
- Data from Soil Health Assessment [Part I](#), [Part II](#), [Part III](#), and [Part IV](#); [Describing Soil Morphology and Identifying Soils](#); and [Ecological Site Descriptions](#)
- The Cropland In-Field Soil Health Assessment Worksheet (page 15 from the [assessment guide](#)) OR the [LandPKS](#) SoilHealth Report with NRCS Criteria
- The Cropland In-Field Soil Health Assessment Worksheet and Resource Indicator Decision Trees (page 16 from the [assessment guide](#))

Introduction

Now that onsite observations and data collection for the in-field soil health assessment is complete you will summarize your findings. These findings, and the responses from the land manager to the management history interview will later be used to guide the development of the [conservation plan](#) for this site.

The Cropland In-Field Soil Health Assessment Worksheet

Using the observations and data you collected in the Soil Health Assessment Parts I-IV, complete the Cropland In-Field Soil Health Assessment Worksheet on page 15 of the Cropland In-Field Soil Health Assessment Guide. For each soil health indicator check “Yes” for each indicator that is met, and “No” for each indicator that is not met. Also complete the meta data for this location along the left side of the assessment worksheet. Submit a copy of the completed worksheet with your laboratory report.

Using the SoilHealth Report in LandPKS

You can use the LandPKS app to summarize the soil health assessments. Navigate to the “SoilHealth (beta)” tab in the “Report” section for your site within the LandPKS app. Click on the green “Download PDF Report with NRCS Criteria” button. This will open a PDF with each of the soil health assessments summarized for this site next to “Yes/No” check boxes for the criteria. Review the summarized data for each indicator and determine if the site does meet the NRCS soil health criteria, then check the appropriate box. Submit a copy of the completed LandPKS SoilHealth report with your laboratory report.

The Cropland In-Field Soil Health Assessment Resource Indicator Decision Trees

The Cropland In-Field Soil Health Assessment Guide includes four decision trees on page 16 for different soil health resource concerns. The four decision trees are for compaction, soil organism habitat loss or degradation, soil organic matter depletion, and aggregate instability. The decision trees each list the indicators relevant to the soil health resource concerns and a single a yes-no question focused on how many indicators were not met. Complete each of the four decision trees and determine what soil health resource concerns exist on this site.

Questions

1. Describe the site conditions and recent operations (tillage, tillage implements used, planting, etc.).
2. What field operations are planned for this site between now and the next time it is planted?
3. What was the average percent ground cover for each location?
4. Based on your responses to the questions above, estimate the remaining plant residue at the

time of planting the next crop using [this extension publication from the University of Nebraska, Lincoln](#).

5. Did any of the soil health indicators above not meet the soil health assessment criteria? Explain why.
6. Could any recent operations or site conditions have influenced any soil health assessments? Explain how the assessments may have been impacted.
7. What soil series was the closest match to the soil(s) at your site? Explain why you thought that series was the best fit.
8. Was the soil series you identified one of the primary map unit components or was it a minor map unit component?
9. What was the land capability classification limitation(s), and how can that limitation(s) be addressed through your conservation plan for this site?
10. Based on the surface textures you observed, are water or wind erosion a concern at this site? Explain why or why not.
11. In what MLRA (name and number) is your site located?
12. Describe the decisions you made using the ESD key to determine the most appropriate ESD for your site. Provide data or observations from your site that was used to make decisions as needed.
13. Identify the representative ESD state that best represents your site. Describe how you came to that conclusion based on the state-and-transition model and supporting information in the “Ecosystem Dynamics” section of the ESD.
14. How did the ESD you identified using the ESD keys compare to the ESD identified using Web Soil Survey or SoilWeb? It is alright if they differed. If they did differ, explain what may have caused a difference.
15. Recall the responses to the interview questions from the land manager who oversees the site. What are their goals for the site, and how does that differ from the current ESD state?
16. Based on the potential transitions described in the ESD, how could your site be managed differently to transition it to a different state? If the current state and the land managers desired state are different, how could the site be managed to achieve that transition?
17. If you had access to locations that represent reference plant communities as well as other states and had permission to sample those locations, describe what you would do to determine the “potential” of your site for improvements to soil health or carbon sequestration. Also, describe the limitations of such comparisons.
18. What are the soil health resource concerns for this site and which indicators allude to those resource concerns? To fully answer this question, complete the Cropland In-Field Soil Health

Assessment Worksheet (page 15 of the assessment) and the Cropland In-Field Soil Health Assessment Resource Indicator Decisions Trees (page 16 of the assessment) for each management area at your study site. These should be included in the Results section of the report.

19. What conservation practices ([USDA-NRCS 2022](#)) can be implemented to address those resource concerns?
20. Based on the responses of the land manager to the management history interview, which of the conservation practices you list for #2 align best with the goals of the land manager?

Laboratory Report Components

Each laboratory report should include the following components unless otherwise specified. Points allocated to each component may vary as necessary.

Name

Include your first and last name.

Laboratory Number and Title

List the laboratory number and title. For example: “Laboratory 4 – Soil Health Assessment 2: Infiltration, Surface Crusts, Soil Structure, and Water Stable Aggregates”.

Date Each Exercise was Conducted

Identify the day you conducted each laboratory exercise. Note, this is likely different than the date you submit the report. Do not include the date of submission, as that will be identified in the learning management system. Also, summarize the weather and site conditions for each day when these exercises were conducted. Soil moisture in particular can play a major role in several soil health assessments.

Introduction

Provide a brief (one to two paragraph) introduction to the site evaluation and soil health assessment. Explain the importance or significance of the procedure(s) being performed.

Methods

Write a concise yet detailed summary of the methods used for the laboratory exercise written in your own words. The methods should contain enough detail that you could use it to perform the same activity again using only your written summary of the methods.

Results

Present your raw data in one or more organized tables. You are encouraged to format and organize your data in a logical way that is useful to you and is able to be appropriately interpreted by your instructor and the land owner/manager. The results section should also include the completed Cropland In-Field Soil Health Assessment Worksheet (page 15 of the assessment) and the Cropland In-Field Soil Health Assessment Resource Indicator Decisions Trees (page 16 of the assessment) for each management area at your study site.

Responses to Questions

In lieu of a traditional results section you will instead respond to a series of questions posed at the end of each laboratory exercise. In some cases these questions will require data analysis, presentation of data in summary tables and/or well-designed figures, or exploration of additional resources and scientific literature. Answer the questions to the best of your ability. Contact the instructor with any questions. The responses to these questions will later be added to the [Conservation Plan](#).

References

Provide a list of all references that were cited within the text of your report. Citations should follow the Journal of Soil and Water Conservation Style Guide (Soil and Water Conservation Society 2023) which is based on the Chicago Manual of Style (University of Chicago Press 2017). References cited in this laboratory manual are cited according to the Journal of Soil and Water Conservation Style Guide, so you are welcome to use citations in this laboratory manual as examples.

