United States Department of Agriculture

Natural Resources Conservation Service

CEAP (Conservation Effects Assessment Project)

Soil Vulnerability Index for Cultivated Cropland

(SVI-cc)

User Guide

Version 2.0
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Soil Science and Resource Assessment Deputy Area
Resource Inventory & Assessment Division – Resource Assessment Branch
Soil and Plant Science Division and National Soil Survey Center
National Geospatial Center of Excellence

Nondiscrimination Statement

Introduction

Purpose

Since 2009, the Conservation Effects Assessment Project (CEAP) Soil Vulnerability Index for cultivated cropland (SVI-cc) has demonstrated it can be a useful tool for extending and translating important scientific findings from CEAP studies into conservation planning guidance for many different soil landscapes (from field to basin).

In 2018, the USDA NRCS Soil Science Division (SSD) and Resource Assessment Division (RAD) sponsored a peer review of the CEAP SVI-cc (06/19/2018 script using FY2015 data sources). The resulting comments from NRCS staff experts in 48 States provided the basis for the refinement of SVI-cc rulesets and terminology. These refinements were made to help improve how well CEAP SVI-cc performs in different soil landscapes, watersheds/basins, and States. Findings from this review and how the original SVI-cc rulesets were adjusted are described in this document.

This User Guide was prepared to document the 2.0 (11/05/2018 script) version of the Conservation Effects Assessment Project (CEAP) Soil Vulnerability Index for Cultivated Cropland (SVI-cc) that reflects changes based upon results of the 2018 peer review.

This document provides basic information about how the CEAP SVI-cc 2.0 was prepared and how it can be used. The peer review focused on the proper construction of the rulesets and resulting ranking of soil map units (and their components) according to soil vulnerability class. These rulesets are intended to be applied to current detailed soil survey data as it is released each fiscal year to create the SVI-cc dataset that is intended to assist in conservation decision making during that fiscal year.

Definitions of terms and descriptions of CEAP SVI-cc 2.0 rulesets with examples are included. Additionally, an SVI-cc 2.0 web application that makes use of the FY2018 gSSURGO/SSURGO data source is described. Supporting map layers are described that include 12-digit hydrologic units (HUC-12) with and without karst geology information. In addition, Major Land Resource Area (MLRA; Soil Survey Staff, USDA NRCS, 2006), and State and county boundaries are also provided as reference map layers. A tutorial for the SVI-cc 2.0 web application with links to the online application is provided in Appendix A and Appendix B (Note: SVI-cc 2.0 data, documentation and web application are for official use only or FOUO)

In Appendix C, a summary of review questions completed by NRCS staff experts from 48 States is provided to document the peer review.

For more information please send an email to Kevin.Ingram@usda.gov or Lee.Norfleet@usda.gov or lnorfleet@brc.tamus.edu.

Background

Soil Vulnerability Index for Cultivated Cropland (SVI-cc) 2.0

SVI and CEAP-Cropland Studies

Initial steps to develop the CEAP-SVI (Conservation Effects Assessment Project Soil Vulnerability Index) were taken in 2009 by the CEAP team and the RAD GIS Lab staff. These scientists and geographers worked to apply key findings reported in CEAP-Cropland Modeling reports about soil vulnerability using detailed soils data (SSURGO). The results from CEAP model runs allowed the CEAP team to assess the inherent potential vulnerability of those input soils to losses of sediment or nutrients during cultivation.

The CEAP modeling involved inputs of farmer survey data and soils information at each CEAP sample point (NRI related) into the Agricultural Policy / Environmental Extender (APEX) model. Farmers reported on a range of farming and conservation practices, such as chemical use, tillage methods, application timing, rotations, use of buffer strips, conservation tillage, cover crops, etc. plus, weather data for 3 years was used for the field where each NRI-CEAP sample data point was located. This allowed the CEAP team to estimate conservation effects for particular growing systems in different areas, and for various soils. These effects included potentials for excess nutrient and sediment delivery into the environment using watershed and basin landscape segments.

The model output was used to identify four ranked categories or classes of “inherent vulnerability” (high, moderately high, moderate, and low) for the NRI-CEAP sample point soils. Inherent vulnerability can be defined as soil vulnerability without the application of effective conservation practices under typical growing conditions. Conventional tillage systems are assumed, and all reported conservation practices were removed to simulate a “no practice” condition. A fifth SVI-cc category called “unclassified” was also identified when insufficient data was available.

The CEAP team used these inherent soil vulnerability classifications to establish a set of SVI rules based on five common soil parameters. These soil parameters are: hydrologic soil group, kwfactor (whole soil erodibility factor–includes rock fragments), slope, soil taxonomic classification, and soil drainage class. Using these commonly available soil parameters, it is possible to classify all detailed soil map units and prepare a Conterminous United States CEAP-SVI map layer illustrating the potential index of inherent soil vulnerability. For regional and National assessments, such maps or digital map layers are “masked” to show just the agricultural land use areas of the landscape, given that agricultural management assumptions are used in CEAP models. Otherwise, all soil map units and their components are assessed to provide SVI-cc 2.0 classifications.

The original CEAP Soil Vulnerability Index assumed the cultivated cropland condition and was known simply as CEAP-SVI. Now, that original SVI is known as SVI-cc (cc stands for cultivated cropland) to distinguish it from future CEAP soil vulnerability indices being developed (for rangeland, forest, and wetlands).

CEAP SVI Up-Scaled for Landscape (Basin/Watershed) Planning

In late 2009, the soil vulnerability classification system was used for planning during the Chesapeake Bay Watershed Initiative (CBWI). Maps for the CBWI basin were developed using established CEAP-SVI rulesets and SSURGO (detailed soil survey data). The resulting SVI maps along with watershed level findings from the USGS-SPARROW model results and other information were used to help identify the most vulnerable regions in the CBWI area. This information combined with the location of specific management practices in place across the region, successfully helped narrow the list of most vulnerable locations within the Chesapeake Bay Watershed study area for targeted planning. Since that time SVI-cc has had a role in identifying the location of vulnerable soils at a landscape level for several agency projects and initiatives. SVI-cc is currently being evaluated by the agency for efficacy in field-level planning.

CEAP SVI Down-Scaled in CEAP-Conservation Benefits Identifier (CCBI)

During National CEAP-Cropland studies, researchers found widespread evidence that a significant portion of highly vulnerable U.S. cropland acres remain "undertreated" or "critically undertreated." The CEAP Conservation Benefits Identifier (CCBI) was developed to help identify those "undertreated" or "critically undertreated" fields for conservation treatment. The CCBI represents an in-development application of the CEAP-SVI. The CCBI is a field-level prototype tool used to rank farm fields according to each field's potential to benefit (improve the agroecosystem by reducing losses of sediment or nutrients) from additional conservation treatments and investments.

CEAP SVI and Conservation Planning in USDA NRCS

Within USDA NRCS there are several efforts to model soil vulnerabilities in landscapes where cultivated agriculture is practiced, as well as traditional conservation planning from the NRCS field office. These include using traditional soil survey soil interpretations (SSURGO and WebSoilSurvey) as well as RUSLE2, Land Capability Classification System, and other models that simulate potential losses of sediment or nutrients from cultivated fields and rank soils according to their vulnerability to these losses.

CEAP-SVI (SVI-cc) is intended to complement local knowledge of soils, farming, and conservation activity, and to support the role local conservation staff have in planning the delivery of conservation. To date, SVI-cc has been used to assist in conservation decisions using additional regional and local information to address conservation challenges in particular regions.

It is important to note that the SVI-cc 2.0 is a "simple screening" tool for soil vulnerability for surface and subsurface losses of sediment, nutrients, and pathogens. Watershed, farm, and field-level conservation level assessments must further scrutinize the landscape to identify and protect source water areas that may fall within these landscapes and be vulnerable to the impacts of agriculture.

The Role of SVI-cc in Conservation Planning

The SVI-cc is a tool designed to speed up the planning process by highlighting the portion of the field where issues related to water runoff (surface loss) or water leaching (subsurface loss) should be readily recognized. SVI-cc places a soil into one of four classes for each water pathway. This allows for rapid landscape interpretation by a planner that may not be intimately familiar with each detailed soil map unit. In this way, SVI-cc is considered a screening tool that can help direct the conservationist to the next logical step in conservation practice decision making for the land owner/operator.

Although soil scientists who prepare soil surveys encourage planners to use all their information, in today's reality of field level planning only minimal soil survey information is generally used in conservation decision making. SVI-cc is an attempt to "curate" or interpret the available detailed soil survey information into the most basic soil properties for ready use by non-soil scientists tasked with the job of conservation planning.

SVI-cc is not perfect. No tool or model or soil interpretation ever will be. Therefore, SVI-cc should not be expected to address 100% of the situations found out in the real world. There will always be unique exceptions that are localized and best handled by soil scientists and soil conservationists with local knowledge and expertise.

Many soil scientists ask why SVI-cc uses the soil erodibility factor (aka "K-factor") as a water leaching criteria. K-factor was invented to be used to estimate sediment erosion, but simple logic would suggest it can be more versatile. A high K-factor value (medium and finer textures) indicates high sediment erosion potential from runoff. However, if the K-factor is low (coarser textures), this indicates potential for greater infiltration.

Rainfall or irrigation water in the soil landscape has a couple of options. This water can flow across the soil surface or move downward through the soil profile or other entry point as subsurface flow (Musgrave, 1955). Therefore, if the K-factor indicates the soil is coarse, with higher infiltration likely, then it follows that leaching should also be more likely.

Similarly, soil scientists point out that hydrologic soil group (aka "HSG") was intended for runoff prediction. Again, logic indicates that if water from rainfall or irrigation is not running off the soil surface, then it must be moving down through the soil profile or other entry point. For example, the definition of HSG Class A indicates high infiltration and high rate of transmission (water is transmitted freely through the soil) (USDA, NRCS, 2009). The HSG soil interpretation may be one of the most highly used and critical to agricultural engineers and therefore remains a key soil characteristic for conservation planning models.

Soil scientists have suggested soil permeability values be used instead of HSG Classes. That could work, but permeability values are not frequently measured. In addition, although considered a soil property, permeability is most often assigned or derived from other soil properties not unlike the soil interpretation, HSG. Permeability also lacks the familiarity among our customer base that HSG enjoys. Therefore, the use of HSG is preferred since it should encompass morphological indicators of wetness, depth to restrictive layers, and other clues to aid in its estimation.

Changes in Terminology for SVI-cc 2.0

As recommended by results of the 2018 peer review, some changes to terms were made for SVI-cc 2.0. These changes are described in Table 1.

*Table 1. SVI-cc 2.0 terminology changes. Note: * indicates terms that are no longer used, except for specialized regional or National studies.*

SVI-cc (old)	***SVI-cc 2.0 (new)***
Runoff	***Surface Loss***
Leaching, Managed	***Subsurface Loss (drained)***
***Leaching**	**Subsurface Loss (undrained)*

The former term "Runoff" is renamed "Surface Loss" and the former term "Leaching, Managed" is renamed "Subsurface Loss (drained)" in SVI-cc 2.0. The former term "Leaching" is renamed "Subsurface Loss (undrained)" and is available only for use in specialized regional or National studies. The updated SVI-cc terms are used throughout this document.

These terminology changes reflect a simplification and consolidation of the SVI-cc rulesets. These changes will be detailed in the Preparation of SVI-cc 2.0 sections, Rulesets.

Changes in SVI-cc Rulesets

Surface Loss

There were some important changes in the SVI-cc 2.0 Surface Loss ruleset. These include:

1. changing from using fragment free erodibility factor (kffact_r) and rock fragment volume to the use of whole soil erodibility factor (kwfact_r) and no rock fragment volume
2. the taxonomic terms pachic and cumulic were added to the histosol/histic epipedon rule

Subsurface Loss (drained)

There were some important changes in the SVI-cc 2.0 Subsurface Loss (drained) ruleset. These include:

1. changing from using fragment free erodibility factor (kffact_r) and rock fragment volume to the use of whole soil erodibility factor (kwfact_r) and no rock fragment volume
2. the taxonomic terms pachic and cumulic were added to the histosol/histic epipedon rule
3. use of the former Leaching, Managed ruleset to represent Subsurface Loss (drained)

Subsurface Loss (undrained)

There were some important changes in the SVI-cc 2.0 Subsurface Loss (undrained) ruleset. These include:

4. changing from using fragment free erodibility factor (kffact_r) and rock fragment volume to the use of whole soil erodibility factor (kwfact_r) and no rock fragment volume
5. the taxonomic terms pachic and cumulic were added to the histosol/histic epipedon rule

Definitions

Conservation Effects Assessment Project (CEAP)

USDA's NRCS and ARS (Agricultural Research Service) use CEAP (Conservation Effects Assessment Project) to assess and quantify the environmental benefits from using conservation practices in cultivated cropland. The goal of the CEAP-Cropland Component is to report conservation effects in terms that represent recognizable outcomes, such as cleaner water and soil quality enhancements that will result in more sustainable and profitable production over time.

Soil Vulnerability

CEAP researchers have chosen the term "soil vulnerability" to describe the capacity of soil resources to withstand potential impacts of cultivation in the landscape by allowing losses of sediment or excess nutrients or pathogens from the farmer's field into surface and ground waters. Such losses can reduce water quality in the agroecosystem and diminish soil productivity. CEAP examines the impacts of these losses at multiple scales (field scale, watershed, and river/lake basin).

NRCS Soil Scientists have applied a similar term referring to "fragility" in the Fragile Soil Index interpretation. When this fuzzy soil interpretation index is near 1 it identifies soils that are *most* vulnerable to degradation (susceptible to erosion with low resilience). This index relies on an equation that uses local soil and landscape parameters such as surface soil organic matter, aggregate stability, rooting depth of profile, vegetative cover, slope, and aridity index for climate.

Soil Interpretation

According to the USDA NRCS National Soil Survey Handbook, Part 617.0, "Soil survey interpretations predict soil behavior for specified soil uses and under specified soil management practices. They can be used for establishing criteria for laws, programs, and regulations at local, State, and national levels. They assist the planning of broad categories of land use, such as cropland, rangeland, pastureland, forestland, or urban development. They are used to assist in preplanning and post planning activities for national emergencies. Soil survey interpretations also help plan specific management practices that are applied to soils, such as irrigation of cropland or equipment use." See USDA, NRCS, 2017.

The SVI-cc rating is considered a crisp classification soil interpretation (has four distinct classes). The SVI-cc rating is restricted to just the cultivated croplands portion of the soil landscape when used in regional and National assessments.

Epipedon

"The epipedon (Gr. epi, over, upon, and pedon, soil) is a horizon that forms at or near the [soil] surface and in which most of the rock structure has been destroyed." (USDA, NRCS Soil Survey Staff, 2014). An epipedon is often called the soil surface horizon.

Soil Map Unit Component

The SVI-cc is computed for individual soil and non-soil bodies called "components" in USDA's detailed soil survey (SSURGO) map units. Soil components generally have soil series names (like Cecil, Hagerstown, or Pawnee) or soil taxonomic names (like udepts or aquolls). Non-soil components have names like rock outcrop or urban land or water. Each component makes up a fraction of the total area of the soil map unit.

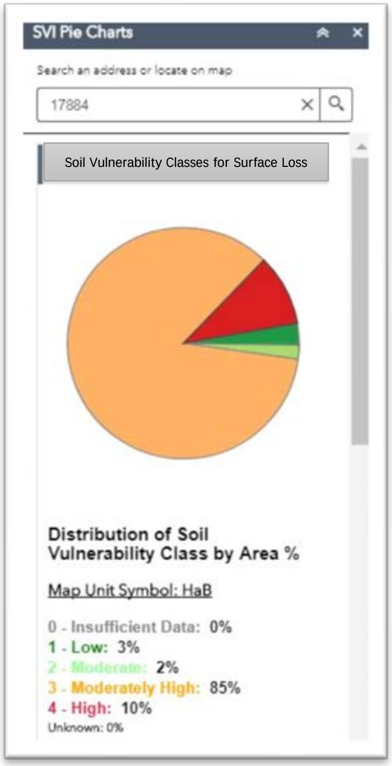
This fraction is called the component percentage and generally totals to 100 percent for each soil map unit. The component percentage is used to help summarize or bin components into one of the four SVI-cc classes (or an "unclassified" condition when data is insufficient) for each soil map unit. The soil map unit breakdown of SVI-cc classes can be illustrated using simple graphics like a pie chart to help communicate the complexity of local soil landscapes.

Soil Map Unit

Soil map units for USDA's detailed soil maps (aka SSURGO or Soil Survey Geographic Database as accessed in the WebSoilSurvey) represent the smallest geographic soil concept that can be mapped using a vector polygon at map scales (map fractions) ranging from 1:12,000 to 1:24,000 in the conterminous U.S. Coarser map scales (smaller map fractions) are used in more remote parts of the U.S. Soil Survey. Each soil map unit can have many soil polygons. Each soil polygon will share the same soil map unit concept (suite and proportion of soil and non-soil components) when identified with the same nationally unique map unit identifier.

When SSURGO is used to map the SVI-cc using GIS (desktop or web map applications), generally the dominant or map unit majority condition SVI-cc class is illustrated using the map legend color. This means the SVI-cc class that is believed to cover the largest land area of the soil map unit was selected for on-screen mapping. Soil map unit pie charts are used to help describe components that differ from the dominant or majority mapping condition.

Figure 1. Example of contrasting Map Unit Composition for SVI-cc Surface Loss illustrated with a pie chart graphic.