Supplemental Information

Required supplemental information includes:

- The Web Soil Survey PDF report for your site
- Ecological Site Descriptions for all ESDs identified at your site
- Photos taken during the laboratory exercise

Additional information can be included in the supplemental information as needed.

References

LandPKS. 2023. LandPKS. <https://landpotential.org/>.

USDA-NRCS. 2021. Cropland In-Field Soil Health Assessment Guide. USDA-NRCS. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/soils/health/?cid=nrcs142p2_053869.

USDA-NRCS. 2022. Conservation Practices. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/?cid=nrcs143_026849.

PART II

CONSERVATION PRACTICES

10.

SOIL WATER MANAGEMENT

Logan M. Simon and Colby J Moorberg

Recommended Reading

The extension publication, *Efficient Crop Water Use in Kansas* ([Presley et al. 2012](#)) presents a set of practices for increasing water use efficiency in crop production, including tillage and residue management, nozzle selection for sprinkler irrigation systems, crop rotations and cover crops, row spacing and plant orientation, nutrient management, and weed control. Additionally, background information on calculating soil moisture content and factors that influence evaporation from soil are presented in the open textbook, *Rain or Shine: An Introduction to Soil Physical Properties and Processes* (Oshner [2019a](#), [2019b](#)).

Learning Objectives

By the end of the laboratory you will:

1. Measure changes in soil water content under four different soil surface management treatments.
2. Determine the effect of soil surface management (residue cover, weed management, etc.) on

soil water content.

Materials

Materials required to complete this laboratory activity include the following:

- Shovel
- Four 5-gallon buckets with holes drilled in the bottom for drainage and numbered 1-4
- Scale (bathroom scale or similar)
- Wheat straw or other crop residues
- Kitchen or toaster oven
- Four oven-safe pans
- Data sheets

Introduction

Water is the most limiting resource for maximum yield potential in crop production, especially in semi-arid and arid climate zones. The primary water inputs to cropland include rain and snow, as well as irrigation. The primary pathways of water loss from cropland includes evaporation, transpiration, surface runoff, and deep percolation. Transpiration is the process by which water is absorbed from the soil by plant roots and used by the plants to ultimately be released as water vapor from the plant leaves to the atmosphere. On the other hand, evaporation, surface runoff, and deep percolation represent water losses with no use by the plant. Efforts to improve water conservation on farmland are aimed at minimizing these pathways of water loss and maximizing soil water storage. Practices that minimize soil disturbance and maximize soil cover will increase water infiltration and water holding capacity while decreasing runoff and evaporation. In this laboratory exercise, we will evaluate the effect of soil surface management on soil water storage.

What is Evapotranspiration?



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=46#oembed-1>

Bucket Preparation, Soil Collection, and Wetting Soil to Field Capacity

In this experiment you will add soil to four 5 gallon buckets, determine initial and final soil moisture content, and determine the impact of four different soil management treatments on soil water loss. *Note: Containers smaller than 5 gallons can be used if the quantity of available soil is limited, if you do not have 5 gallon buckets available, or if 5 gallon buckets filled with moist soil are too heavy to physically handle.*

Bucket Preparation

The four 5-gallon buckets should be clean, and have holes drilled into the bottom of the buckets to allow gravitational water to drain out the bottom to prevent saturated conditions. Number the buckets 1-4 with a marker. Weigh each bucket and record the mass (kg) in the data sheet.

Adding Soil

The soil you will use will preferably come from your field site being used for other laboratory activities, but can come from other sources if needed. Large clods should be broken up into smaller aggregates, if applicable. Add soil to each bucket to within 5 cm of the top of the bucket. Weigh each bucket as you are filling them in order

to add approximately the same mass of soil to each bucket. Tamping the soil lightly as you fill the bucket may help prevent voids.

Wetting Buckets to Field Capacity

Next, slowly add water to each bucket to bring it up to field capacity, which is achieved when water freely drains out of the drain holes in the bottom of the bucket. There may be preferential flow paths that allow water to drain freely out the bottom while dry pockets of soil remain. To fix avoid this, wait for approximately five hours after the initial wetting, then add water again until water freely drains out the bottom of the bucket. The buckets are at field capacity once the buckets stop dripping out the bottom. Collect a subsample of soil (approximately 500 grams) from each bucket and determine the the moisture content as described below. After collecting the subsample, weigh the buckets and record the mass at field capacity in the data sheet.

Establishing Treatments and Monitoring Moisture Loss

Treatments are designed to mimic typical soil management practices following crop harvest on farmland (Table 1). Bucket 1 will have wheat straw or some other crop residue added to completely cover the surface of the soil. For this bucket, weed seedlings should be removed periodically as seeds germinate and emerge from the moist soil. Bucket 2 will have bare soil. No crop residues will be added and weed seedlings should be removed periodically as needed. Bucket 3 will have no crop residues added, but weed seedlings that germinate will be allowed to grow through the duration of the experiment. The treatment used for bucket 4 is up to you. Think about what management practices might influence evapotranspiration, and develop a testable hypothesis that compares the four treatments. Record that hypothesis in the data sheet. Establish that treatment on the fourth bucket as appropriate. Once all treatments are prepared, store the buckets in a covered location to prevent rain or other elements from affecting the results of your experiment.

Calculate Soil Water Content and Water Loss

Calculate Gravimetric Soil Moisture Content at Field Capacity

Calculate the gravimetric soil moisture content (soil moisture content on a mass basis) of the buckets at field capacity using your subsample. Gravimetric soil water content is calculated as:

$$\text{Percent gravimetric water} = \frac{\text{mass of water}}{\text{mass of oven-dry soil}} \times 100\%$$

Where the mass of water is the difference in mass between the moist soil mass and oven-dry soil mass. To determine the difference between moist and oven-dry mass, weigh the 500 g subsamples immediately after collecting them from the buckets. Record this moist mass in the data sheet. Then dry the soil in an oven-safe pan using an oven under low heat (105°C, 221°F) for at least 24 hours, or until the soil mass reaches a steady-state condition where it no longer loses mass.

Calculate Bulk Density

Soil bulk density is calculated as follows:

$$\text{Bulk density} = \frac{\text{mass of oven-dry soil}}{\text{volume of soil}}$$

The entire volume of soil was not dried to determine the total mass of oven-dry soil. However, that total mass can be estimated using the soil moisture content at field capacity. The moisture content in the field capacity subsample is proportional to the moisture content of the entire bucket. That proportion can be expressed as follows:

$$\frac{\text{mass of water in subsample}}{\text{mass of oven-dry subsample}} = \frac{\text{mass of water in bucket}}{\text{mass of oven-dry in bucket}}$$

The gravimetric water content can be considered the proportion of the total moist soil mass that comes from water. Thus, the mass of the dry soil can be estimated using the following calculation:

$$\text{Oven-dry soil mass} = \left(1 - \frac{\text{mass of water}}{\text{mass of oven-dry soil}}\right) \times \text{Total mass of moist soil}$$

Which simplifies to:

$$\text{Oven-dry soil mass} = (1 - \text{soil moisture}) \times \text{Total mass of moist soil}$$

We will assume the soil volume is five gallons, which converts to 18.93 dm³. Based on the bulk density equation above, divide the mass of dry soil in each bucket (kg) by a volume of 18.93 dm³ to determine the bulk density (kg/dm³). This density unit is mathematically equivalent to the more common unit, g/cm³.