For example, although the soil map unit analyzed in Figure 1 has an SVI-cc Surface Loss class of 3 or Moderately High Vulnerability (orange) for 85% of the area, this same map unit also has components with 10% High Vulnerability (class 4 in red), 3% Low Vulnerability (class 1 in dark green), and 2% Moderate Vulnerability (class 2 in light green). This pie chart indicates a complex soil landscape requiring careful management for surface loss under cultivation. Map unit compositions for SVI-cc subsurface loss (drained or undrained) can yield a different pie chart composition break down for the same soil map unit. Figure 1 illustrates such a condition for a residual limestone soil map unit found in the Northern Ridge and Valley Province of Pennsylvania.

Detailed Soil Survey Mapping

The most detailed vector soil survey map product is known as the Soil Survey Geographic Database or more often by its acronym SSURGO ("sir-go"). SSURGO data are developed and maintained by the USDA Natural Resources Conservation Service with annual updates accessible through the WebSoilSurvey and the USDA Geospatial Data Gateway.

For a more in-depth description of SSURGO, please visit https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053627.

For information on the gridded equivalent of SSURGO called Gridded SSURGO or gSSURGO for short, please visit https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053628.

Source Water Protection Areas

Surface water (streams, rivers, and lakes) or ground water (aquifers) can serve as sources of drinking water, referred to as source water. Source water provides water for public drinking water supplies and private water wells. Public utilities treat most water used for public drinking water supplies. Protecting source water from contamination can reduce treatment costs. Protecting source water also reduces risks to public health from exposures to contaminated water (USEPA, 2019).

The term "Source Water" is used to define drinking water in its original environment, either as surface water (rivers, streams, reservoirs, lakes) or as groundwater (aquifers), before being withdrawn, treated, and distributed by a water system. Source Water Protection (SWP) is the act of preventing contaminants from entering public drinking water sources. (Iowa Department of Natural Resources, 2019).

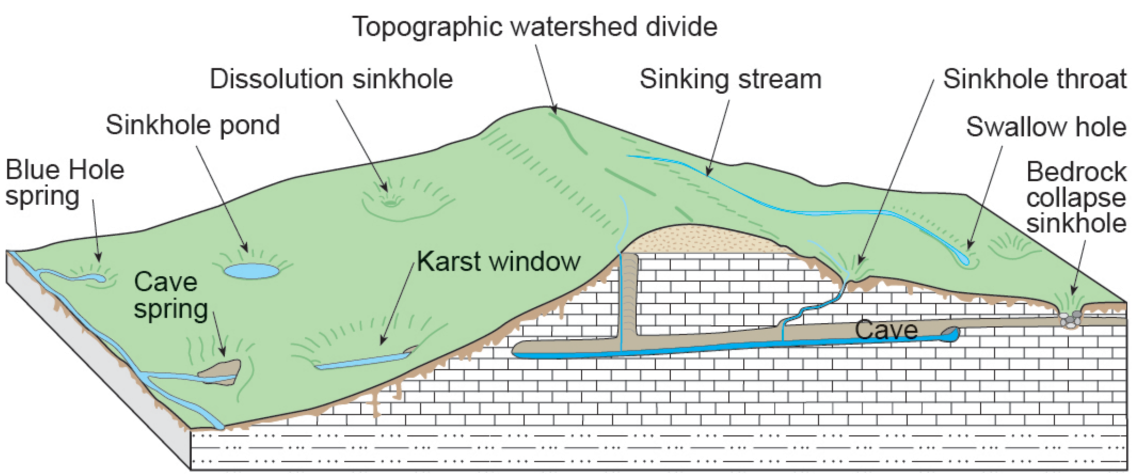
Source water protection areas are considered within the USDA NRCS National Water Quality Initiative (NWQI) with emphasis on locally-led voluntary conservation with the primary goal to reduce nonpoint sources of nutrients, sediment, and pathogens related to agriculture (USDA NRCS, 2018). In addition, the 2018 Farm Bill identifies 10% of NRCS conservation funding to be directed toward source water protection (ASDWA, 2018).

Source water protection areas include different kinds of landscapes but generally cover some type of water recharge zone near the source water extraction location. The karst landscape consideration would be just one example of potential source water protection areas; well head locations provide another, as well as surface streams and rivers used as drinking water sources by communities.

Karst

“Karst is a type of landscape. A karst landscape has sinkholes, sinking streams, caves, and springs. The term "karst" is derived from a Slavic word that means barren, stony ground. It is also the name of a region in Slovenia near the border with Italy that is well known for its sinkholes and springs. Geologists have adopted “karst” as the term for all such terrain, describing the whole landscape, not a single sinkhole or spring. A karst landscape most commonly develops on limestone but can develop on several other types of rocks, such as dolostone (magnesium carbonate or the mineral dolomite), gypsum, and salt. Precipitation infiltrates into the soil and flows into the subsurface from higher elevations and generally toward a stream at a lower elevation. Weak acids found naturally in rain and soil water slowly dissolve the tiny fractures in the soluble bedrock, enlarging the joints and bedding planes. Below is a schematic diagram of karst terrain in Kentucky.” (Kentucky Geologic Survey and University of Kentucky https://www.uky.edu/KGS/water/general/karst/karst_landscape.htm)

Figure 2. Generalized block diagram showing typical karst landscape in Kentucky (Kentucky Geologic Survey, 2018).



Data Sources Used

Cultivated Cropland Mask 2017

Note: The cultivated cropland map layer is now used only for regional and National assessments that require estimates of land area in cultivated cropland. The SVI-cc 2.0 SSURGO/gSSURGO map layer will no longer be “masked” for local use, generally at

1:24,000 and finer (larger) map scales. This avoids the potential exclusion of cultivated lands due to ever changing local land use patterns through time.

A custom CEAP cultivated cropland map layer was prepared by the NRCS Resources Assessment Division (RAD) staff for use in CEAP and various National Resources Inventory (NRI) projects. This custom cultivated cropland map layer is used to “mask” the underlying soil survey map so that only the cultivated cropland soils will appear in the resulting SVI-cc soil interpretation when mapped.

The CEAP cultivated cropland map layer attempts to include all lands that are in cultivation, plus those in managed hayland and pastureland, plus known Conservation Reserve Program (CRP) uses. The following discussion describes how the CEAP cultivated cropland map layer was prepared.

The USDA National Agricultural Statistics Service (NASS) publishes a landcover map called the Cultivated Layer that includes cultivated cropland for the Conterminous United States (CONUS) based on the previous 5 years of the annual NASS Cropland Data Layer (CDL).

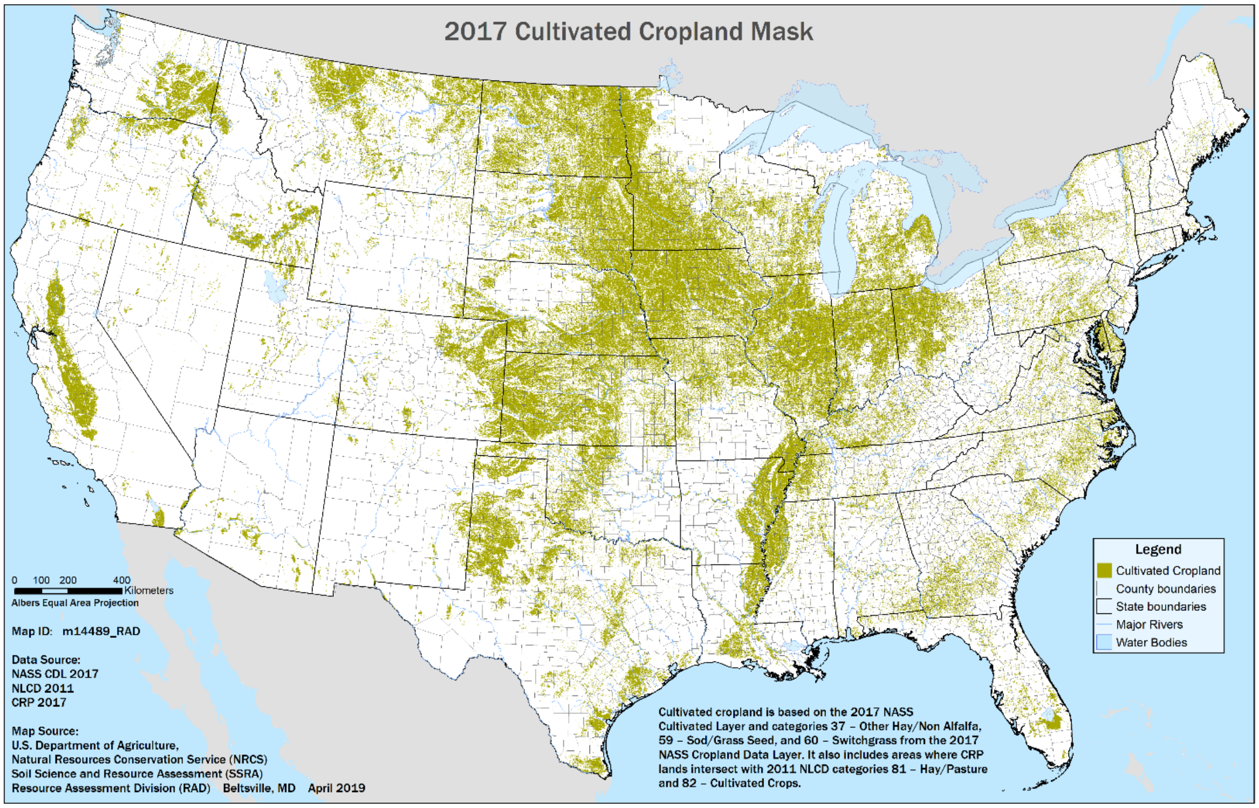
The current Cultivated Cropland layer was prepared using the 2017 Cultivated Layer, along with the 2017 NASS CDL, and the U.S. Geological Survey (USGS) National Land Cover Database (NLCD) from 2011 plus the USDA 2017 FSA Common Land Unit (CLU) where CRP and NLCD Hay/Pasture or Cultivated Crops were used to determine the cultivated cropland layer used with the SVI-cc 2.0 for regional and National assessments. See Table 2. The previous version of the Cultivated Cropland layer used sources from 2014 and the 2011 NLCD (SVI-cc 1.0).

This map layer will likely need to rely on the previous fiscal year data sources due to the time needed to compile and assure quality once source data are available. See Figure 3.

Table 2. Land use sources and land use categories used to prepare the custom CEAP cultivated cropland 2017 map layer used to mask soil survey map units at 1:24,000 and coarser (smaller) map scales.

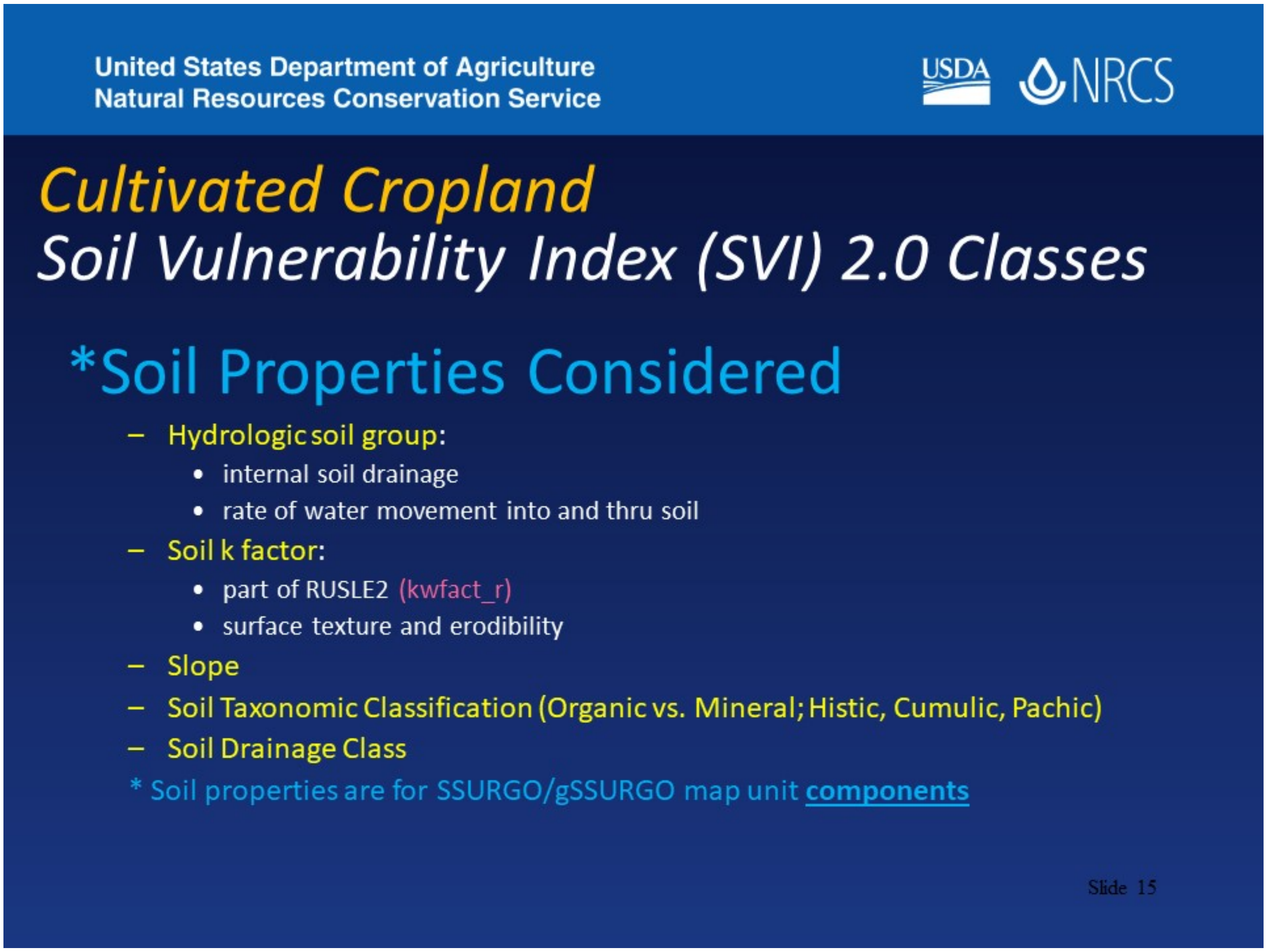
Source	Land Use Categories
2017 Cultivated Layer	2 – Cultivated
2017 Crop Data Layer	37 – Other Hay/Non Alfalfa 59 – Sod/Grass Seed 60 – Switchgrass
2017 Common Land Unit	CRP in NLCD Hay/Pasture/Cultivated
2011 NLCD	81 – Hay/Pasture 82 – Cultivated Crops

Figure 3. Cultivated Agricultural Land as estimated using the USDA NRCS RAD map layer "cultivated cropland mask."



Detailed Soil Survey Data (SSURGO/gSSURGO)

Figure 4. SVI-cc 2.0 relies on five soil parameters provided in USDA detailed soil survey source, SSURGO (components).



SVI-cc 2.0 classifications rely on five soil parameters that are provided by the SSURGO/gSSURGO data sources (Soil Survey Staff, 2017). These include: hydrologic soil group (profile), soil kw-factor (surface-whole soil), soil slope (surface), soil taxonomic classification (organic versus mineral – profile), and soil drainage class (profile) for individual soil map unit components. See Figure 4.

Major Land Resource Areas (MLRAs)

Major Land Resource Areas (MLRAs) as published in 2006 are provided as a reference map layer to assist scientists with a regional soil landscape review of SVI-cc as it extends in the soil landscape beyond State and basin/watershed boundaries.

The United States, Caribbean and Pacific Basin Major Land Resource Areas Geographic Database serves as the geospatial expression of the map products presented and described in Agricultural Handbook 296 (2006). Land resource categories historically used at State and national levels are land resource units, land resource areas, and land resource regions. Land resource units (LRUs) are the basic units from which major land resource areas (MLRAs) are determined. They are also the basic units for State land resource maps. LRUs are typically coextensive with State general soil map units, but some general soil map units are subdivided into LRUs because of significant geographic differences in soils, climate, water resources, or land use. LRUs generally are several thousand acres in size. A unit can be one continuous area or several separate areas that are near each other.

Major land resource areas are geographically associated land resource units. Land resource regions are a group of geographically associated major land resource areas. Identification of these large areas is important in statewide agricultural planning and has value in interstate, regional, and national planning.