Convert Gravimetric Water Content to Volumetric Water Content

The gravimetric water content (percent or decimal) can be multiplied by the bulk density to determine the volumetric water content. Note: this is because one gram of water is equal to 1 cm³ of water. The mathematical explanation is as follows:

$$\frac{\text{Mass of water}}{\text{Mass of oven dry soil}} \times \frac{\text{Mass of oven dry soil}}{\text{Volume of soil}} = \frac{\text{Mass of water}}{\text{Volume of soil}} = \frac{\text{Volume of water}}{\text{Volume of soil}}$$

Convert all gravimetric water contents to volumetric water contents by multiplying each gravimetric water content by the bulk density for each of the four buckets.

Calculate Depth Equivalent of Water

In many applications it is useful to express the water content as a depth equivalent of water. The depth equivalent of water can be calculated by multiplying the depth of soil by the volumetric water content as follows:

$$\text{Depth of water} = \text{Depth of soil} \times \text{Volumetric water content}$$

Measure the height of soil from the bottom of the bucket to the top of the soil in the bucket, then multiply that depth by the volumetric water content, as shown above, to determine the depth equivalent of water. Do this for each of the four buckets.

Quantify Water Loss

Allow the experiment to progress for approximately eight weeks. Remove any residue or above-ground plant biomass, then weigh each of the four buckets to determine the final total moist soil mass. Calculate the final gravimetric water content. Using the bulk density determined previously, calculate the final volumetric water content and the final depth equivalent of water. Finally, calculate the difference in the depth equivalent of water at the beginning of the study and the end to determine the depth of water that was lost to evaporation (or evapotranspiration in the case of the treatment with weeds present).

Questions

1. What was the fourth soil surface management treatment you chose to investigate? (*Note, be sure to include the details in the methods section of the laboratory report.*)
2. State your hypothesis for this experiment.
3. Did the depth of water lost to evaporation (or evapotranspiration) differ between the four

treatments? Was your hypothesis confirmed or rejected?

4. The USDA-NRCS lists several conservation practices that can help address water conservation on farmland. Based on your observations, which if any practice(s) do you recommend and why? Refer to the [USDA-NRCS National Conservation Practices](#) for details.

References

Ochsner, T. 2019a. Evaporation and Wind Erosion. *In* Rain or Shine: An Introduction to Soil Physical Properties and Processes. Stillwater, OK: Oklahoma State University. <https://open.library.okstate.edu/rainorshine/part/soil-water-content-and-potential/>.

Ochsner, T. 2019b. Soil and Water Content and Potential. *In* Rain or Shine: An Introduction to Soil Physical Properties and Processes. Stillwater, OK: Oklahoma State University Libraries. <https://open.library.okstate.edu/rainorshine/part/evaporation-and-wind-erosion/>.

Presley, D., D. Shoup, J. Holman, and A. Schlegel, eds. 2012. Efficient Crop Water Use in Kansas. Manhattan, KS: Kansas State University Agricultural Experiment Station and Cooperative Extension Service. <https://www.bookstore.ksre.ksu.edu/Item.aspx?catId=363&pubId=15559>.

University of Nebraska-Lincoln. 2015. What is evapotranspiration? Lincoln, NE. https://www.youtube.com/watch?v=EuW9Sd3i_mY.

USDA-NRCS. 2022. Conservation Practices. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/?cid=nrcs143_026849.

11.

CONSTRUCTION SITE EROSION AND SEDIMENT CONTROL

Recommended Reading

The Environmental Protection Agency (EPA) is tasked with enforcing the Clean Water Act which, among other things, regulates the discharge of pollutants from point sources. One example is sediment from construction sites. More information on this topic is available from the EPA's Stormwater Discharge from Construction Activities web page ([US EPA Office of Water 2022b](#)). While other pollutants from construction sites can be discharged to surface water bodies, sediment is the primary concern. Turbidity is the primary measurement used to assess water quality in runoff from construction sites. The EPA's web page on Turbidity Benchmark Monitoring (DeWatering) under the Construction General Permit provides an overview of measuring turbidity and monitoring water quality of runoff from construction sites ([US EPA Office of Water 2022a](#)).

Learning Objectives

By the end of the laboratory you will:

1. Identify conservation practices used on active construction sites and disturbed areas

Materials

Materials required to complete this laboratory activity include the following:

- Camera or a smart phone with a camera

Safety

Construction sites are dangerous places. This scavenger hunt activity requires you to visit construction sites. Please do not enter construction sites without explicit permission from the construction site manager. You may observe and photograph the construction site from a safe distance that is open to the public, such as from a nearby road, sidewalk, or fenceline. Do not trespass on private property. Wear appropriate personal protective equipment as necessary. Please do not act in a conspicuous manner that may raise suspicion from construction workers or passersby.

You are encouraged to talk to the contractors on site, if they are willing. You will likely find that most construction workers, such as the family members of the author of this laboratory manual, are very friendly and more than happy to talk to you about construction and the practices they use on site.

Introduction

Construction sites often have large areas of disturbed soils with minimal ground cover. If storms occur before that soil is covered, significant amounts of soil can be eroded from the site and delivered to nearby streams and surface water bodies as sediment. Sediment from construction sites is considered a point-source pollutant, and can cause serious disturbances to streams, floodplains, and other downstream water bodies. As a result, sediment from construction sites is regulated in the US by the Environmental Protection Agency (EPA) for all sites that are at least 1 acre (0.41 hectares) in size, or that are part of a planned development that exceeds 1 acre in size. Sediment contributes to increased turbidity in water, which can be easily measured on site. As a result, the EPA ([2022a](#)) has developed turbidity benchmark monitoring requirements that set a maximum amount of turbidity that can be tolerated in nearby streams as a result of construction site activities.

Construction Site Conservation Practice Scavenger Hunt

There are many different conservation practices that can be deployed on construction sites to reduce soil erosion and sediment discharges to streams. A selection of these process are listed below. For this activity you will observe construction sites that are active or were recently active. You need to identify and photograph six different construction site conservation practices being used. Visits to multiple construction sites may be required to identify six practices in total. You may count duplicate conservation practices toward the six practices only if they were observed on separate construction sites. For example, if silt fences are installed on two separate construction sites you may submit photos of the silt fences from both construction sites and count them as two of the six conservation practices.

Construction Site Conservation Practices

- Seeding to grass
- Straw mulch
- Hydromulch
- Ground blanket
- Silt fence
- Special silt fence
- Temporary diversion
- Temporary slope drain
- Riser basins

- Temporary silt basin
- Temporary rock silt check
- Temporary rock sediment dam
- Rock pipe inlet sediment trap
- Rock inlet sediment trap
- Stilling basin
- Surface outlet (skimmer)
- Flashboard riser outlet
- Baffles
- Polyacrylamide (PAM)

Laboratory Report

This scavenger hunt does not conform to our traditional [laboratory report](#) format. Please use the following headings and sections in your report.

Name

Laboratory Number and Title

Date the Exercise was Conducted

Introduction

Provide a brief introduction describing why conservation practices are important for disturbed areas like construction sites.

Description of Construction Site(s)

Identify the location of the construction site and describe what is being constructed to the best of your knowledge. If you observe the construction site regularly, describe things you have noticed over time about the activities on site regarding conservation practices, soil disturbance, runoff, etc.

Construction Site Conservation Practices and Assessment

Name at least six conservation practices that you observed at the construction site(s) and provide a captioned picture that you took of each of these practices. *Note that using images taken by others may constitute a copyright infringement and violates the student code of conduct.*

Discussion

Provide your assessment of whether or not the conservation practice was installed correctly and if maintenance is needed for each of the six practices you documented from this scavenger hunt. Further, evaluate whether erosion and sediment are being adequately controlled at this site, and if additional conservation practices may be needed.

Summary

Summarize your observations and assessments.

References

US EPA Office of Water. 2022a, February 8. Turbidity Benchmark Monitoring (Dewatering) under the Construction General Permit. <https://www.epa.gov/npdes/turbidity-benchmark-monitoring-dewatering-under-construction-general-permit>.

US EPA Office of Water. 2022b, March 17. Stormwater Discharges from Construction Activities. <https://www.epa.gov/npdes/stormwater-discharges-construction-activities>.

PART III

VIRTUAL FIELD TRIPS AND INTERVIEWS

12.

VIRTUAL FIELD TRIP - DYNAMIC SOIL PROPERTIES AT A PAIRED WATERSHED STUDY

Recommended Reading

There are no recommended readings for this laboratory.

Learning Objectives

By the end of this laboratory you will:

1. Define “dynamic soil properties”
2. Observe the methods being used to study dynamic soil properties at the Clay Center paired watershed study

Materials

For this lab you will only need your device, an internet connection, and the virtual tour YouTube video.

Introduction

Dynamic soil properties are soil properties that can change based on soil management. The following video provides an overview of dynamic soil properties within the context of soil health from Dr. Skye Wills, Soil Scientist with the USDA-NRCS.

This first video provides a definition of “dynamic soil properties” and discusses the relevance to soil management practices and soil mapping.



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=351#oembed-1>

Virtual Tour Videos

This virtual tour features Tom Roth, a retired State Agronomist with the USDA-NRCS in Kansas. Tom now consults with the USDA-NRCS on a paired watershed study being used to monitor dynamic soil properties near Clay Center, Kansas. The following is a two-part video tour of that experiment.



One or more interactive elements has been excluded from this version of the text. You can view

them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=351#oembed-2>



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=351#oembed-3>

Discussion

After watching this video you will be participating in either part of either an in-class discussion or an online discussion through your learning management system. Please contribute to that discussion by responding to the questions listed below.

Questions

1. Identify at least three dynamic soil properties mentioned in the video.
2. Provide a definition for each property identified above and explain how different management decisions may change that property over time.
3. Summarize why phosphorus was important to the watershed where this study site is located.
4. What was one thing that surprised you as you watched this virtual tour?

References

Moorberg, Colby. 2022. Dynamic Soil Properties – Paired Watershed Study Tour, Part I. Clay Center, Kansas: ColbyDigsSoil. https://www.youtube.com/watch?v=o_WqrZoIeI4.

Moorberg, Colby. 2022. Dynamic Soil Properties – Paired Watershed Study Tour, Part II. Clay Center, Kansas: ColbyDigsSoil. <https://www.youtube.com/watch?v=nReRcqiDfBs>.

USDA-NRCS. 2015. The Science of Soil Health: Dynamic Soil Properties. 2015. <https://www.youtube.com/watch?v=BZLde2famp8>.

13.

VIRTUAL FIELD TRIP - SOUTHWEST KANSAS FARM TOUR

Recommended Reading

This virtual tour features a farmer explaining the conservation practices he and his brothers use on their operation to conserve soil and water on both irrigated and rain-fed fields. A relevant extension publication is Efficient Crop Water Use in Kansas ([Presley et al. 2012](#)). In addition, the Important Agricultural Soil Properties ([Rogers et al. 2015a](#)) and Agricultural Crop Water Use ([Rogers et al. 2015b](#)) extension publications serve as excellent primers on efficient crop water use.

Learning Objectives

By the end of this laboratory you will:

1. Identify and describe soil and water conservation practices used in southwest Kansas
2. Highlight the lessons learned from the Dust Bowl and how that translates to conservation practices used in that area in modern agriculture

Materials

For this lab you will only need your device, an internet connection, and the virtual tour YouTube video.

Introduction

Southwest Kansas, along with southeast Colorado, northeast New Mexico, and the Texas and Oklahoma panhandles was the epicenter of the Dust Bowl during the 1930s. Since then there has been many changes to agronomic practices, advances in soil science and soil conservation strategies, and great improvements to irrigation pump technology that has allowed this area centered over the Ogallala aquifer to continue agriculture in many ways that is vastly different from agriculture leading up to and during the Dust Bowl. In this ride along farm tour of the Rome operation near Hugoton, Kansas, Dave Rome gives an overview of the practices he and his brothers use to manage water, soil erosion, soil fertility, weeds, and more on both irrigated and rain-fed fields. The video features questions and commentary from aTom Roth, retired Kansas State Agronomist with the USDA-NRCS, and Colby Moorberg, Associate Professor of Soil Science in the Kansas State University Department of Agronomy.

Virtual Tour Video



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=340#oembed-1>

Discussion

In place of a traditional laboratory report, for this virtual tour you will be either having a discussion in class, or be posting to a virtual discussion through your learning management system. Please contribute to that discussion by responding to the questions listed below.

Questions

1. Identify and describe at least two water conservation practices Dave Rome mentioned he and his brother's are using on their fields.
2. Identify and describe at least two soil conservation practices Dave Rome mentioned he and his brother's are using on their fields.
3. The Rome operation is near Hugoton, Kansas, which was in the heart of the Dust Bowl. Based on your understanding of the Dust Bowl are some lessons learned from that environmental disaster and how does that translate into practices being used by the Romes?
4. What was one thing that surprised you as you watched this virtual tour?

References

Moorberg, Colby. 2022. Southwest Farm Tour with Dave Rome. Hugoton, Kansas: ColbyDigsSoil.
<https://www.youtube.com/watch?v=Yv2zozFmDgE>.

Presley, D., D. Shoup, J. Holman, and A. Schlegel, eds. 2012. Efficient Crop Water Use in Kansas. Manhattan, KS: Kansas State University Agricultural Experiment Station and Cooperative Extension Service. <https://www.bookstore.ksre.ksu.edu/Item.aspx?catId=363&pubId=15559>.