12-Digit Hydrologic Units

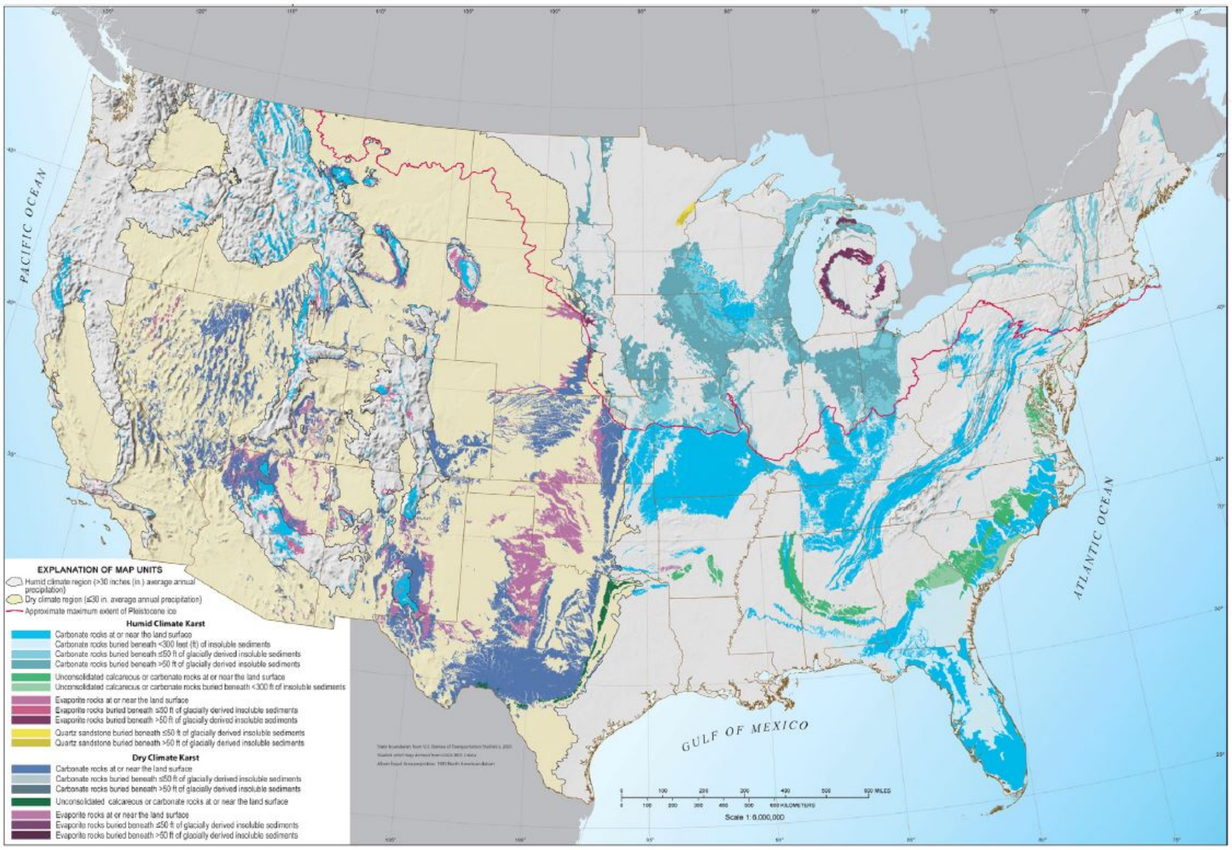
A July 9, 2010 edition of the Watershed Boundary Dataset (WBD) in 9.2 file geodata base format was used to identify 12-digit hydrologic units (12-digit HUCs) for the lower 48 States (conterminous U.S.).

This data set is a complete digital hydrologic unit boundary layer to the sub-watershed (12-digit) 6th level for the entire United States. This data set consists of geo-referenced digital data and associated attributes created in accordance with the "Federal Guidelines, Requirements, and Procedures for the National Watershed Boundary Dataset; Chapter 3 of Section A, Federal Standards, Book 11, Collection and Delineation of Spatial Data; Techniques and Methods 11-A3" (04/01/2009), https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/water/watersheds/dataset/. Polygons are attributed with hydrologic unit codes for 4th level sub-basins, 5th level watersheds, 6th level sub-watersheds, name, size, downstream hydrologic unit, type of watershed, non-contributing areas, and flow modification.

USGS Karst Geology

Some landscapes are at greater risk of contamination of soil and groundwater from spills or leakage from manure pits; nutrients, pathogens, and agrichemicals applied during cultivation; or industrial spills. Karst landscapes are among those landscapes at risk because they have more direct pathways between the surface and underground aquifers due to the high porosity of the underlying limestone bedrock. Karst aquifers supply drinking water to about 20-25% of the global population (Ford and Williams, 2007; Bandy et al., 2018). See Figure 5.

Figure 5. Karst and potential karst areas in soluble rocks in the contiguous United States (Weary and Doctor, 2014).



Information related to estimating presence or absence of carbonate karst geology in 12-digit hydrologic units (12-digit HUCs) was taken from Weary and Doctor, 2014.

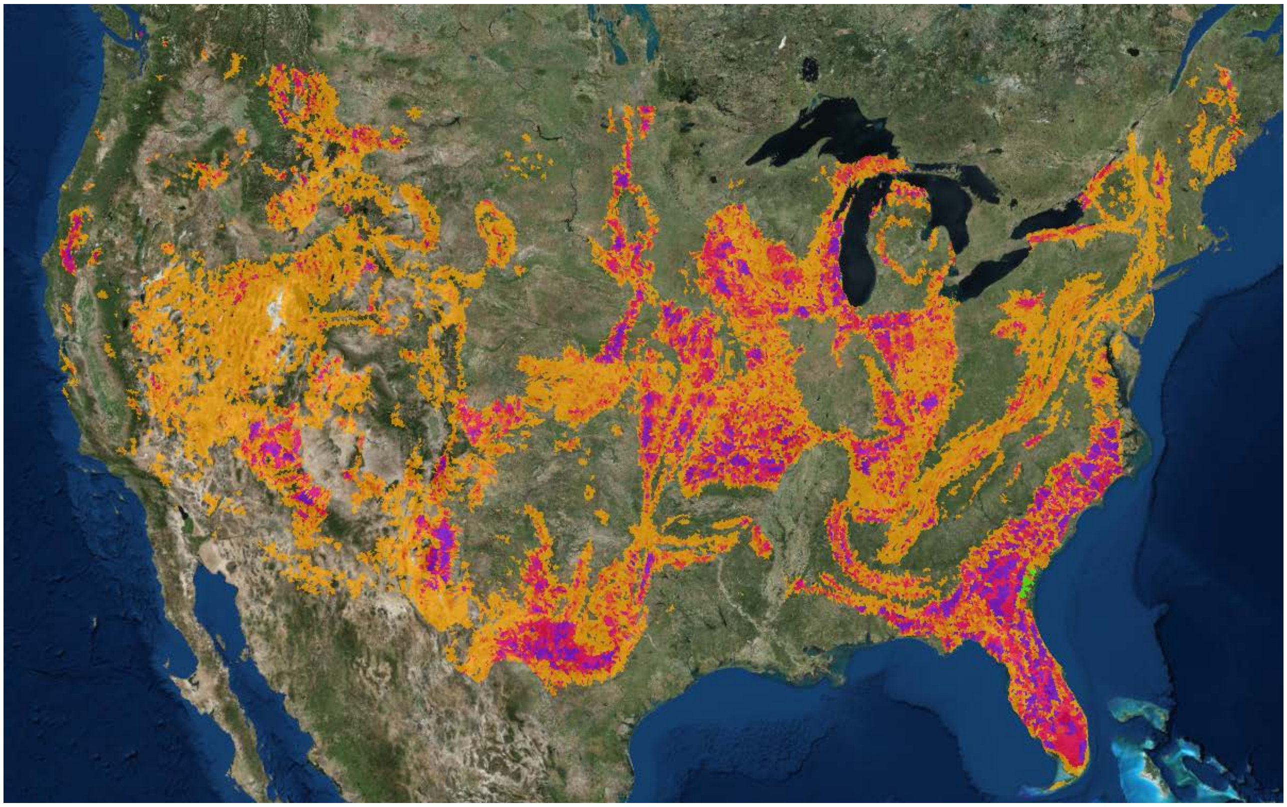
Specifically, the “Carbonate karst” map layer (Carbonate48) was used.

The “Carbonate karst” map layer (Carbonate48) data were compiled to delineate the distribution of karst and potential karst and pseudokarst areas of the United States. The data in this report are preliminary, and there is an expectation of upgrade in content, quality, and resolution in future versions. The data are released as an Open-File Report to expedite transfer of this information to various users across the United States. These data were compiled from multiple sources at various spatial resolutions. They are intended for use as guidance in determining the distribution of areas of potential karst at national, State, and regional scales. Because of differences in projection and scale of the various geologic datasets, spatial errors and location inconsistencies are particularly noticeable along some State boundaries, particularly coastlines and riparian borders. These data should not be used to define boundaries for site-specific applications or for legal purposes.

12-Digit Hydrologic Units with Presence of Carbonate Karst Geology

This dataset is called the carbonate karst “heat” map layer (huc12_carbkarst_heat) map layer and was developed by RAD staff in 2017 to identify those 12-digit HUCs that have the presence of carbonate karst geology to help screen for karst landforms, and karst soils. See Figure 6. An estimate of the percent area for carbonate karst geology in each HUC-12 is included and allows the intensity or “heat” of carbonate karst for each HUC-12 to be mapped. Higher percentages indicate greater likelihood of presence of carbonate karst soil landscapes. This information was developed to support the Conservation Effects Assessment Project (CEAP) Soil Vulnerability Index for Cultivated Cropland (SVI-cc) NRCS peer review and documentation in 2017.

Figure 6. Carbonate karst "heat map" for conterminous U.S. based on USGS karst mapping (Weary and Doctor, 2014) as expressed using 12-digit HUC. Pink and purple colors indicate larger karst landscape areas within 12-digit HUC watersheds, and golden colors indicate smaller karst landscape areas.



The carbonate karst heat map layer identifies those 12-digit HUCs that have the presence of carbonate karst geology that can be used to help screen for karst landforms and karst soils. An estimate of the percent area for carbonate karst geology in each HUC-12 is included. Weary and Doctor (2014) was used as the source for karst information in this study. Just the carbonate karst attributes were considered in this study.

A simple identity processing step between the HUC-12 and the carbonate karst attributes within the USGS karst sources was prepared and the addition of an attribute called "carbonate_karst" was populated with a 1 to indicate presence of karst. A second attribute was added called "percent_karst" that was computed by dividing the acreage of carbonate karst geology within each HUC-12 by the total area of the HUC-12 and multiplying by 100.

A few coastal and interior HUC-12 features yielded values that exceeded 100 percent and should be examined more closely in future studies. These data are only for evaluation and should be considered as such for the CEAP SVI-cc review project use. A standard Albers Equal Area projection was used for this calculation.

Citation is given as:

USDA NRCS Resource Assessment Division (RAD). 2017. 12-digit HUCs with Presence of Carbonate Karst in the Conterminous US version 1.0 for use in SVI-cc assessment and documentation based upon Weary and Doctor, 2014. USDA Natural Resources Conservation Service, Resource Assessment Division. Beltsville, MD.

Base Maps

ArcGIS™ base map sources provide county boundaries, photo base map imagery, landform, and other basic reference map materials for SVI-cc peer review. An NRCS county boundaries service may also be used.

Preparation of SVI-cc 2.0

The CEAP Soil Vulnerability for Cultivated Cropland Index (SVI-cc) is a "crisp set" soil survey interpretation (classifies vulnerability into sets or classes with non-fuzzy boundaries). This soil interpretation uses a set of rules generally designed to be applied to the cultivated cropland portion of detailed soil survey maps (SSURGO/gSSURGO). The Soil Vulnerability Index for Cultivated Cropland (SVI-cc) was developed using CEAP modeling results to rank a soil for vulnerability to loss of sediment, excess nutrients, or pathogens from cultivation. Such losses from cultivated fields can lead to reduction in surface and ground water quality in local and regional agroecosystems and diminish soil productivity. CEAP modeling relies on 18,691 detailed sample points in the U.S. (USDA, NRCS 2019).

CEAP modeling on cultivated cropland for 80th percentile sample points with R Factor (rainfall erosivity factor used in USLE; USDA, 1978) >=250 formed the basis for SVI-cc Surface Loss classes (runoff). This R factor region was selected to get the greatest impact of rainfall on cropland soils. These classes include sediment loss rates (T/ac/yr) as follows: 1-Low is <=2, 2-Moderate is >2-5, 3-Moderately High is >5-8, and 4-High is >8. The loss rates are from model estimates under a no-practice condition where all conservation practices controlling soil loss were removed. See Table 3.

*Table 3. CEAP modeling on cultivated cropland for *80th percentile sampling points with R Factor (rainfall erosivity factor used in USLE) >= 250 formed the basis for SVI-cc Surface Loss (formerly Runoff) class thresholds. Modeling estimates used assumptions that no conservation practices were used, and conventional tillage was used.*

*CEAP Sediment Loss Rate (Mg/ha/yr)	*CEAP Sediment Loss Rate (T/ac/yr)	SVI-cc Surface Loss Class
<=4.5	<=2	1 – Low
>4.5–11.2	>2-5	2 – Moderate
>11.2-17.9	>5-8	3 – Moderately High
>17.9	>8	4 – High

CEAP modeling on cultivated cropland for 80th percentile sample points with R Factor (rainfall erosivity factor used in USLE) ranges of 150-249 formed the basis for SVI-cc Subsurface Loss (drained) classes. This R factor region was selected since it had the highest rates of nitrogen application. Subsurface Loss (drained) was formerly the leaching, managed classification.

These classes include subsurface water loss rates (inches/yr) as follows: 1-Low is <=2, 2-Moderate is >2-5, 3-Moderately High is >5-8, and 4-High is >8 (Thompson, et al., 2019 Journal of Soil and Water Conservation manuscript in preparation).

See Table 4.

*Table 4. CEAP modeling on cultivated cropland for **80th percentile sample points with R Factor (rainfall erosivity factor used in USLE) ranges from 150-249 formed the basis for SVI-cc Subsurface Loss (drained) (formerly leaching, managed) classes. Modeling estimates used assumptions that no conservation practices were used, and conventional tillage was used.*

**CEAP Subsurface Water Loss Rate (mm/yr)	**CEAP Subsurface Water Loss Rate (in/yr)	SVI-cc Surface Loss Class
<=50	<=2	1 – Low
>50-125	>2-5	2 – Moderate
>125-200	>5-8	3 – Moderately High
>200	>8	4 – High

Based on the soil properties associated with the 80th percentile CEAP sample points described above in Tables 3 and 4, five basic soil parameters were chosen as predictors of these potential surface loss and subsurface loss classes. These soil parameters form the basis for the SVI-cc surface loss and SVI-cc subsurface loss rulesets. (USDA, NRCS 2011; 2018). For example, a threshold for a K-factor of <0.28 was chosen where 80% of those CEAP/NRI points met the modeled 2 T/ac/yr sediment surface loss criteria using a recursive partitioning statistical procedure.

The five soil parameters chosen include: hydrologic soil group, percent slope, K-factor (kwfactor is used because it accounts for rock fragment content) plus presence or absence of certain soil taxonomic classification terms. These soil classification terms include: Histosol, histic epipedon, cumulic epipedon, or pachic epipedon. SSURGO/gSSURGO components provided the source for these parameters in SVI-cc preparation.

There are three parts to the SVI-cc. These parts relate to 1) surface loss, 2) subsurface loss (drained), and 3) subsurface loss (undrained). Subsurface loss (drained) approximates vulnerability conditions when Ag land drainage systems are used in relatively level and/or wet landscapes. Subsurface loss (undrained) approximates vulnerability conditions when Ag land drainage systems are NOT used in relatively level and/or wet landscapes. Each part shares five classes of ranked soil vulnerability. These classes are: 0 – Unclassified (due to insufficient data), 1 - Low, 2 - Moderate, 3 - Moderately High, and 4 – High (see Figure 7).

Figure 7. Five Classes of Soil Vulnerability to loss of sediment or excess nutrients or pathogens under cultivation.

The Low vulnerability class indicates the least hazard to sediment, excess nutrient, or pathogen loss and the High vulnerability class indicates the greatest hazard. SVI-cc rulesets for these classes will be described next in this user guide.

Rulesets

Three rulesets with soil parameter thresholds were used to create the SVI-cc for Surface Loss, SVI-cc Subsurface Loss (drained), and SVI-cc Subsurface Loss (undrained) classifications. These rulesets were supplied by the CEAP research staff and implemented by NSSC staff through use of ArcGIS™ desktop scripted tools.

Each ruleset used soil parameters that relied on surface horizon or component representative attributes for SSURGO map units. Each SSURGO component was evaluated and given an SVI-cc classification for each soil map unit in the Conterminous U.S. (FY2018 gSSURGO/SSURGO was used in this example). Resulting SVI-cc classifications using all components were included in the descriptions and mapping. The SVI-cc information in the SVI-cc Web Application is done using the map unit majority SVI-cc classification (aka dominant condition or DCD). At map scales greater (coarser) than 1:24,000, SVI-cc map themes were masked using a custom cropland layer before mapping. Details of the SVI-cc rulesets are discussed next.

SVI-cc 2.0 Surface Loss

Figure 8. Rules for four classes of SVI-cc 2.0 Surface Loss Vulnerability. Class 1 indicates low (dark green), Class 2 indicates moderate (light green), Class 3 indicates moderately high (orange), and Class 4 indicates high (red) vulnerabilities.

$SVI_{cc\text{-}surface\ loss}$

Histosol or Histic Epipedon or Cumulic or Pachic Classifications	Hydrologic Soil Group (hydgrp)	% Slope (slope_r)	Kfactor (kwfact_r)	Cultivated Lands Surface Loss Vulnerability Class
Yes	All	All	All	1 - Low
No	LIKE 'A%'	All	All	1 - Low
No	LIKE 'B%'	<4	All	1 - Low
No	LIKE 'C%'	<2	All	1 - Low
No	LIKE 'D%'	<2	<0.28	1 - Low
No	LIKE 'B%'	4 to 6	<0.32	2 - Moderate
No	LIKE 'C%'	2 to 6	<0.28	2 - Moderate
No	LIKE 'D%'	<2	>=0.28	2 - Moderate
No	LIKE 'B%'	4 to 6	>=0.32	3 - Moderately High
No	LIKE 'C%'	2 to 6	>=0.28	3 - Moderately High
No	LIKE 'D%'	2 to 4	All	3 - Moderately High
No	LIKE 'B%'	>6	All	4 - High
No	LIKE 'C%'	>6	All	4- High
No	LIKE 'D%'	>4	All	4 - High

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SVI-cc surface loss parameters and rules are provided in Figure 8: hydrologic soil group, percent slope, K-factor (kwfactor is used because it accounts for rock fragment content) plus presence or absence of certain soil taxonomic classification terms. These soil classification terms include: Histosol, histic epipedon, cumulic epipedon, or pachic epipedon. When these terms are present, the SVI-cc surface loss 2.0 is given a 1-Low class, regardless of the hydrologic group, slope, or kwfactor.