Rogers, D. H., J. Aguilar, I. Kisekka, P. L. Barnes, and F. R. Lamm. 2015a. Agricultural Crop Water Use. 12. Manhattan, KS: Kansas State University Agricultural Experiment Station and Cooperative Extension Service. <https://www.bookstore.ksre.ksu.edu/Item.aspx?catId=363&pubId=18185>.

Rogers, D. H., J. Aguilar, I. Kisekka, P. L. Barnes, and F. R. Lamm. 2015b. Important Agricultural Soil Properties. 8. Manhattan, KS: Kansas State University Agricultural Experiment Station and Cooperative Extension Service. <https://www.bookstore.ksre.ksu.edu/Item.aspx?catId=363&pubId=18183>.

14.

VIRTUAL FIELD TRIP - CIMARRON NATIONAL GRASSLAND

Recommended Reading

This virtual tour features a US Forest Service Forester giving Tom Roth (previously showcased in) and Dr. Moorberg a guided tour of the Cimarron National Grasslands. Information about the Cimarron National Grasslands can be found on the US Forest Serve web page for the grasslands ([US Forest Service, nd.](#)). Information about the Santa Fe National Historic Trail can be found on the National Park Service web page for the trail ([US National Park Service, 2023](#)).

Learning Objectives

By the end of this laboratory you will:

1. Describe the history of the Cimarron National Grasslands and its connection to the Dust Bowl
2. Identify and describe conservation practices used to manage the Cimarron National Grasslands

3. Explain challenges to managing the Cimarron National Grasslands that exist today

Materials

For this lab you will only need your device, an internet connection, and the virtual tour YouTube video.

Introduction

In this virtual tour of the Cimarron National Grassland we explore an area that was in the heart of the Dust Bowl. The 108,000 acres of the Cimarron National Grassland were restored to grasslands in order to conserve the vulnerable soils and prevent wind erosion after decades of use for wheat production up until the 1930s. USDA Forest Service Ranger, Jeff Outhier guides Tom Roth, retired USDA-NRCS State Agronomist (Kansas), and Colby Moorberg, Associate Professor of Soil Science at Kansas State University on this tour of the grasslands.

Virtual Tour Video



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://kstatelibraries.pressbooks.pub/soil-water-conservation-lab-manual/?p=52#oembed-1>

Discussion

In place of a traditional laboratory report, for this virtual tour you will be either having a discussion in class, or be posting to a virtual discussion through your learning management system. Please contribute to that discussion by responding to the questions listed below.

Questions

1. Briefly summarize the history of the Cimarron National Grasslands and why it was established.
2. Identify and describe at least two conservation practices Jeff Outhier and his team use to manage the 108,000 acres of the Cimarron National Grasslands.
3. Explain challenges to managing the Cimarron National Grasslands that exist today
4. What was one thing that surprised you as you watched this virtual tour?

References

Moorberg, C. 2023. A Tour of Cimarron National Grassland. Elkart, KS. <https://www.youtube.com/watch?v=TXhQsD0gYkg&t>.

US Forest Service. n.d. Cimarron National Grassland. <https://www.fs.usda.gov/wps/portal/fsinternet3/cs/recarea/psicc/recarea>.

US National Park Service. 2023, October 16. Cimarron National Grassland. <https://www.nps.gov/places/cimarron-national-grassland.htm>.

PART IV

PREDICTING SOIL EROSION

15.

UNIVERSAL SOIL LOSS EQUATION (USLE)

Acknowledgement and Recommended Reading

This laboratory was designed to introduce you to soil erosion modeling using the first widespread soil erosion model used, the Universal Soil Loss Equation (USLE). This laboratory is based on the [Soil Erosion and Conservation](#) laboratory in the Soils Laboratory Manual ([Moorberg and Crouse 2021](#)), which is based on the Universal Soil Loss Equation: A Handbook for Nebraska Producers ([Jones et al. 1988](#)). A history of the development of the USLE is available from the USDA-ARS ([2016](#)).

Learning Objectives

By the end of the laboratory you will:

1. Learn the factors that control soil erosion by water
2. Estimate soil erosion on a hillslope using the USLE
3. Investigate the impact of soil conservation practices

Materials

Materials required to complete this laboratory activity include the following:

- Soil cover and slope data from [Soil Health Assessment Part I: Soil Cover, Slope, and Residue Breakdown](#)
- Information about the crop rotation for your study site

Introduction

The Universal Soil Loss Equation (USLE) is a soil erosion model initially developed by the USDA-ARS, the USDA-NRCS, and Purdue University. The model is empirical, which means it was developed based on observations from experiments. It was first published in 1965 and later updated in 1978. A computerized version of the model, known as the Revised Universal Soil Loss Equation (RUSLE), was released in 1992 and has since replaced by the RUSLE2 version of the model which operates within Microsoft Windows.

While the manual version of USLE is no longer used for developing conservation plans, that version of the model provides an excellent example of how erosion models can be used to predict the impacts of different conservation practices on rates of water erosion rates when developing a conservation plan.

The USLE is written as:

$$A = R \times K \times LS \times C \times P$$

where A is the estimated long term average soil loss in tons per acre per year, R is the rainfall erosivity in units of foot-tons per acre per year, K is the soil erodibility factor, LS is the slope length and steepness factor, C is the cover-management factor, and P is the supporting practices factor. The USLE is a multiplicative model, so the annual erosion rate, A, is the product of each of the five factors. The average annual erosion rate can be converted from units of tons per acre to Megagrams per hectare by multiplying by a factor of 2.24.

For this laboratory you will be predicting soil erosion rates for your study site using the USLE.

Estimate Erosion Rate Under Existing Conditions

Erosivity Factor, R

The erosivity for a given location is dependent upon the long term averages of the intensity and distribution of rainfall at a specific location. Thus, the R factor for the location of your field site will be different from other sites. The erosivity, R can be determined from [this web app](#) provided by the EPA for stormwater permitting for the National Pollution Discharge Elimination System (US EPA 2022). To determine the R value for your site, enter January 1 and December 31 for the current calendar year as the beginning and end date of the “construction” project. Next, navigate to your study site on the map or enter the latitude and longitude if it is known. Then click the “Calculate R Factor” button. This will populate the page with the R value for your study site.

Soil Erodibility Factor, K

You will find the K factor using Web Soil Survey. Using your computer, navigate to the Web Soil Survey. Navigate to the location of your study site. Using the rectangular or the polygon area of interest (AOI) tools, draw the area of interest for your study site. Click on the “Soil Map” tab. Note the soil mapping unit that covers the slope of interest at the study site. Click on the “Soil Data Explorer” tab, then click on the “Soil Properties and Qualities” sub-tab. Expand “Soil Erosion Factors, and click on “K Factor, Whole Soil”. Click on “View Rating” to load that data onto the map. Scroll down, and note the “Rating” for the soil mapping unit of interest. This is the K factor you will use for the USLE.