The table in Figure 8 is organized to show the thresholds of each soil parameter for each of the four SVI-cc Surface Loss classes. The Undefined or 0 class is used when insufficient information is available to perform the SVI-cc Surface Loss classification and is therefore not included in Figure 8. Parameters are described in the column headers, and each row indicates the threshold that defines the vulnerability class.

Color is used to organize the table with the least vulnerable (dark green) classes near the top and the most vulnerable (red) classes near the bottom. Soil parameter thresholds are grouped by resulting SVI-cc class.

Each color corresponds to the SVI-cc class colors that are used in GIS mapping and pie charting. Class 1 indicates a Low Vulnerability for Surface Loss and is shown in dark green, Class 2 indicates a Moderate Vulnerability for Surface Loss and is shown in light green, Class 3 indicates a Moderately High Vulnerability for Surface Loss and is shown in orange, and Class 4 indicates a High Vulnerability for Surface Loss and is shown in red. Note that all hydrologic soil groups can be class 1 (Low), whereas only hydrologic soil groups like B, C, or D can be class 2, 3, or 4 (Moderate, Moderately High, and High) depending on slope or K-factor (kwfact_r). Also note, Histosols or soils with histic epipedons or that have cumulic or pachic classifications are class 1 (Low) regardless of hydrologic soil group, slope, or K-factor.

SVI-cc 2.0 Subsurface Loss (Drained)

Figure 9. Rules for SVI-cc 2.0 Subsurface Loss (drained) assume agricultural land drainage practices are used on relatively level and wet soils.

SVI cc-subsurface loss (drained)

Histosol OR Histic Epipedon OR Cumulic OR Pachic	Hydrologic Soil Group (hydgrp)	% Slope (slope_r)	Kfactor (kwfact_r)	Subsurface Loss Vulnerability Class (slopes >3% and drainage classes better than sw poorly)	Subsurface Loss (drained) Vulnerability Class (<=3% slope, v. poor, poor, sw poor drainage classes)
No	LIKE 'D%'	All	All	1 - Low	3 - Moderately High
No	LIKE 'C%'	All	All	2 - Moderate	4 - High
No	LIKE 'B%'	All	>= 0.24	2 - Moderate	4 - High
No	LIKE 'B%'	>=3 AND <= 12	<0.24	3 - Moderately High	
No	LIKE 'A%'	>12	All	3 - Moderately High	
No	LIKE 'B%'	<3	<0.24	4 - High	4 - High
No	LIKE 'A%'	<=12	All	4 - High	4 - High
Yes	All	All	All	4 - High	4 - High

*
Drained assumes relatively level and wet soils ARE drained (tile or ditch)
Undrained assumes relatively level and wet soils ARE NOT drained (tile or ditch)

SVI-cc Subsurface Loss (drained) rules are provided in Figure 9. SVI-cc Subsurface Loss (drained) uses five soil parameters: soil taxonomic classification, hydrologic soil group, whole soil K-factor (kwfact_r includes surface rock fragment content), percent slope, and soil drainage class.

The SVI-cc Subsurface Loss (drained) rating assumes that soils that are relatively level and have poor drainage are drained (tile or ditch). Relatively level is indicated by slopes <= 3 percent, and poor drainage is indicated by soil drainage classes of somewhat poorly drained, poorly drained, and very poorly drained. This subset of soils is put into Class 4 (High Vulnerability) with the exception of all soils like hydrologic group "D%" which are put into Class 3 (Moderately High Vulnerability).

For all other soils (those that ARE NOT relatively level with poor drainage), only hydrologic soil groups like D can be class 1 (Low), whereas hydrologic soil groups like B or C can be class 2 (moderate). Soils with hydrologic soil groups like A or B can be class 3 (Moderately high). Those soils with hydrologic soil groups like A or B or that qualify as Histosols or soils with histic epipedons or that have cumulic or pachic classifications are class 4 (High) regardless of hydrologic soil group, slope or K-factor.

The table in Figure 9 is organized showing the thresholds of each soil parameter for each of the four SVI-cc Subsurface Loss classes. The Undefined or 0 class is used when insufficient information is available to perform the SVI-cc Subsurface Loss classification and is therefore not included in Figure 9. Parameters are described in the column headers, and each row indicates the threshold that defines the vulnerability class.

Color is used to organize the table with the least vulnerable (dark green) classes near the top and the most vulnerable (red) classes near the bottom. Soil parameter thresholds are grouped by resulting SVI-cc class.

Each color corresponds to the SVI-cc class colors that are used in GIS mapping and pie charting. Class 1 indicates a Low Vulnerability for Subsurface Loss (drained) and is shown in dark green, Class 2 indicates a Moderate Vulnerability for Subsurface Loss (drained) and is shown in light green, Class 3 indicates a Moderately High Vulnerability for Subsurface Loss (drained) and is shown in orange, and Class 4 indicates a High Vulnerability for Subsurface Loss (drained) and is shown in red.

SVI-cc 2.0 Subsurface Loss (Undrained)

*Figure 10. Rules for SVI-cc Subsurface Loss (undrained) assume agricultural land drainage practices ARE NOT used on relatively level and wet soils. **NOTE:** This classification is reserved for selected National and Regional applications as well as special local studies.*

SVI cc-subsurface loss (undrained)

Histosol OR Histic Epipedon OR Cumulic OR Pachic	Hydrologic Soil Group (hydgrp)	% Slope (slope_r)	Kfactor (kwfact_r)	Subsurface Loss (undrained) Vulnerability Class
No	LIKE 'D%'	All	All	1 - Low
No	LIKE 'C%'	All	All	2 - Moderate
No	LIKE 'B%'	All	>= 0.24	2 - Moderate
No	LIKE 'B%'	>=3 AND <= 12	<0.24	3 - Moderately High
No	LIKE 'A%'	>12	All	3 - Moderately High
No	LIKE 'B%'	<3	<0.24	4 - High
No	LIKE 'A%'	<=12	All	4 - High
Yes	All	All	All	4 - High

* **Drained** assumes relatively level and wet soils ARE drained (tile or ditch)
Undrained assumes relatively level and wet soils ARE NOT drained (tile or ditch)

SVI-cc Subsurface Loss (undrained) rules are provided in Figure 10. SVI-cc Subsurface Loss (undrained) uses five soil parameters: soil taxonomic classification, hydrologic soil group, whole soil K-factor (kwfact_r includes surface rock fragment content), percent slope, and soil drainage class. NOTE: SVI-cc Subsurface Loss (undrained) classification is reserved for selected National and Regional applications as well as special local studies.

The SVI-cc Subsurface Loss (undrained) rating assumes that soils that are relatively level and have poor drainage ARE NOT drained (tile or ditch). Relatively level is indicated by slopes <= 3 percent, and poor drainage is indicated by soil drainage classes of somewhat poorly drained, poorly drained, and very poorly drained.

Only soils with hydrologic soil groups like D can be class 1 (Low) in SVI-cc Subsurface Loss (undrained), whereas hydrologic soil groups like B or C can be class 2 (Moderate).

Soils with hydrologic soil groups like A or B can be class 3 (Moderately High) for SVI-cc Subsurface Loss (undrained). Those soils with hydrologic soil groups like A or B or that qualify as Histosols or soils with histic epipedons or that have cumulic or pachic classifications are class 4 (High) for SVI-cc Subsurface Loss (undrained) regardless of hydrologic soil group, slope, or K-factor.

The table in Figure 10 is organized showing the thresholds of each soil parameter for each of the four SVI-cc Subsurface Loss (undrained) classes. The Undefined or 0 class is used when insufficient information is available to perform the SVI-cc Subsurface Loss classification and is therefore not included in Figure 10. Parameters are described in the column headers, and each row indicates the threshold that defines the vulnerability class.

Color is used to organize the table with the least vulnerable (dark green) classes near the top and the most vulnerable (red) classes near the bottom. Soil parameter thresholds are grouped by resulting SVI-cc class.

Each color corresponds to the SVI-cc class colors that are used in GIS mapping and pie charting. Class 1 indicates a Low Vulnerability for Subsurface Loss (undrained) and is shown in dark green, Class 2 indicates a Moderate Vulnerability for Subsurface Loss (undrained) and is shown in light green, Class 3 indicates a Moderately High Vulnerability for Subsurface Loss (undrained) and is shown in orange, and Class 4 indicates a High Vulnerability for Subsurface Loss (undrained) and is shown in red.

SVI-cc 2.0 GIS Processing Steps

There are six basic SVI-cc GIS processing steps, each described briefly below. A more detailed explanation can be found in specific toolbox documentation and resulting dataset metadata. Example calculations and figures in this document use FY2018 gSSURGO. These tools can be used with current published soil survey data. Step 2 is only used for National and Regional assessments performed to support the NRI and CEAP programs that require a reasonable estimate of cultivated cropland. The six steps are:

1. The SVI-cc Toolbox (11/05/2018 edition of ArcGIS™ desktop toolbox prepared by NSSC) and FY2018 gSSURGO/SSURGO File Geodatabase were used to create 6 tables: SVI_Horizons, SVI_Components, SVI_DCD (provides dominant or majority condition class for map unit), SVI_Chart (includes Surface_Loss, Subsurface_Loss_drained, and Subsurface_Loss_undrained) for U.S. Soil components. These tools use SVI rulesets for cultivated cropland as determined by the CEAP researchers and outlined in the previous section.
2. FY2018 gSSURGO (CONUS) file geodatabase was masked using a RAD custom 2017 Cultivated Cropland mask as described in Data Sources Used.
3. SVI_DCD table was joined or related to unmasked (or masked for national and regional assessments) MapunitRaster_CONUS_30m and used to map the

majority or dominant condition SVI-cc class for SVI-cc surface loss and subsurface loss rulesets.

4. SVI_Components and SVI_Chart tables were used to prepare supporting map unit component SVI breakdowns (narrative and pie charts) using SAS scripts prepared by RAD staff.
5. Mapping of SVI-cc [surface loss and subsurface loss (drained or undrained)] themes were done using standard legend colors based upon the dominant condition or map unit majority SVI-cc class.
6. Supporting base map layers and other reference map layers were provided in the CEAP FY2018 SVI Web Application developed by RAD and NCGE (see Appendix A and B for guidance for access and tutorial).

SVI 2.0 Tools and Sample Classifications

SVI-cc 2.0 Toolbox in ArcGIS™ Desktop

Using the 11/05/2018 edition of the SVI–cc Toolbox in ArcGIS™ Desktop, six tables were created: SVI_Horizons, SVI_Components, SVI_DCD, SVIChart_Surface_Loss, SVIChart_Subsurface_Loss_drained, and SVIChart_Surface_Loss _undrained. This tool is used by RAD or NSSC Staff to prepare the SVI-cc mapping attributes using gSSURGO/SSURGO sources.

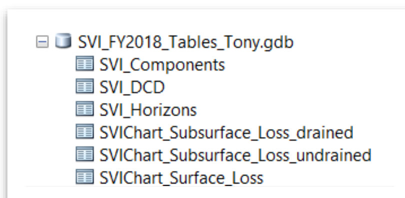
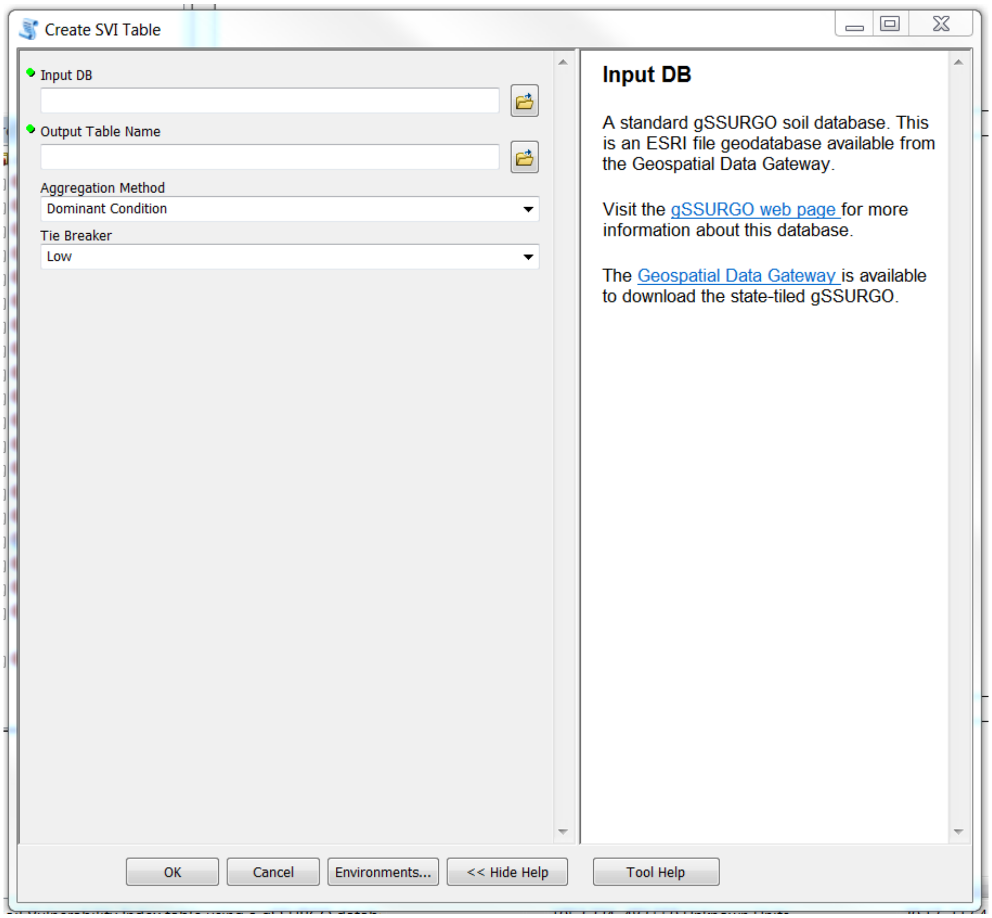


Figure 11. The 6 SVI-cc tables created by the SVI-cc Toolbox in ArcGIS Desktop: SVI_Horizons, SVI_Components, SVI_DCD, SVIChart_Subsurface_Loss_drained, SVIChart_Subsurface_Loss_undrained, and SVIChart_Surface_Loss.

Figure 12. Screenshot of SVI-cc 2.0 ArcGIS™ Toolbox used to create SVI-cc tables using local gSSURGO File Geodatabase datasets.



SVI-cc 2.0 Web Application

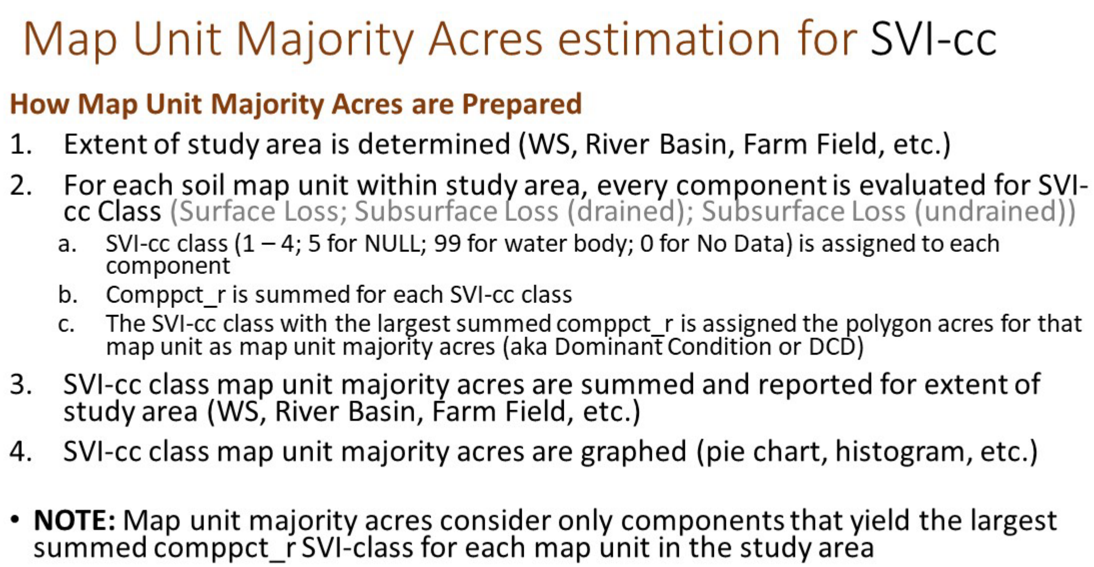
The RAD Staff and NCGE have prepared an interactive SVI-cc 2.0 Web Application in Geoportal that provides interactive access to three SVI-cc map layers derived from the FY2018 gSSURGO/SSURGO sources. See Appendices A and B for guidance to access the map layers and for a tutorial.

Methods for Estimating SVI-cc Class Acreages

The key use for the SVI-cc is to screen study areas (basins, watersheds, farmsteads, fields, etc.) by assessing the land area or acreage occupied by soils grouped into individual SVI-cc classes. Those study areas with greater high risk acreages are considered in greater need of conservation treatment. The traditional method of estimating acreage for SVI-cc classes that is used by NRCS for ranking study areas is the Map Unit Majority or Dominant Condition (DCD) method. Figure 13 describes the process of preparing acreage estimates using this method.