Alternatively, you can find the K factor using SoilWeb. Open the SoilWeb web app in a computer or mobile device browser and navigate to the study site. Click on the location of the relevant hillslope on the map. This brings up a list of soil series for that map unit. Click on the appropriate soil series (this is often the soil series for which the mapping unit is named). Next, click on the “K_f Factor” button to display the K factors which have been assigned for each horizon. Use the K factor listed for the surface horizon.

Topographic Factor, LS

The topographic factor is a function of the steepness and length of a slope. Using Table 1, determine the LS factor given the length of slope and percent slope you previously observed for your field site.

Table 1. Values for the topographic factor, LS

Slope Gradient		Slope Length (ft)						
(%)	50	100	150	200	300	400	600	
2	0.16	0.20	0.23	0.25	0.28	0.30	0.34	
4	0.30	0.40	0.47	0.53	0.62	0.70	0.82	
6	0.49	0.67	0.82	0.95	1.17	1.35	1.65	
8	0.70	0.99	1.21	1.41	1.72	1.98	2.43	
10	0.97	1.37	1.68	1.94	2.37	2.74	3.36	
12	1.28	1.80	2.21	2.55	3.13	3.61	4.42	
14	1.62	2.30	2.81	3.25	3.98	4.59	5.62	
16	2.01	2.84	3.48	4.01	4.92	5.68	6.95	
18	2.43	3.43	4.21	4.86	5.95	6.87	8.41	
20	2.88	4.08	5.00	5.77	7.07	8.16	10.00	

For Terraced Slopes

If your site has been terraced, this is done individually for each of the terraces. On broad-based terraces the percent slope and length of slope is determined from the top of a terrace to the channel behind the next terrace downslope. For step-back terraces the percent slope and length of slope is determined from the bottom of a terrace to the channel of the next terrace downslope.

Cover-Management Factor, C

Use Table 2 to determine the C factor. The crop rotations are located in the far left column. Identify the appropriate row for the current management at the study site. For example, the appropriate row for a corn (Co) field being planted into soybeans (B) is Co-B. Note the crop abbreviations in the footnote. Next, determine the C factor based on the amount of residue left on the soil surface at the time of planting for the next crop for either tillage or no-till operations.

Table 2. Values for combinations of tillage and residue for the cover and management factor, C.

Management	Tillage	Tillage	Tillage	Tillage	Tillage	Tillage	No-till	No-till	No-till	No-till	No-till	No-till
Residue	<5% (Fall)	<5% (Spring)	20%	30%	40%	50%	20%	30%	40%	50%	60%	70%
Co-Co†‡	.34	.30	.17	.16	.15	.12	.14	.13	.11	.10	.08	.07
Co-B	.40	.37	.31	-	-	-	.20	.15	.14	.11	-	-
Co-W	.34	.30	.14	.11	.10	.09	.14	.13	.11	.10	.08	.06
Co-O	.34	.30	.15	.12	.11	.11	.14	.13	.11	.10	.08	.06
Co-M	.25	.24	.12	.11	.10	-	-	-	-	-	-	.02
Co-Co-M	.29	.27	.16	.13	.12	.11	.13	.12	.10	.09	.07	.06
Co-FB	.40	.36	.22	.18	.14	-	-	.13	.11	-	-	-
Co-SB	.40	.36	.23	.18	-	-	.21	.17	-	-	-	-
B-B	.46	.44	.36	-	-	-	-	-	.27	.22	-	-
B-Co	.39	.33	.20	.16	.13	.11	-	-	-	.09	.08	.07
B-W	.30	.28	.18	.16	.12	-	-	-	-	-	-	.03
O-B	.14	.10	.08	-	-	-	.08	.07	.06	.05	-	-
O-Co	.13	.09	.08	.07	.06	.05	-	.06	.05	.04	.03	.02
W-B	.19	-	.14	-	-	-	-	-	-	.07	.06	-
W-M	.10	-	-	-	-	-	-	-	-	-	-	-
W-W	.20	.20	.10	.09	.08	.07	-	-	-	-	-	.04
W-O	.23	.23	.12	.11	.09	.08	-	-	-	-	-	-
W-Co	.16	.16	.13	.11	.10	.08				.06	.05	.04
FL-Co	.59	.45	.25	.18	.14	.11	-	-	-	-	-	-
FL-W	.47	.39	.15	.11	.09	.07	-	-	-	-	-	-
FB-SB	.42	.35	.29	.24	.20	-	.23	.19	.16	.13	.11	-
SB-FB	.41	.37	.25	.22	.18	-	.23	.19	.16	.13	.11	-
SB-Co	.35	.33	.22	.17	.14	-	-	-	-	-	-	-
M (Est.)	-	-	-	-	-	-	-	-	-	-	-	.02

†Milo may be substituted for corn. All C-values are for wide row plantings.

‡Crop abbreviations are as follows: Co, Corn; B, soybeans; W, wheat; M, meadow (alfalfa, clover, grass, etc.); Fb, field beans; SB, sugar beats; FL, mechanical fallow.

Supporting Practices Factor, P

Use Table 3 for the P factor for contour farming and contour strip-cropping and/or Table 4 for the P factor for terraces with underground outlets or grassed waterways. In situations where both contour farming and terracing are used, the P factors can be multiplied together.

	Contour Farming	Contour Farming	Contour Strip Cropping	Contour Strip Cropping	Contour Strip Cropping
Slope Gradient (%)	Max Slope Length (ft)	P Value	Strip Width (ft)	P Value	P Value
1 - 2	400	0.6	130	0.30	0.45
3 - 5	300	0.5	100	0.25	0.38
6 - 8	200	0.5	100	0.25	0.38
9 - 12	120	0.6	80	0.30	0.45
13 - 16	100	0.7	80	0.35	0.52
17 - 20	100	0.8	60	0.40	0.60

Table 4. Conservation practice P values for terraces with underground outlets or waterways.

Terrace Interval	Underground Outlets	Waterways with percent grade of:		
(ft)		0.1-0.3	0.4-0.7	0.8
	Pt Values	Pt Values	Pt Values	Pt Values
<110	0.5	0.6	0.7	1.0
110-140	0.6	0.7	0.8	1.0
140-180	0.7	0.8	0.9	1.0
180-225	0.8	0.8	0.9	1.0
225-300	0.9	0.9	1.0	1.0
300+	1.0	1.0	1.0	1.0

Estimate the Erosion Rate Under Existing Conditions

Now that all factors have been determined, multiply them together as described in the introduction. If one factor is not applicable, then do not include that factor in the calculation, or use the value 1 (which does not change the product). For example, if no terracing, contour tillage, or contour strip-cropping are used, then the P factor would be 1 or could be omitted from the calculation for simplicity. This may also apply to the C factor if conventional tillage is used and no residue remains at the time of planting the next crop, or if the appropriate C value was listed as a dash in the table.

Estimate Erosion Rate After Conservation Practices are Implemented

Now that you have estimated the average annual erosion rate by water for the hillslope under existing management practices, you can begin to model erosion rates under different management scenarios. The R and K factors must remain the same, since they are inherent to the site. However, the LS, C, and P factors can change with different management. The LS factor can change with terracing. The C factor can change if different crops are used, or additional residue is left on the field at the time of planting as a result of reduced tillage intensity, or if no-till is used. The P factor can change by adopting contour tillage, contour strip-cropping, or installing terraces.

Explore different management scenarios and calculate the predicted water erosion rate under those scenarios. Use the USLE to model erosion rates for at least two different management scenarios that differ in some way from the existing management system. Describe those scenarios in detail and remember to state all assumptions made for each scenario. Note that sites that are permanently vegetated, such as rangeland sites, will have small average annual erosion rates, so implementation of conservation practices may result in only nominal changes to those rates.

Questions

1. How does the erosion rate under the existing management system compare to the tolerable erosion rate, T, which can be found in the Web Soil Survey or SoilWeb?

2. How do the erosion rates under the two different management scenarios you conceived compare to the tolerable erosion rate, T ?
3. What other management practices could be implemented to reduce this erosion rate even further?
4. Conservation practices range in the cost required in order to implement them. For example, adopting contour tillage in place of tillage up-and-down hillslopes incurs no additional expenses. On the contrary, installing terraces is an expensive venture and often requires financial assistance from the federal government. Discuss the potential return on investment for the conservation practices that you explored in the different management scenarios.

References

- Jones, A. J., D. Walters, W. G. Hance, E. C. Dickey, and J. R. Culver. 1988. Universal Soil Loss Equation: A Handbook for Nebraska Producers. Lincoln: Nebraska Cooperative Extension Service. <http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=2620&context=extensionhist>.
- Moorberg, C., and D. Crouse. 2021. Soils Laboratory Manual: K-State Edition, Version 2.0. K-State Edition, Version 2.0. New Prairie Press. <https://newprairiepress.org/ebooks/39>.
- USDA ARS. 2016. "USLE History." USDA ARS. August 12, 2016. <https://www.ars.usda.gov/midwest-area/west-lafayette-in/national-soil-erosion-research/docs/usle-database/usle-history/>.
- US EPA. 2022. Low Erosivity Waiver (LEW). <https://lew.epa.gov/>.

16.

WATER EROSION PREDICTION PROJECT (WEPP)

Acknowledgement and Recommended Reading

The Water Erosion Prediction Project (WEPP) was developed by researchers and staff members of the USDA-ARS, USDA-NRCS, and cooperating Land-Grant Universities. The most recent iteration of the model is designed to be used as a web application and can be accessed on the USDA-NRCS WEPP web page ([USDA-NRCS 2023](#)). The current draft of the WEPP Web-Based NRCS User Guide ([USDA-NRCS 2020](#)) is available under the help menu of the WEPP web interface.

Learning Objectives

By the end of the laboratory you will:

1. Become familiar with the use and application of the WEPP model
2. Run simulations in WEPP and show proficiency in changing settings, changing a management template, saving and opening files, etc.
3. Use the WEPP model to estimate the impacts of implementing conservation practices on soil

erosion

Materials

Materials required to complete this laboratory activity include the following:

- Soil cover and slope data from [Soil Health Assessment Part I: Soil Cover, Slope, and Residue Breakdown](#)
- Information about the crop rotation for your study site

Introduction

The Water Erosion Prediction Project (WEPP) model was developed by the USDA Agriculture Research Service (ARS) and Natural Resources Conservation Service (NRCS) along with university researchers to predict soil erosion on individual slopes and small watersheds. The newest iteration of WEPP has or will replace RUSLE2 for soil erosion modeling. To gain a further understanding of how the model operates, read the draft of the Water Erosion Prediction Project (WEPP) Web-Based NRCS User Guide available through a link at the top of the help menu within the WEPP web interface.

Estimate Erosion Rates Under Existing Management Practices

For the assignment for this lab you will conduct a series of simulations for your study site. Follow the directions below, and refer to the user guide if you have any questions about how to perform one of the steps.

Access the WEPP user interface available through the [Water Erosion Prediction Project web page](#) then complete the following steps for your study site.

Select the county where your study site is located, then use the WEPP Map feature to select the appropriate field. Select the map unit and map unit component for the simulation from within that field. Describe the slope steepness, length of slope, aspect, and shape. Then select the management template that most closely matches the practices used by the landowner or producer.

In the management screen, edit the operations, dates of operations, target yields, added residue, and any spray operations as needed. Save the management file (.man file) to your local directory (your computer's hard drive or a USB flash drive). Now you are ready to run the simulation. Run the simulation and save it to History as the Benchmark Run. View and save the PDF Summary of the Run to your local directory.

Estimate Erosion Rates Under Alternative Management Practices

Now you are ready to conduct some simulations based on changes to land management. Reopen the Management and make changes that you expect will lead to reductions in rates of water erosion rates and are likely to recommend to the land owner or producer. For example, you can reduce tillage intensity, add a cover crop, use contouring, etc. Save this modified Management file to your local directory (.man file). Run this simulation and save it to the History as Alternative 1. Save the Project Run (done on the Projects Screen) to your local directory.

Next you will repeat this process to simulate a second alternative (Alternative 2). Save the Project Run to your local directory as before.

You will submit your benchmark and alternative project files (.prg files) as evidence that you can accomplish these tasks. Do so along with your responses to the following questions.

Questions

1. What was the average erosion rates for the Benchmark run and Alternative 1? Did the resulting change in erosion rate for Alternative 1 meet your expectations for a reduction in soil erosion? Explain.
2. Describe what you changed in your management from the Benchmark run to the Alternative 1 run.

3. Considering your responses to Questions 1 and 2, what would you test next in order to further reduce the erosion rate? Explain your reasoning.
4. Compare and contrast WEPP and the USLE. Specifically, what are the advantages of each model compared to the other one? What are some of the disadvantages of each model?
5. What types of erosion are modeled using WEPP? (Hint: refer to the resources cited in the introduction)

References

USDA-NRCS. 2020. Water Erosion Prediction Project (WEPP): WEPP Web-Based NRCS User Guide. Washington, D.C. <https://brenton.nserl.purdue.edu/wepp/data/wepp-nrcs-users-guide-3-2020.pdf>.

USDA-NRCS. 2023. Water Erosion Prediction Project. <https://www.nrcs.usda.gov/resources/tech-tools/water-erosion-prediction-project>.

PART V

CONSERVATION PLAN

17.

CONSERVATION PLAN

Learning Objectives

By the end of developing your conservation plan you will:

1. Create a professional grade conservation plan for your field site
2. Develop skills required for prescribing and evaluating management practices
3. Improve communication skills through writing, speaking, and teamwork

Introduction

Conservation plans serve as blueprints for implementing conservation practices on the landscape. They are typically developed by a soil conservationist working closely with the landowners, farmers, ranchers, and other stakeholders.