The method used to prepare the soil map unit SVI-cc class pie charts used in the FY2018

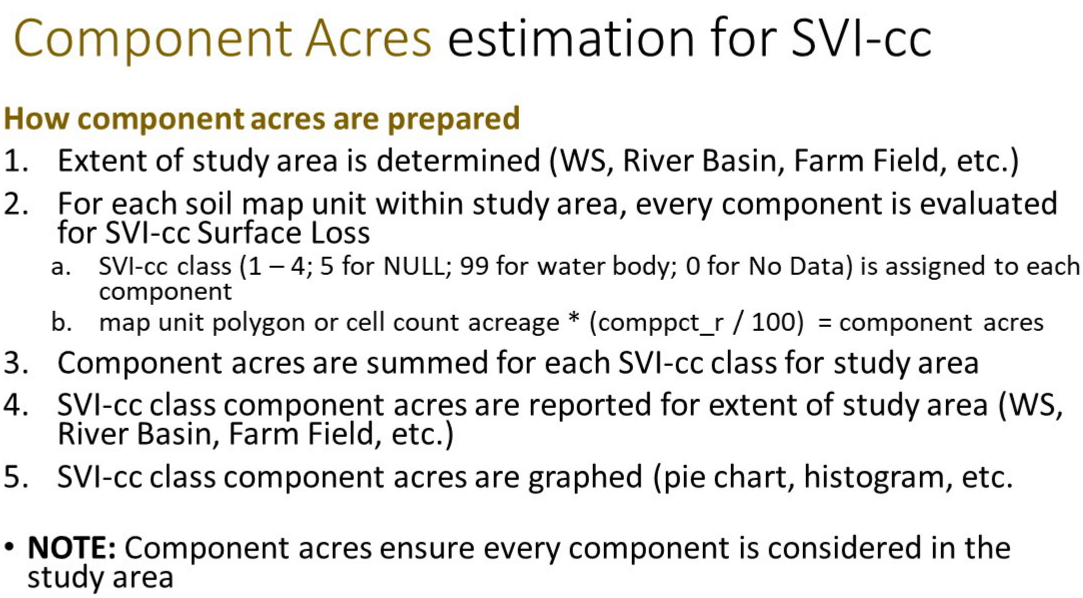
Figure 13. Process steps for Map Unit Majority or Dominant Condition (DCD) method used in SVI-cc Class mapping.



SVI-cc 2.0 Web Application relies on all soil map unit components and is called the "component method." In the component method, the comppct_r for each SSURGO/gSSURGO map unit is summarized by SVI-cc class and presented in pie-chart format. The component method includes the contribution of all map unit components with enough data to produce an SVI-cc classification. If a map unit produces a NULL or No Data fraction this is also included in the pie chart. See Figure 14.

An advantage of the component acreage method is that all soils are considered in the resource assessment process, rather just those soils that make up the majority condition soil vulnerability for a given soil map unit. This alerts the planner about possible contrasting soil vulnerability conditions that may exist within a planning unit.

Figure 14. Description of the component method for computing SVI-cc acreage.



Example Table Calculations and Summary

To help explain the SVI-cc classification, a few example map units were chosen to be classified. Each example map unit will be examined according to the original input soil parameters and the resulting component level SVI-cc classifications.

Keep in mind that SVI-cc classification is performed on an individual soil component basis, and then the majority condition (sometimes called “dominant condition”) or classification is generally mapped. This process can sometimes mask contrasting soil classifications for SVI-cc. By examining each individual table, you will gain a better insight into the complexity of the given map unit regarding SVI-cc classification and potential soil performance in the landscape under cultivation regarding potential loss of sediment and excess nutrients or pathogens.

SVI_Horizons

All SVI-cc needed SSURGO/gSSURGO input parameters that are derived from the horizon table are collected in the SVI-Horizons table. This table provides the source for the epipedon or surface horizon information as given in the SVI-components table. This table is not used in mapping but is preserved for reference in the SVI-cc model evaluation.

SVI_Components

The SVI-cc classification process for a SSURGO/gSSURGO map unit begins with the individual soil components in the map unit. Once the component level SVI-cc is determined for each of the three resource concerns: Surface Loss, Subsurface Loss (drained), and Subsurface Loss (undrained), then component percentages are used to determine the majority or dominant condition SVI-rating for mapping (found in the SVI_DCD table) for each resource concern.

Several example SSURGO/gSSURGO map units (FY2018 source) were selected to describe the SVI-cc component classification process. These map units were selected to illustrate the range of soil properties and map unit complexity and the resulting SVI-cc classifications that can be found in cultivated cropland across the conterminous U.S.

The following map units were chosen as examples of the SVI_Component table: Spa or Sparenberg from Texas (figure 15); Cd or Catden from New York (figure 16); HaB or Hagerstown from PA (figure 17); Gm or Gilford from Indiana (figure 18); C740B or Temvik from North Dakota (figure 19); VaA or Orangeburg from South Carolina (figure 20); and 43 or Terra Ceia from Florida (figure 21).

The SVI-cc resource concern ratings are provided at the bottom of each figure with input parameters shown in the left hand column with component values for each input given in rows within each component column (Component 1, Component 2, etc.). The map units in these figures will be contrasted with a second set of figures in the SVI_DCD section. The SVI_DCD table example figures illustrate the soil map unit majority or dominant condition SVI-cc classification rating used for mapping.

Both figures use color to identify the vulnerability rating class.

Figure 15. Texas map unit SpA soil component inputs and resulting SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 22.

Map Unit Name: Sparenberg clay, 0 to 1 percent slopes, occasionally ponded Map Unit Key: 379010 Map Unit Symbol: SpA				
Attribute	**Component 1**	**Component 2**	**Component 3**	**Component 4**
Component Name	Sparenberg	Ranco	Chapel	Seagraves
Component Percent	80	10	5	5
Percent Slope (rv)	0.3	0.3	0.5	0.5
Taxonomic Order	Vertisols	Vertisols	Vertisols	Alfisols
Taxonomic Subgroup	Udic Haplusterts	Ustic Epiaquerts	Udic Calciusterts	Typic Haplustalfs
Hydrologic Group	D	D	D	B
Surface Kwfactor (whole soil)	0.2	0.17	0.17	0.32
Drainage Class	Somewhat poorly drained	Poorly drained	Somewhat poorly drained	Moderately well drained
SVI-cc Surface Loss	1 - Low	1 - Low	1 - Low	1 - Low
SVI-cc Subsurface Loss (Drained)	3 - Moderately High	3 - Moderately High	3 - Moderately High	2 - Moderate
SVI-cc Subsurface Loss (Undrained)	1 - Low	1 - Low	1 - Low	2 - Moderate

Figure 16. New York map unit Cd (Catden) soil component inputs and resulting SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 23.

Map Unit Name: Catden muck, drained, 0 to 2 percent slopes Map Unit Key: 293903 Map Unit Symbol: Cd					
Attribute	**Component 1**	**Component 2**	**Component 3**	**Component 4**	**Component 5**
Component Name	Catden	Wawayanda	Muskego	Pinnebog	Natchaug
Component Percent	80	5	5	5	5
Percent Slope (rv)	0	1	1	1	0
Taxonomic Order	Histosols	Histosols	Histosols	Histosols	Histosols
Taxonomic Subgroup	Typic Haplosaprists	Limnic Haplosaprists	Limnic Haplosaprists	Hemic Haplosaprists	Terric Haplosaprists
Hydrologic Group	B/D	C/D	B/D	B/D	B/D
Surface Kwfactor (whole soil)					
Drainage Class	Very poorly drained	Very poorly drained	Very poorly drained	Very poorly drained	Very poorly drained
SVI-cc Surface Loss	1 - Low	1 - Low	1 - Low	1 - Low	1 - Low
SVI-cc Subsurface Loss (Drained)	4 - High	4 - High	4 - High	4 - High	4 - High
SVI-cc Subsurface Loss (Undrained)	4 - High	4 - High	4 - High	4 - High	4 - High

The Catden map unit is 100 percent composed of organic soils (Histosols). The presence of a Histosol triggers SVI-cc rules that over-ride all other soil parameters to classify the SVI-cc Surface Loss = 1 – Low and SVI-cc Subsurface Loss (drained or undrained) = 4 – High for that component.

Figure 17. Pennsylvania map unit HaB (Hagerstown) soil component inputs and resulting SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 24.

Map Unit Name: Hagerstown silt loam, 3 to 8 percent slopes
Map Unit Key: 538991
Map Unit Symbol: HaB

Attribute	Component 1	Component 2	Component 3	Component 4	Component 5
Component Name	Hagerstown	Carbo	Opequon	Funkstown	Timberville
Component Percent	85	5	5	3	2
Percent Slope (rv)	5	5	6	1	4
Taxonomic Order	Alfisols	Alfisols	Alfisols	Alfisols	Ultisols
Taxonomic Subgroup	Typic Hapludalfs	Typic Hapludalfs	Lithic Hapludalfs	Oxyaquic Hapludalfs	Typic Hapludults
Hydrologic Group	B	D	D	B	B
Surface Kwfactor (whole soil)	0.37	0.43	0.28	0.37	0.37
Drainage Class	Well drained	Well drained	Well drained	Moderately well drained	Well drained
SVI-cc Surface Loss	3 - Moderately High	4 - High	4 - High	1 - Low	3 - Moderately High
SVI-cc Subsurface Loss (Drained)	2 - Moderate	1 - Low	1 - Low	2 - Moderate	2 - Moderate
SVI-cc Subsurface Loss (Undrained)	2 - Moderate	1 - Low	1 - Low	2 - Moderate	2 - Moderate

The HaB map unit represents a group of residual limestone soils commonly found in karst landscapes. This map unit would be a candidate for further adjustment to SVI-cc rulesets for the presence of karst within the local watershed. The presence of karst presents increased risk for loss of excess nutrients and biological hazards from Surface Loss or leaching into groundwater drinking water supplies.

Figure 18. Indiana map unit Gm (Gilford) soil component inputs and resulting SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 25.

Map Unit Name: Gilford loam
Map Unit Key: 272461
Map Unit Symbol: Gm

Attribute	Component 1
Component Name	Gilford
Component Percent	100
Percent Slope (rv)	1
Taxonomic Order	Mollisols
Taxonomic Subgroup	Typic Endoaquolls
Hydrologic Group	A/D
Surface Kwfactor (whole soil)	0.2
Drainage Class	Poorly drained
SVI-cc Surface Loss	1 - Low
SVI-cc Subsurface Loss (Drained)	4 - High
SVI-cc Subsurface Loss (Undrained)	4 - High

Figure 19. North Dakota map unit C740B (Temvik) soil component inputs and resulting SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 26.

Map Unit Name: Temvik silt loam, 3 to 6 percent slopes
Map Unit Key: 2564336
Map Unit Symbol: C740B

Attribute	Component 1	Component 2	Component 3	Component 4	Component 5	Component 6
Component Name	Temvik	Wilton	Williams	Linton	Mandan	Tonka
Component Percent	85	5	4	3	2	1
Percent Slope (rv)	4	4	4	4	4	0.5
Taxonomic Order	Mollisols	Mollisols	Mollisols	Mollisols	Mollisols	Mollisols
Taxonomic Subgroup	Typic Haplustolls	Pachic Haplustolls	Typic Argiustolls	Typic Haplustolls	Pachic Haplustolls	Argiaquic Argialbolls
Hydrologic Group	B	B	B	B	B	C/D
Surface Kwfactor (whole soil)	0.32	0.32	0.24	0.37	0.37	0.32
Drainage Class	Well drained	Well drained	Well drained	Well drained	Well drained	Poorly drained
SVI-cc Surface Loss	3 - Moderately High	1 - Low	2 - Moderate	3 - Moderately High	1 - Low	1 - Low
SVI-cc Subsurface Loss (Drained)	2 - Moderate	4 - High	2 - Moderate	2 - Moderate	4 - High	4 - High
SVI-cc Subsurface Loss (Undrained)	2 - Moderate	4 - High	2 - Moderate	2 - Moderate	4 - High	2 - Moderate

Figure 20. South Carolina map unit VaA (Orangeburg) soil component inputs and resulting SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 27.

Map Unit Name: Orangeburg loamy sand, 0 to 2 percent
Map Unit Key: 1151499
Map Unit Symbol: VaA

Attribute	Component 1
Component Name	Orangeburg
Component Percent	90
Percent Slope (rv)	1
Taxonomic Order	Ultisols
Taxonomic Subgroup	Typic Kandiudults
Hydrologic Group	B
Surface Kwfactor (whole soil)	0.15
Drainage Class	Well drained
SVI-cc Surface Loss	1 - Low
SVI-cc Subsurface Loss (Drained)	4 - High
SVI-cc Subsurface Loss (Undrained)	4 - High

This VaA map unit from South Carolina is 90 percent Orangeburg soils and 10 percent NULL (component is not identified within the database). NULL conditions do not produce an SVI-cc classification.

Figure 21. Florida map unit 43 (Terra Ceia) soil component inputs and resulting SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 28.

Map Unit Name: Terra Ceia muck, drained, frequently ponded, 0 to 1 percent slopes
Map Unit Key: 1407302
Map Unit Symbol: 43

Attribute	Component 1	Component 2	Component 3	Component 4	Component 5
Component Name	Terra Ceia	Torry	Okeechobee	Pahokee	Okeelanta
Component Percent	84	4	4	4	4
Percent Slope (rv)	0.5	0.5	0.5	0.5	0.5
Taxonomic Order	Histosols	Histosols	Histosols	Histosols	Histosols
Taxonomic Subgroup	Typic Haplosaprists	Typic Haplosaprists	Hemic Haplosaprists	Lithic Haplosaprists	Terric Haplosaprists
Hydrologic Group	A/D	A/D	A/D	A/D	A/D
Surface Kwfactor (whole soil)					
Drainage Class	Very poorly drained	Very poorly drained	Very poorly drained	Very poorly drained	Very poorly drained
SVI-cc Surface Loss	1 - Low	1 - Low	1 - Low	1 - Low	1 - Low
SVI-cc Subsurface Loss (Drained)	4 - High	4 - High	4 - High	4 - High	4 - High
SVI-cc Subsurface Loss (Undrained)	4 - High	4 - High	4 - High	4 - High	4 - High

The Terra Ceia map unit is 100 percent organic soils (Histosols). The presence of a Histosol triggers SVI-cc rules that over-ride all other soil parameters to classify the SVI-cc Surface Loss = 1 – Low and SVI-cc Subsurface Loss (drained or undrained) = 4 – High for that component.

SVI_DCD

The SVI_DCD table contains the map unit majority or dominant condition SVI-cc classifications that are used in GIS or Web Application mapping. As previously mentioned, although the mapped SVI-cc classification generally represents a majority condition, it can mask underlying SVI-cc component classifications with greater or lesser risks. The same SSURGO/gSSURGO map units described in figures 15 through 21 are used here to illustrate how the SVI_DCD table values are determined based on all components.

Each figure represents one of the map units discussed in the SVI_Component section and is organized with columns (left to right) for component, component percent, SVI-cc classification, and the majority condition SVI-cc classification with summed component percent in parentheses. Color is used to denote the SVI-cc classification for each component and the resulting majority condition used for mapping with the summed map unit component percentage in parentheses.

Figure 22. Texas map unit SpA map unit majority or dominant condition ratings used for mapping SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 15.

Component	Component %	SVI-cc Surface Loss	Majority Condition for Mapping with Summed (%)
Sparenberg	80	1 - Low	1 - Low (100)
Ranco	10	1 - Low	
Chapel	5	1 - Low	
Seagraves	5	1 - Low	
NULL	0		
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Drained)**	**Majority Condition for Mapping with Summed (%)**
Sparenberg	80	3 - Moderately High	3 - Moderately High (95)
Ranco	10	3 - Moderately High	
Chapel	5	3 - Moderately High	
Seagraves	5	2 - Moderate	
NULL	0		
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Undrained)**	**Majority Condition for Mapping with Summed (%)**
Sparenberg	80	1 - Low	1 - Low (95)
Ranco	10	1 - Low	
Chapel	5	1 - Low	
Seagraves	5	2 - Moderate	
NULL	0		
Total	100		

The SpA map unit majority condition is 100% Low for Surface Loss, 95% Moderately High for Subsurface Loss (drained), and 95% Low for Subsurface Loss (undrained).

Figure 23. New York map unit Cd (Catden) map unit majority or dominant condition ratings used for mapping SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 16.

Component	Component %	SVI-cc Surface Loss	Majority Condition for Mapping with Summed (%)
Catden	80	1 - Low	1 - Low (100)
Wawayanda	5	1 - Low	
Muskego	5	1 - Low	
Pinnebog	5	1 - Low	
Natchaug	5	1 - Low	
NULL	0	1 - Low	
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Drained)**	**Majority Condition for Mapping with Summed (%)**
Catden	80	4 - High	4 - High (100)
Wawayanda	5	4 - High	
Muskego	5	4 - High	
Pinnebog	5	4 - High	
Natchaug	5	4 - High	
NULL	0	4 - High	
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Undrained)**	**Majority Condition for Mapping with Summed (%)**
Catden	80	4 - High	4 - High (100)
Wawayanda	5	4 - High	
Muskego	5	4 - High	
Pinnebog	5	4 - High	
Natchaug	5	4 - High	
NULL	0	4 - High	
Total	100		

The Catden map unit is 100 percent organic soils (Histosols). The presence of a Histosol triggers SVI-cc rules that over-ride all other soil parameters to classify the SVI-cc Surface Loss = 1 – Low and SVI-cc Subsurface Loss (drained or undrained) = 4 – High for that component.

Figure 24. Pennsylvania map unit HaB (Hagerstown) map unit majority or dominant condition ratings used for mapping SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 17.

Component	Component %	SVI-cc Surface Loss	Majority Condition for Mapping with Summed (%)
Hagerstown	**85**	3 - Moderately High	3 - Moderately High (87)
Carbo	5	4 - High	
Opequon	5	4 - High	
Funkstown	3	1 - Low	
Timberville	2	3 - Moderately High	
NULL	0		
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Drained)**	**Majority Condition for Mapping with Summed (%)**
Hagerstown	**85**	2 - Moderate	2 - Moderate (90)
Carbo	5	1 - Low	
Opequon	5	1 - Low	
Funkstown	3	2 - Moderate	
Timberville	2	2 - Moderate	
NULL	0		
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Undrained)**	**Majority Condition for Mapping with Summed (%)**
Hagerstown	**85**	2 - Moderate	2 - Moderate (90)
Carbo	5	1 - Low	
Opequon	5	1 - Low	
Funkstown	3	2 - Moderate	
Timberville	2	2 - Moderate	
NULL	0		
Total	100		

The HaB map unit represents a group of residual limestone soils that are commonly found in karst landscapes. HaB map unit majority condition is 87% Moderately High for Surface Loss, 90% Moderate for Subsurface Loss (drained), and 90% Moderate for Subsurface Loss (undrained). Note that 10% of this map unit has a High rating for Surface Loss.

This map unit would be a candidate for further adjustment to SVI-cc rulesets for the presence of karst within the local watershed. The presence of karst presents increased risk for loss of excess nutrients and pathogens from Surface Loss or Subsurface Loss (drained or undrained) into groundwater drinking water supplies.

Figure 25. Indiana map unit Gm (Gilford) map unit majority or dominant condition ratings used for mapping SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 18.

Component	Component %	SVI-cc Surface Loss	Majority Condition for Mapping with Summed (%)
Gilford	100	1 - Low (100)	1 - Low (100)
NULL	0		
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Drained)**	**Majority Condition for Mapping with Summed (%)**
Gilford	100	4 - High	4 - High (100)
NULL	0		
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Undrained)**	**Majority Condition for Mapping with Summed (%)**
Gilford	100	4 - High	4 - High (100)
NULL	0		
Total	100		

The Gm map unit has a single Gilford component (poorly drained), therefore the map unit is 100% Gilford and the unit majority condition is 100% Low for Surface Loss, 100% High for Subsurface Loss (drained), and 100% High for Subsurface Loss (undrained).

Figure 26. North Dakota map unit C740B (Temvik) soil component inputs and resulting SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 19.

Component	Component %	SVI-cc Surface Loss	Majority Condition for Mapping with Summed (%)
Temvik	85	3 - Moderately High	3 - Moderately High (88)
Wilton	5	1 - Low	
Williams	4	2 - Moderate	
Linton	3	3 - Moderately High	
Mandan	2	1 - Low	
Tonka	1	1 - Low	
NULL	0		
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Drained)**	**Majority Condition for Mapping with Summed (%)**
Temvik	85	2 - Moderate	2 - Moderate (92)
Wilton	5	4 - High	
Williams	4	2 - Moderate	
Linton	3	2 - Moderate	
Mandan	2	4 - High	
Tonka	1	4 - High	
NULL	0		
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Undrained)**	**Majority Condition for Mapping with Summed (%)**
Temvik	85	2 - Moderate	2 - Moderate (93)
Wilton	5	4 - High	
Williams	4	2 - Moderate	
Linton	3	2 - Moderate	
Mandan	2	4 - High	
Tonka	1	2 - Moderate	
NULL	0		
Total	100		

The C740B map unit majority condition is 88% Moderately High for Surface Loss, 92% Moderate for Subsurface Loss (drained), and 93% Moderate for Subsurface Loss (undrained). Note that 8% of this map unit is High for Subsurface (drained) and 7% High for Subsurface (undrained) due to Pachic and/or poorly drained conditions.

Figure 27. South Carolina map unit VaA (Orangeburg) map unit majority or dominant condition ratings used for mapping SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 20.

Component	Component %	SVI-cc Surface Loss	Majority Condition for Mapping with Summed (%)
Orangeburg	90	1 - Low (90)	1 - Low (90)
NULL	10	NULL	
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Drained)**	**Majority Condition for Mapping with Summed (%)**
Orangeburg	90	4 - High	4 - High (90)
NULL	10	NULL	
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Undrained)**	**Majority Condition for Mapping with Summed (%)**
Orangeburg	90	4 - High	4 - High (90)
NULL	10	NULL	
Total	100		

This VaA map unit from South Carolina is 90 percent Orangeburg soils and 10 percent NULL (component is not identified within the database). NULL conditions do not produce an SVI-cc classification.

Figure 28. Florida map unit 43 (Terra Ceia) map unit majority or dominant condition ratings used for mapping SVI-cc ratings for Surface Loss; Subsurface Loss (drained); and Subsurface Loss (undrained). Compare with Figure 21.

Component	Component %	SVI-cc Surface Loss	Majority Condition for Mapping with Summed (%)
Terra Ceia	84	1 - Low	1 - Low (100)
Torry	4	1 - Low	
Okeechobee	4	1 - Low	
Pahokee	4	1 - Low	
Okeelanta	4	1 - Low	
NULL	0		
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Drained)**	**Majority Condition for Mapping with Summed (%)**
Terra Ceia	84	4 - High	4 - High (100)
Torry	4	4 - High	
Okeechobee	4	4 - High	
Pahokee	4	4 - High	
Okeelanta	4	4 - High	
NULL	0		
Total	100		
Component	**Component %**	**SVI-cc Subsurface Loss (Undrained)**	**Majority Condition for Mapping with Summed (%)**
Terra Ceia	84	4 - High	4 - High (100)
Torry	4	4 - High	
Okeechobee	4	4 - High	
Pahokee	4	4 - High	
Okeelanta	4	4 - High	
NULL	0		
Total	100		

The Terra Ceia map unit is 100 percent organic soils (Histosols). The presence of a Histosol triggers SVI-cc rules that over-ride all other soil parameters to classify the SVI-cc

Surface Loss = 1 – Low and SVI-cc Subsurface Loss (drained or undrained) = 4 – High for that component.

SVIChart_Tables

The SVIChart_ Tables organize all map unit component level SVI-cc classifications for Surface Loss, Subsurface Loss (drained), and Subsurface Loss (undrained) for mapping and pie chart generation of the SSURGO vector soil map layer.

In addition, further processing at the feature (polygon level) was done by RAD staff using SAS scripts to prepare tables that when joined with the SSURGO vector map layer provide fast responses to user query in the Geoportal SVI-cc web mapping application.

Data Citation and Metadata Review

It is a good scientific practice to cite all the data sources and methods used to conduct an assessment or research study. A section on methods and materials commonly cites other literature sources, which are listed in a reference section.

The USDA Natural Resources Conservation Service recommends the following citations be used in internal and published documents that describe assessments and studies which used the Soil Vulnerability Index for Cultivated Cropland Map Layers and Attributes. The following example citations are tailored to reflect the FY2018 gSSURGO/SSURGO sources used in the SVI-cc 2.0 web mapping application in Geoportal.

The Citation for Soil Vulnerability Indices on Cultivated Cropland 2.0 Map Products

When using current fiscal year SVI-cc 2.0 information releases, citations for these data will need to be updated to reflect the SSURGO/gSSURGO release dates. Example citations are provided below based upon the November 5, 2018 edition of the SVI-cc processing script and the FY2018 SSURGO/gSSURGO dataset released November 27, 2017.

SVI-cc 2.0 Surface Loss

USDA NRCS. Conservation Effects Assessment Project (CEAP) Soil Vulnerability Index for Cultivated Cropland 2.0 Surface Loss or (SVI-cc-sl) Map Layer and Attributes for the Conterminous United States. United States Department of Agriculture, Natural Resources Conservation Service, Resource Assessment Division. Available online at https://geoportal.sc.egov.usda.gov/portal/home/index.html. 20171127 (FY2018 official release).

SVI-cc 2.0 Subsurface Loss (Drained)

USDA NRCS. Conservation Effects Assessment Project (CEAP) Soil Vulnerability Index for Cultivated Cropland 2.0 Subsurface Loss (drained) or (SVI-cc-ssld) Map Layer and Attributes for the Conterminous United States. United States Department of Agriculture, Natural Resources Conservation Service, Resource Assessment Division. Available online at https://geoportal.sc.egov.usda.gov/portal/home/index.html. 20171127 (FY2018 official release).

SVI-cc 2.0 Subsurface Loss (Undrained)

USDA NRCS. Conservation Effects Assessment Project (CEAP) Soil Vulnerability Index for Cultivated Cropland 2.0 Subsurface Loss (undrained) (SVI-cc-sslu) Map Layer and Attributes for the Conterminous United States. United States Department of Agriculture, Natural Resources Conservation Service, Resource Assessment Division. Available online at https://geoportal.sc.egov.usda.gov/portal/home/index.html. 20171127 (FY2018 official release).

Citation for SVI-cc 2.0 Table File Geodatabase and Individual SVI-cc Tables

USDA NRCS Resource Assessment Division Staff. 2018. CEAP Soil Vulnerability Index for Cultivated Cropland 2.0 (SVI-cc) attribute tables for the Conterminous US generated using FY2018 gSSURGO and the 11052018 edition of the SVI-cc 2.0 ArcGIS™ Desktop Toolbox. File Geodatabase format with metadata. United States Department of Agriculture, Natural Resources Conservation Service. 20171127 (FY2018 official release).

See ArcCatalog description of the File Geodatabase for more detailed SVI-cc metadata information.

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Acronyms

acronym	definition
CDL	NASS Cropland Data Layer
CEAP	Conservation Effects Assessment Project
CLU	NASS Common Land Unit
cm	centimeter
cogeomordesc	Component Geomorphic Description table
CONUS	Conterminous United States
drainagecl	Soil drainage class in SSURGO
ES(D)	Ecological Site (Description)
ESRI®	Environmental Systems Research Institute, Inc.
FY	Federal Fiscal Year (begins October 1 of each year)
Geomfname	Geomorphometry Name column in the cogeomordesc table
gSSURGO	Gridded Soil Survey Geographic Database
hydgrp	Hydrologic soil group for component in SSURGO
kffactor	Fragment free K-factor or erodibility factor for component surface in SSURGO
kwfactor	Whole soil K-factor or erodibility factor for component surface in SSURGO
m	meter
MLRA	Major Land Resource Area
mm	millimeter
MRLC	Multi Resolution Land Characteristics
muaggatt	Map Unit Aggregate Attribute Table in SSURGO
mukey	Map Unit Key in SSURGO
muname	Map Unit Name in SSURGO
mupolygon	Map Unit Polygon in SSURGO
musym	Map Unit Symbol in SSURGO
NCSS	National Cooperative Soil Survey
NED	National Elevation Database
NGCE	National Geospatial Center of Excellence
NLCD	National Land Cover Database
NRCS	Natural Resources Conservation Service
NRI	National Resources Inventory
NSSH	National Soil Survey Handbook
sieveno10_r	Representative values of the sieve number 10 for component surface rock fragments
slope_r	Representative soil component slope in SSURGO
Sq	square
SQL	Standard or Structured Query Language
SSURGO	Soil Survey Geographic Database

SVI	Soil Vulnerability Index
SVI-cc	Soil Vulnerability Index for Cultivated Cropland
SVI-CC	Soil Vulnerability Index for Cultivated Cropland
SVI-cc-sl	Soil Vulnerability Index for Cultivated Cropland-2.0 Surface Loss
SVI-cc-ssl	Soil Vulnerability Index for Cultivated Cropland-2.0 Subsurface Loss
taxclname	Soil taxonomic name for component in SSURGO
taxorder	Soil taxonomic order for component in SSURGO
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VALU	Value Added Look Up Table

Appendix A

Updated Guidance on accessing SVI-cc 2.0 Geoportal

Note: All graphics were prepared using Geoportal 10.5.1 and may appear slightly different in Geoportal 10.6.1.

Accessing NRCS Geoportal to use the CEAP SVI-cc 2.0 Web Application

All USDA NRCS staff have access to the SVI-cc 2.0 Web Application and Documentation via the entry web page shown in **Step 1.** below.

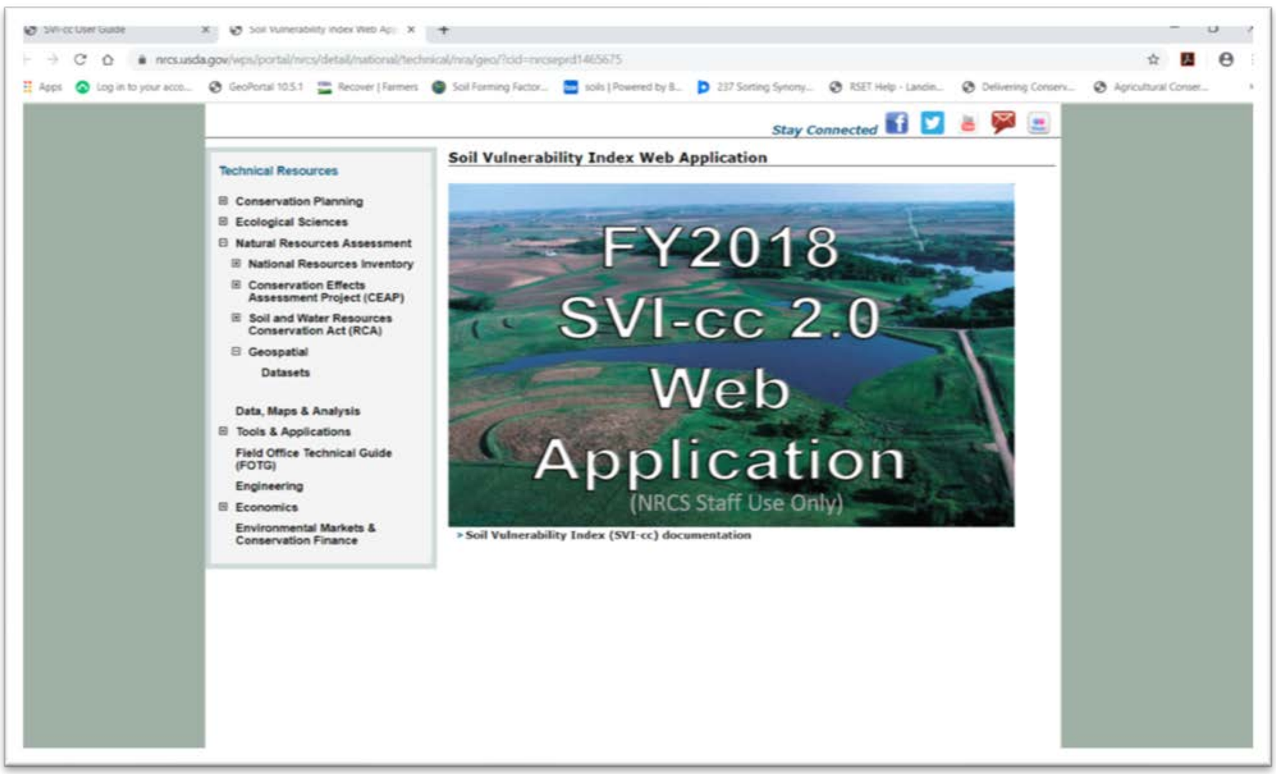
Please Note: If you have never used the Geoportal, you will be logging into the Geoportal for the first time using your EAUTH credentials to access the SVI-cc 2.0 web application.

If you have trouble accessing the SVI-cc 2.0 Web application, contact either Robert (Tony) Oesterling at robert.oesterling@usda.gov or Chieh (Peter) Chen at chieh.chen@usda.gov on the RIAD staff.