Your conservation plan will be developed with the target audience being the landowner, land manager, or producer (hereon referred to as the land manager) you have been working with throughout this course. The conservation plan should be written and produced at a quality at which it could be immediately implemented as written by the land manager. It should be professionally done and easy to read by a lay-person. While your instructor will be the one reading and grading the report, you are encouraged to provide it to the land manager. Write it as though it was written for them.

Management Plan Outline

Abstract

An abstract is a short summary of the entire document, and has a maximum of 250 words. Abstracts are written in a way where everything that is important in the document is reflected in the abstract. The content of the abstract should be written as a single paragraph and include the following items in the order listed: an introductory statement, objectives, site characterization, management plan recommendations, predicted changes to erosion rates, and conclusions.

Introduction

Provide an introduction that's one or two paragraphs in length that introduces the landowner to your conservation plan. This section should describe what is included in the rest of the report and how that information was collected.

Site Characterization

This section will be used to describe the site, its current conditions, and the current management in detail.

Location and Area

Use this section to describe location of the field, and list any nearby landmarks, such as nearby roads or landmarks that a layperson could use to navigate to the site. A legal description of the plot of land would be appropriate as well. Also, list the total area, in acres.

Description of Current Management

This section will describe all of the details of the current management plan, including many of the practices that may impact erosion rates. Describe in detail the current crop rotation; tillage practices that are used; what, if any conservation practices that are already in use, such as contour tillage, terraces, etc. Create a map of the site that readily identifies terraces, field boundaries, and nearby landmarks if they are close enough (like roads, for example). You are encouraged to develop professional quality maps using ArcGIS or similar programs.

Soil Map

Provide a written summary of the soil mapping units that exist on the site, along with the total area, and percent of total area associated with each mapping unit. Include the actual soil map report that was retrieved from the web soil survey in the appendix to the report.

Soil Erosion under Current Management

Estimate the total amount of water and wind erosion that occurs at the site currently. Water erosion from sheet (aka interrill) and rill erosion should be estimated using WEPP, as was done in the [Water Erosion Prediction Project \(WEPP\)](#) laboratory activity. Wind erosion should be estimated using WEPS, as was done in the Wind Erosion Prediction System (WEPS) laboratory activity. For both simulations a summary of all parameters should be listed and described in enough detail that someone else could use the same information and come to the same estimation of water erosion. The use of a table for describing the factors used for WEPP and WEPS models is recommended for reporting these details.

If there is a gully erosion at your study site the rate of water erosion from ephemeral and perennial gullies should be estimated using the following document:

USDA NRCS. 2002. Estimating Soil Loss From Gully Erosion. 8. https://efotg.sc.egov.usda.gov/references/public/MO/gully-ephemeral_erosion.pdf

Soil Health Assessment

Summarize your Cropland In-field Soil Health Assessment findings in this section. Identify any individual assessments that identified potential soil health resource concerns for the site. Include either the NRCS Cropland In-field Soil Health Assessment worksheet OR the LandPKS Soil Health Report in the Appendix.

Management Plan

Describe the conservation practices you are recommending that the land manager adopt in this section.

Map of Conservation Practices (Recommended)

It is highly recommended that you include a map of the conservation practices that you recommend to the land manager. If you do not have prior experience with mapping software like ArcGIS or QGIS, then a rudimentary map will suffice. Note: nice looking maps can be drawn in PowerPoint using a satellite image of the site as a background and shapes and labels added over the top

Crop Rotation & Cropping Systems

If your recommendation includes using the land for crop production, describe in detail the cropping system and rotations that you recommend implementing in the field. The actual rotation may stay the same, but with management changes such as using contour tillage or no-till. Including a table similar to the management files used in the WEPP and WEPS models is recommended for demonstrating your rotation. Provide estimates of residue that would exist at the time of planting the following crop. Lastly, with the Web Soil Survey report included in the appendix, include yield estimates for your crops, forages, or range grasses as needed.

Pasture Management

If your recommendation includes using the land for pasture, describe in detail the pasture management practices that your group recommends implementing in the field. Include pasture production estimates provided by the Web Soil Survey with the soil survey report in the appendix. Also, including a table similar to the management file used in the WEPP model may prove to be useful in demonstrating your rotation.

Tillage

In this section, describe what tillage operations you plan to use, if any, and describe why those practices were chosen. Referring to the table of operations in the “Crop Rotation & Cropping Systems” and/or “Pasture Management” sections may be useful in your discussion.

Construction Site and Urban Soil Management

If your site is not an agricultural field, but instead is intended to be used for building site or urban development, describe the conservation practices you recommend during and after construction.

Conservation Structures

If you plan on installing terraces, grassed waterways, or other conservation structures then include both a description of what you plan to implement, and a description of where those practices will be installed. Also include a map of where those practices will be implemented in the field.

Management for Surrounding Lands

If you plan to adopt any conservation practices for the lands surrounding the field of interest, then include

both a description of what you plan to implement, and a description of where those practices will be installed. Also denote where those practices would be implemented on the map.

Soil Erosion under New Management Plan

Estimate soil erosion that would occur under the new management plan if it was fully implemented. Provide the same level of detail for the WEPP and WEPS model parameters as you did for the estimation of erosion under the current management practices. If your site has gully erosion and your conservation plan adequately addresses that concern, then it will be assumed that gully erosion will be eliminated once your conservation practices are implemented. Thus, you do not need to include any estimations of gully erosion under the new management plan.

T Values

Determine the T values for the dominant soil mapping units at the site using the Web Soil Survey, and determine if current total erosion rates and soil erosion rates following your conservation plan exceed tolerable rates of soil loss. *Note: It should be a goal to develop a conservation plan that at least meets T values.*

Summary & Conclusions

Provide an overall summary for the management plan and the impact it will have on soil and water conservation at this site. The summary and conclusions should be three or more paragraphs in length. The first paragraph of this section should summarize the methods used, the site characteristics, and what practices are both being used currently. The second paragraph should outline the conservation practices and changes to existing management practices that you are recommending. The third paragraph should focus on the expected outcomes of the conservation plan, such as the expected reduction in erosion, comparison of erosion rates to the T value, improvements to soil health, and other resource concerns that were addressed.

References

Cite your references using the style guide from the Journal of Soil and Water Conservation. Note: this is the same style used in this laboratory manual and *Soil and Water Conservation: An Annotated Bibliography*. It is recommended that you cite conservation practice standards, conservation practice standard overviews, and extension bulletins for each of the conservation practices you recommend implementing on this field. These references should be cited in the text where appropriate.

Appendix

Include any additional information that would be of use to the producer in this section. This section should include a soil map and other reports from the Web Soil Survey, the soil health report from LandPKS, reports from WEPP and WEPS simulations, and other information that will be useful to the land manager based upon your recommendations.

Grading

The conservation plan will be graded as described in the rubric provided by your instructor.

Conservation Plan Presentation

You will present this conservation plan to your instructor and classmates. Your instructor will provide details regarding the day and time of the presentation and the grading rubric that will be used. The land manager will be invited to attend this presentation, if they so desire.

APPENDIX

This is where you can add appendices or other back matter.