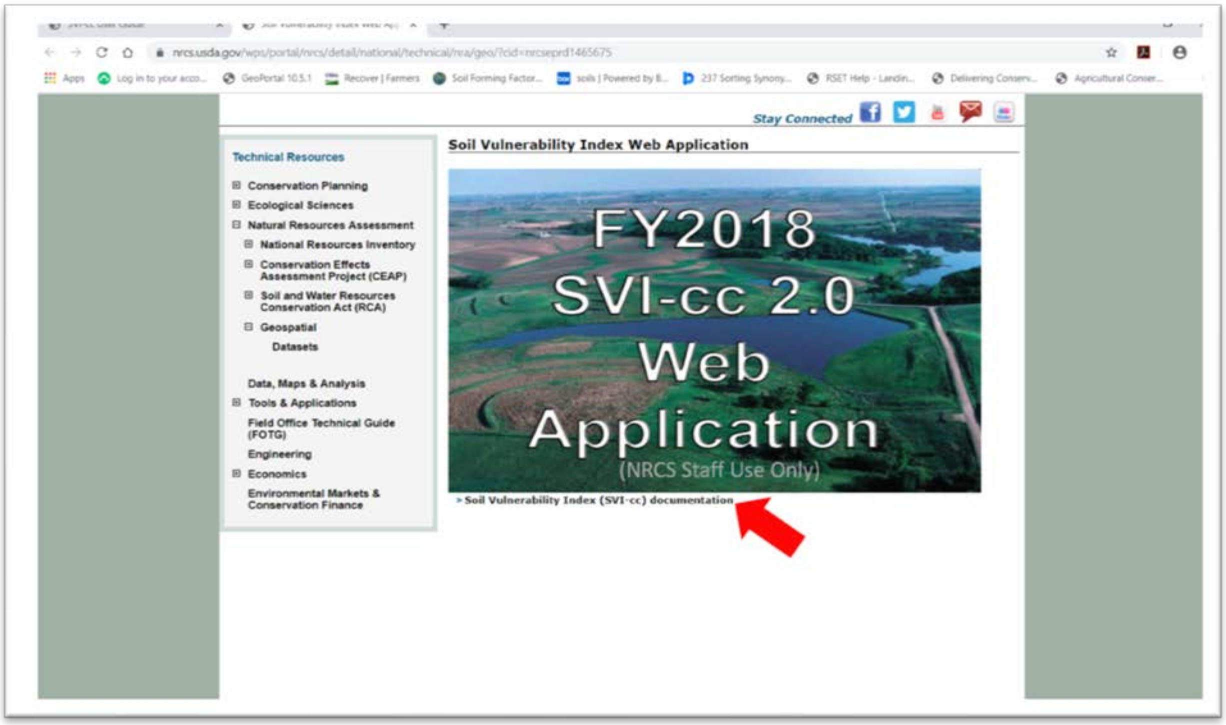
Getting Started

Step 1. Go to the "FY2018 SVI-cc 2.0 Web Application" starting or entry web page located at:

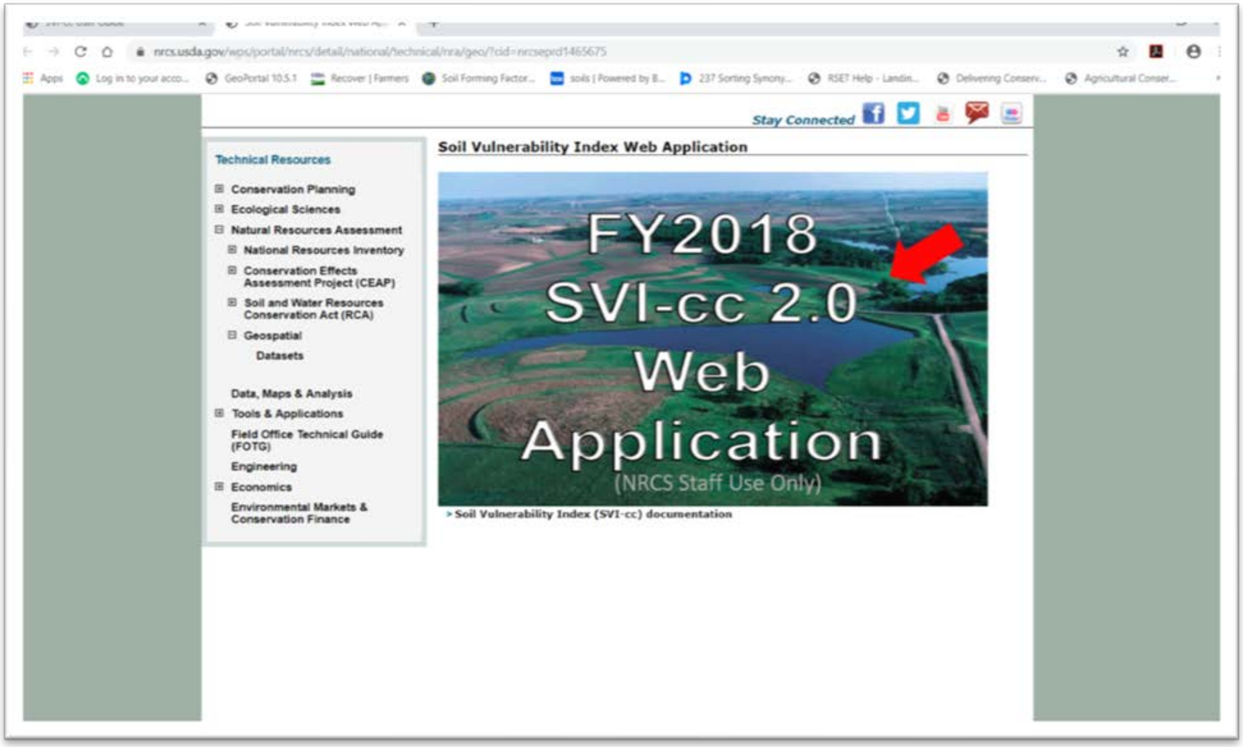
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/geo/?cid=nrcseprd1465675

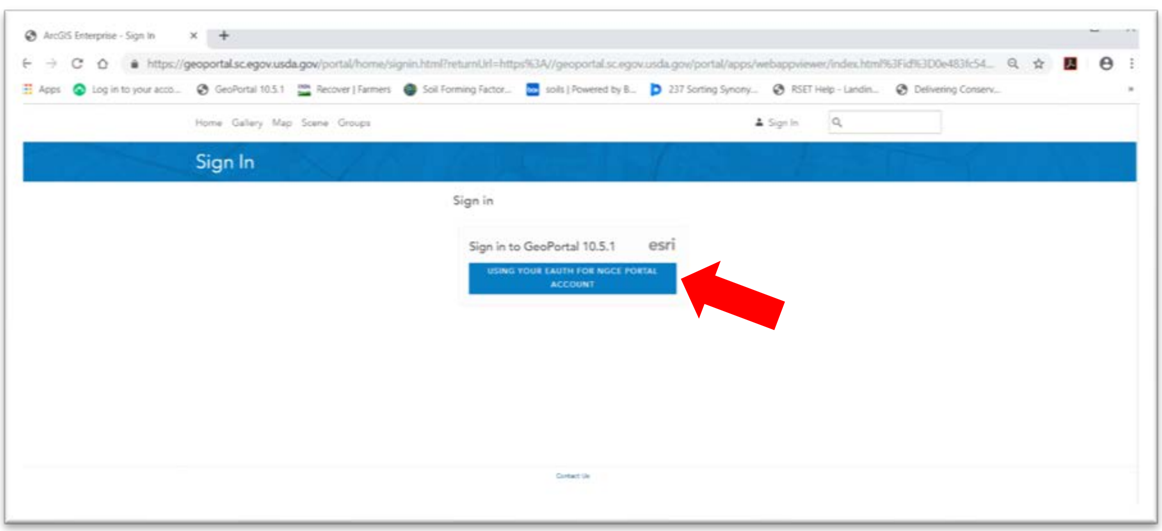


Step 2. Download the SVI-cc 2.0 User Guide PDF document by clicking the link indicated by the red arrow in the image above. Please review the user guide.

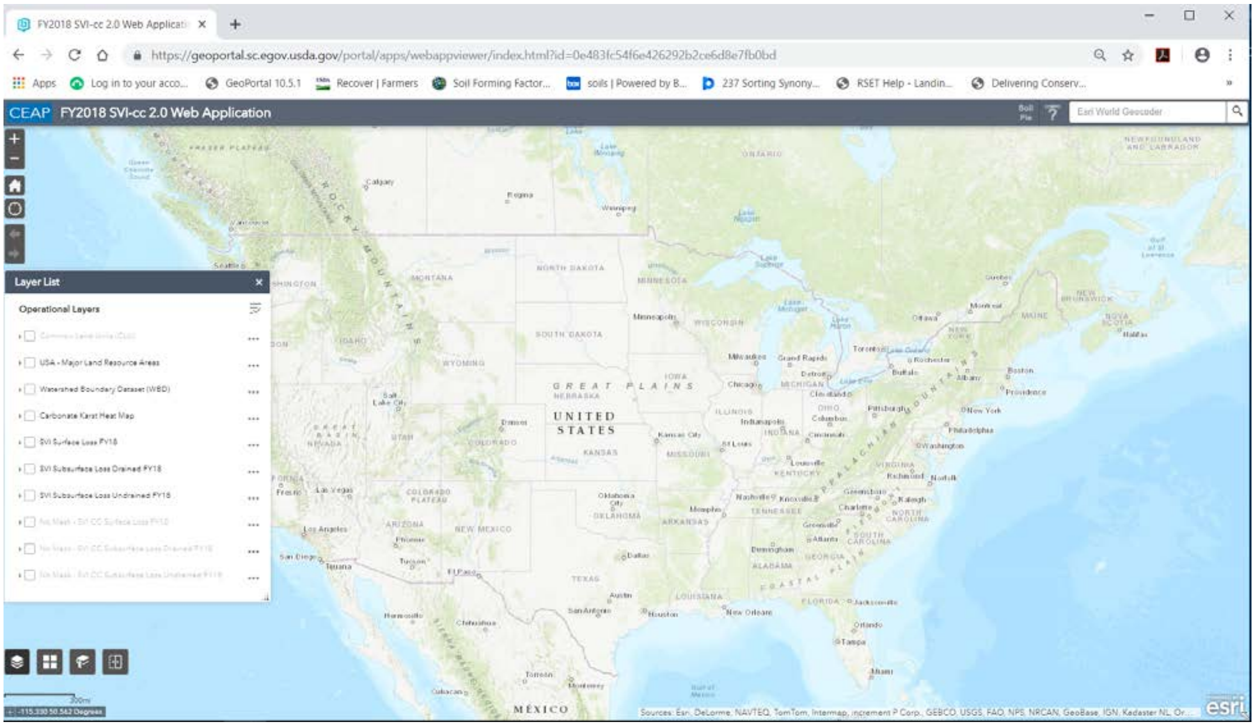


Step 3. Click on this web site image to sign into the NRCS Geoportal using your EAUTH credentials.





Step 4. You will then enter the FY2018 CEAP SVI-cc 2.0 Web Application. Please go to **Appendix B** in the SVI-cc 2.0 User Guide for a tutorial on how to effectively use this web application.



Appendix B

SVI-cc 2.0 Web Application Tutorial

Note: All graphics were prepared using Geoportal 10.5.1 and may appear slightly different in Geoportal 10.6.1.

CEAP FY2018 SVI-cc 2.0 Web Application (FOUO) Tutorial

The USDA NRCS CEAP FY2018 SVI-cc 2.0 Web Application (FOUO) and allows users to query and evaluate the “Soil Vulnerability Index for Cultivated Cropland (SVI-cc 2.0)” for risk of losses of sediment, nutrients and pathogens due to 1) surface losses; 2) subsurface losses, drained; and 3) subsurface losses, undrained. There are two map layers for each of these resource concerns and corresponding SVI-cc 2.0 ruleset (one with a cultivated cropland mask and one with no mask).

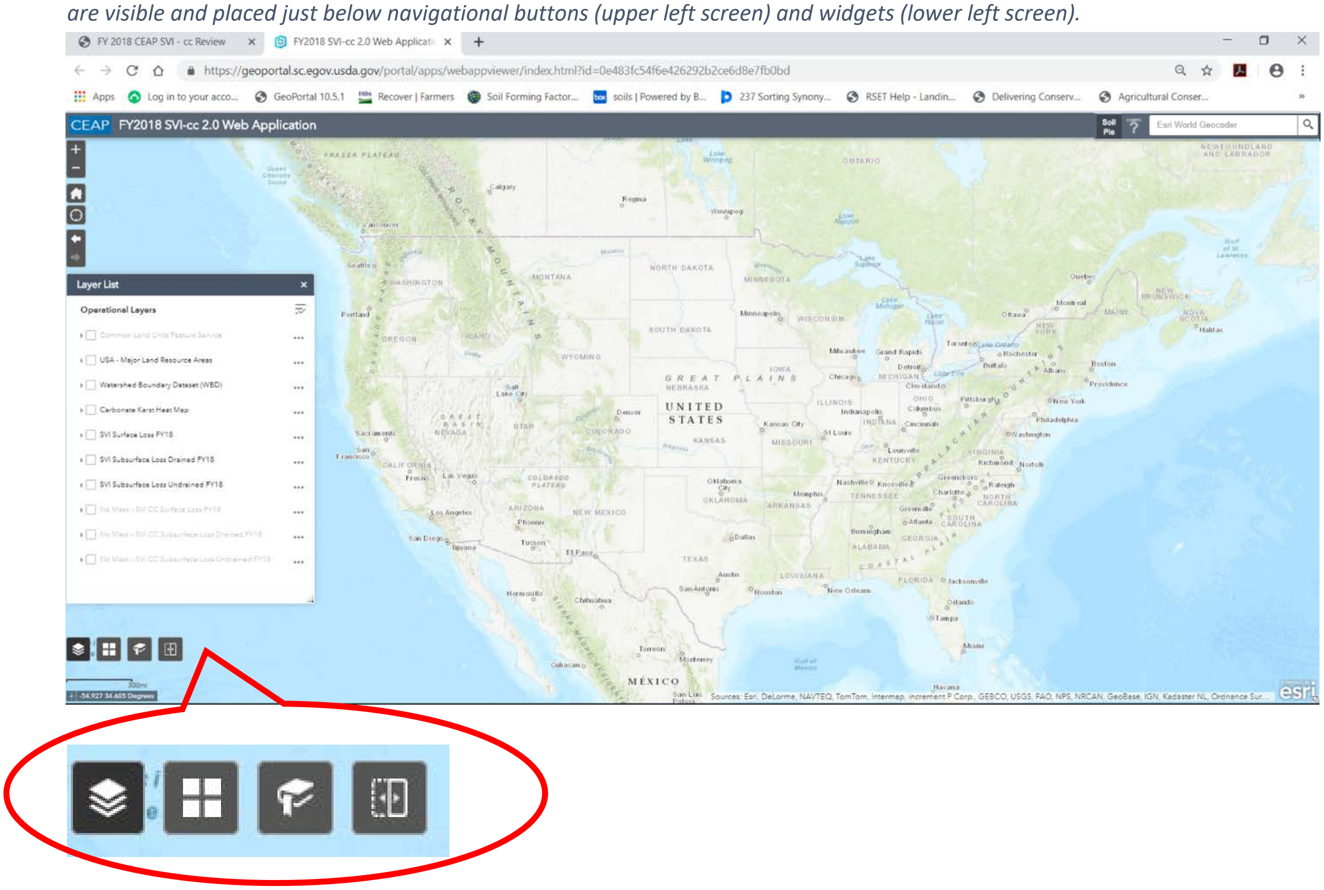
Map Layers and Related Widgets

There are (10) individual map layers that the user can turn on and off. Four of these are reference layers (Common Land Unit, Major Land Resource Areas, Watershed Boundary Dataset, and Carbonate Karst Heat Map). See Figures 4-7. Some of these reference map layers will be visible only at National and regional levels and some will only be visible at field levels. The county boundary map layer with names is always present.

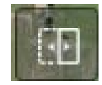
Six of the ten map layers are SVI-cc map layers (2 for each SVI-cc ruleset). Masked SVI-cc layers are only visible at National and regional views with a topographic base map. The no mask SVI-cc layers are visible only at field level views with a NAIP aerial photo base map. See Figures 8-13.

When map layers are “grayed out” in the Layer List, they are not available for viewing at the current map scale. The user will generally need to zoom in before these layers are available for use.

Figure 1. User needs to click the map layer widget button to open the Layer List and size and position so that all 10 map layers are visible and placed just below navigational buttons (upper left screen) and widgets (lower left screen).



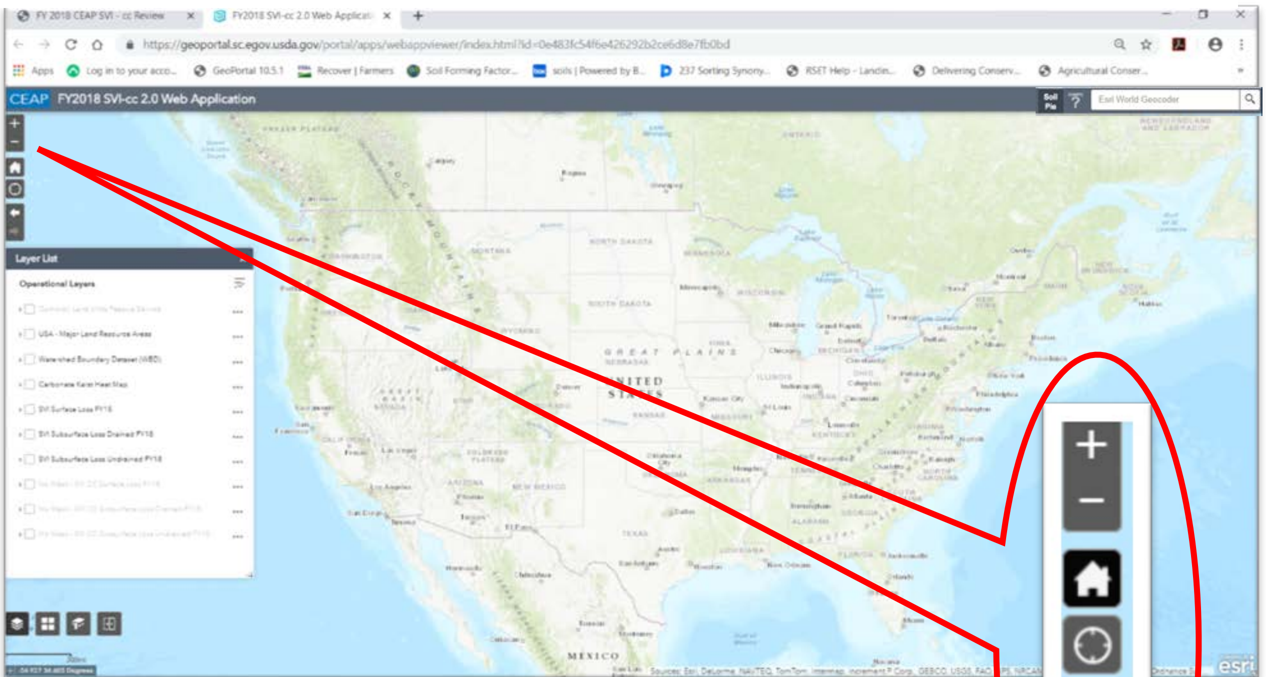
There are four widgets (lower left hand of screen) that are available to assist users in reviewing and analyzing the SVI-cc map layer datasets.

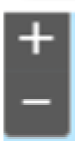
 Layer List  Base map Gallery  Bookmark  Swipe

Navigation Buttons

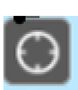
There are four navigational buttons (upper left hand screen). See Figure 2.

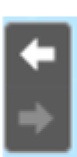
Figure 2. There are 4 navigational buttons located in the upper left screen. These are used to zoom, return to "home" or full extent, and "go back" to a previous extent or the "back button".



 Zoom In/Out

 Default Extent

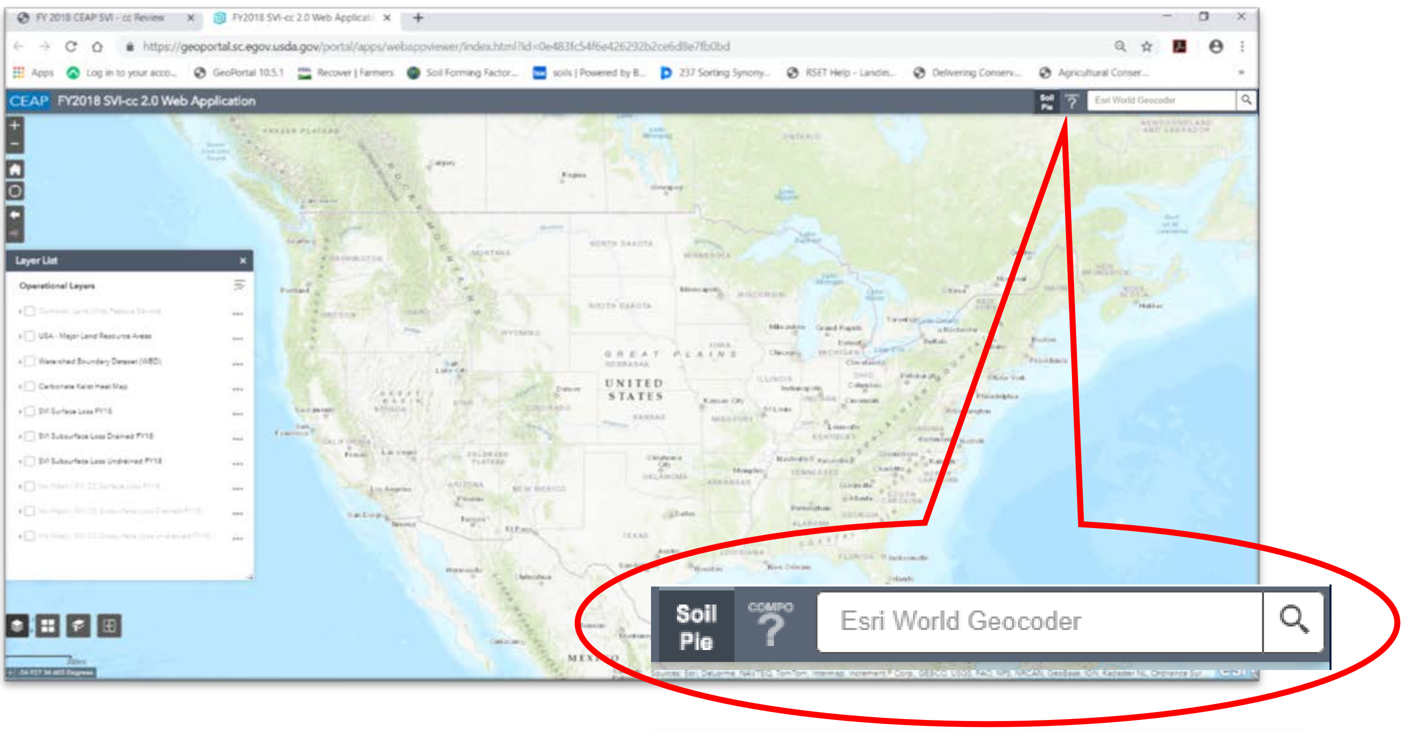
 My Location

 Previous Extent or "Back Button"

Soil Pie Chart and Soil Component Query Widgets

There are two Soil query widgets: Soil pie chart and soil component query widgets. See Figure 3.

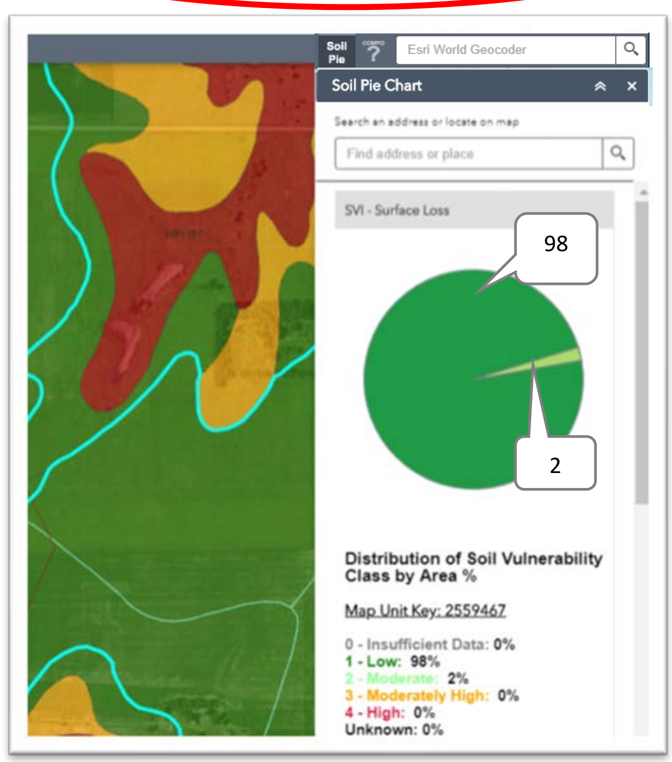
Figure 3. The Soil Pie Chart Widget and the Soil Component Query Widget are located in the upper right screen area along with the Geocoder window that is used for address searches, etc.



Soil Pie Chart Widget

Each FY2018 SSURGO map unit (has blue highlight) component output is summarized and presented in pie chart format. Percentages of SSURGO map unit can be seen when cursor is placed on segment of pie chart. User can scroll down for corresponding SVI-cc ruleset result (Surface Loss; Subsurface Loss, drained; Subsurface Loss, undrained).

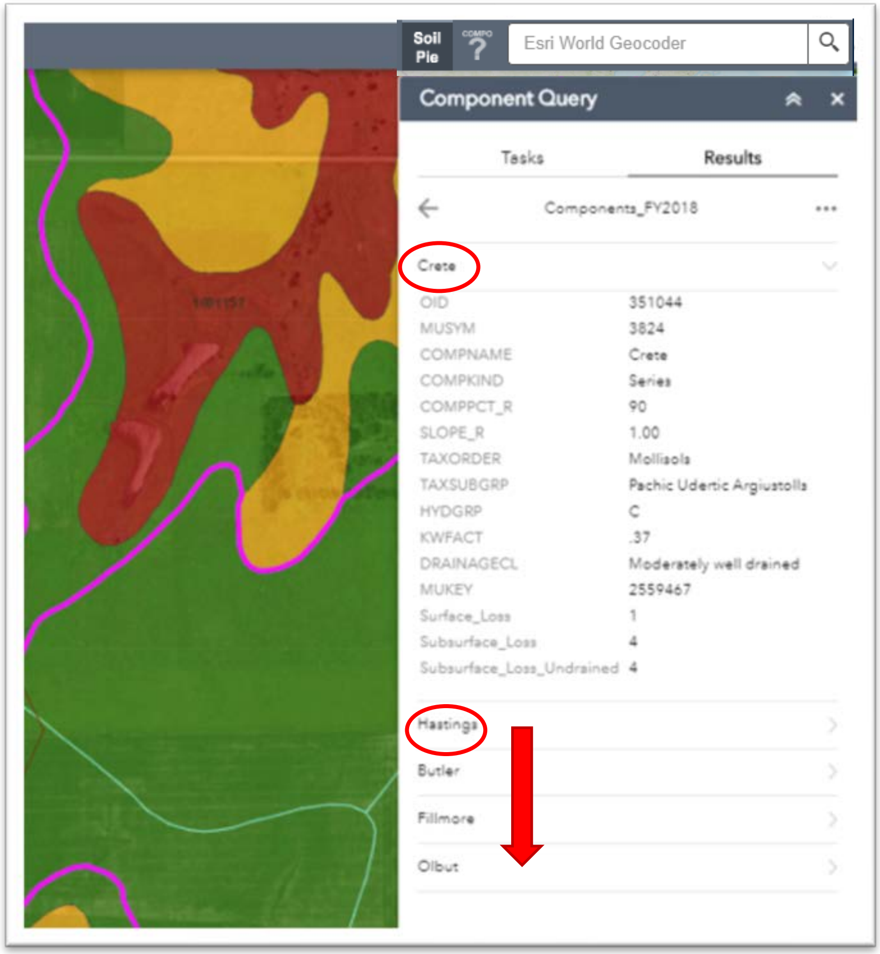
This example SSURGO map unit has 5 individual soil components.

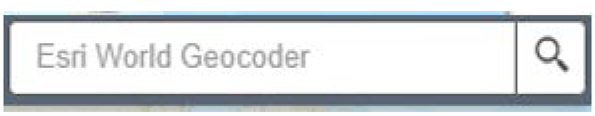


Soil Component Query Widget

Each FY2018 SSURGO map unit (has pink highlight) component input and output parameters are presented in collapsible panels (click to open/close).

This example SSURGO map unit has 5 individual soil components.





Address Search Geocoder

User can enter street addresses, zip codes, names of counties or states to zoom to respective locations.

Figure 4. Major Land Resource Areas (MLRA) map layer turned on in the map layer list. Symbols appear when zoomed in.

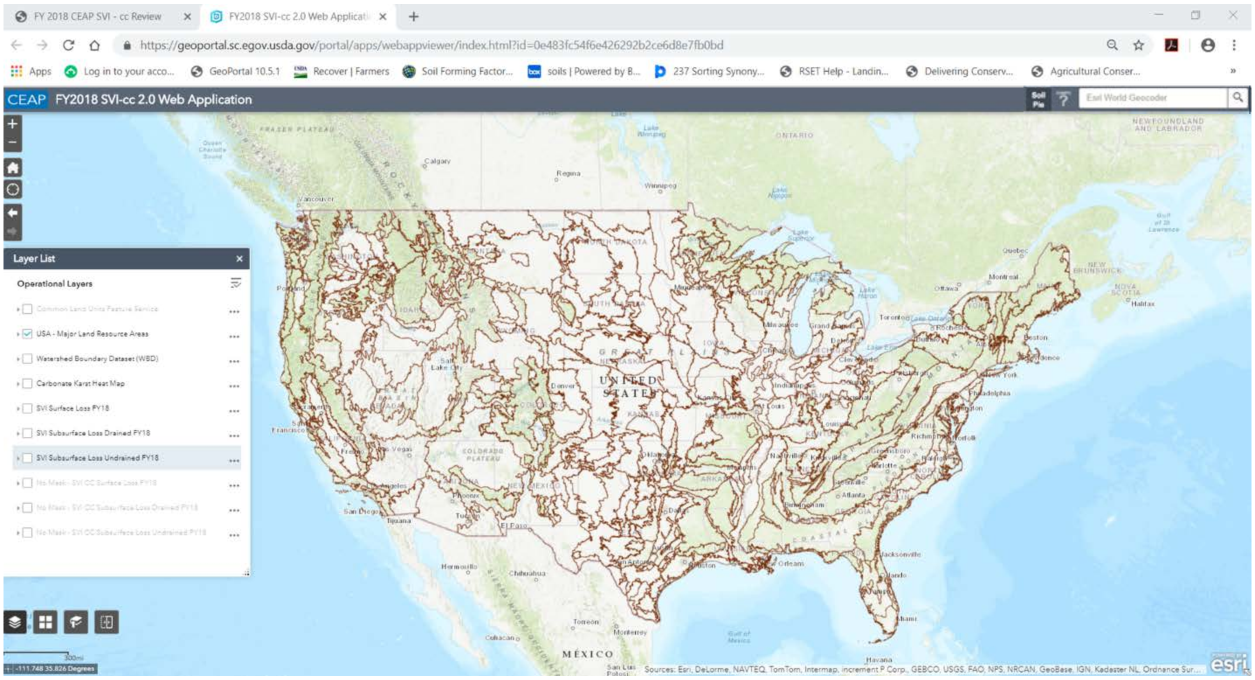


Figure 5. Watershed Boundaries Dataset turned on in the map layer list (HUC2). HUC4, HUC8 and HUC12 delineations with symbols appear when zoomed in.

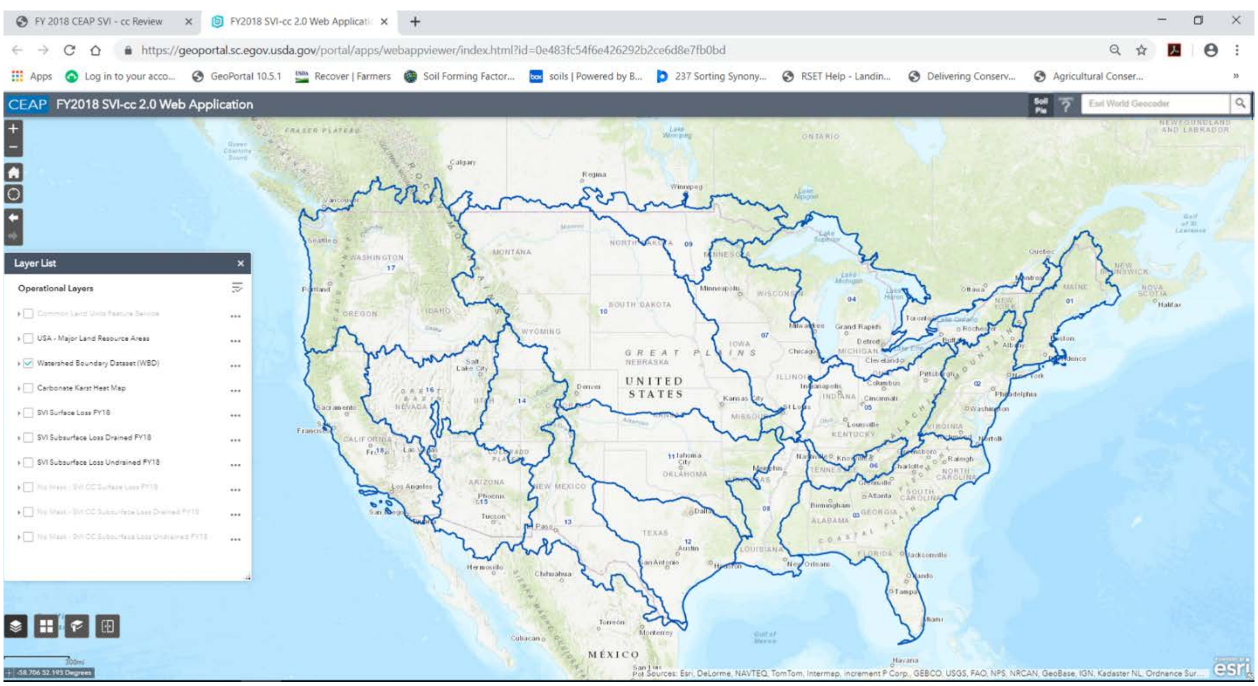


Figure 6. Carbonate Karst Heat Map with HUC2 boundaries. Bright pink and purple colors indicate a larger land area within the HUC12 covered by carbonate karst bedrock, indicating a greater likely hood of karst landscape source water areas.

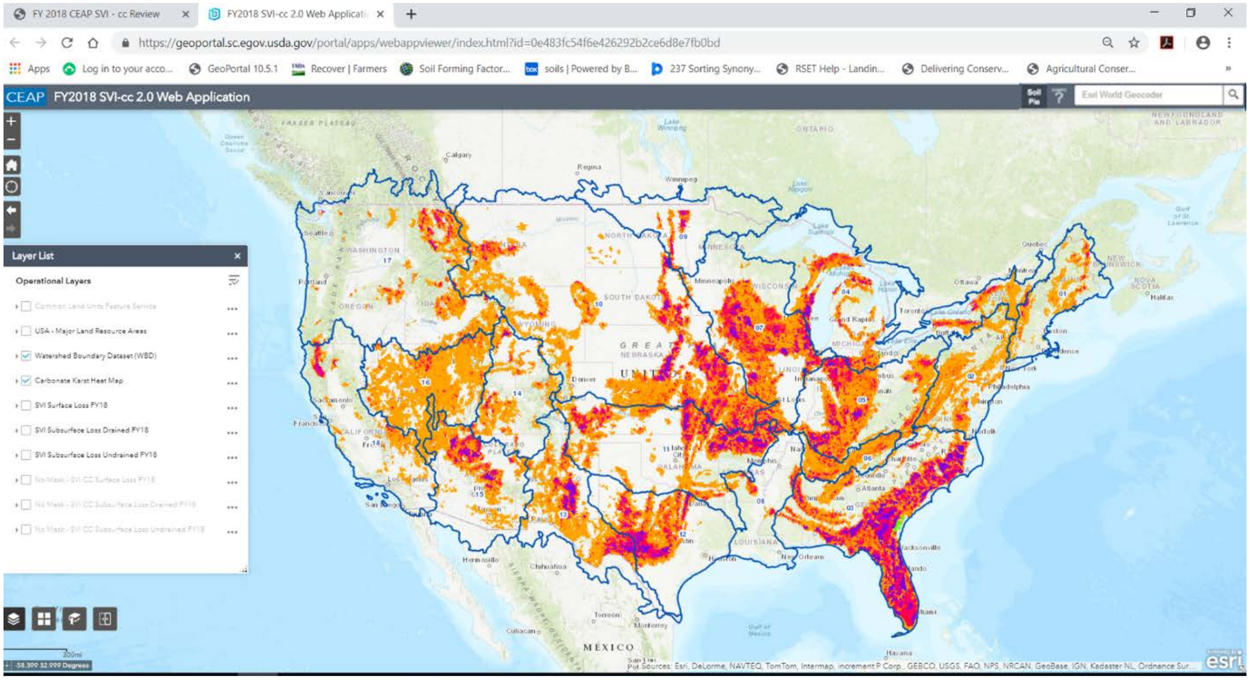
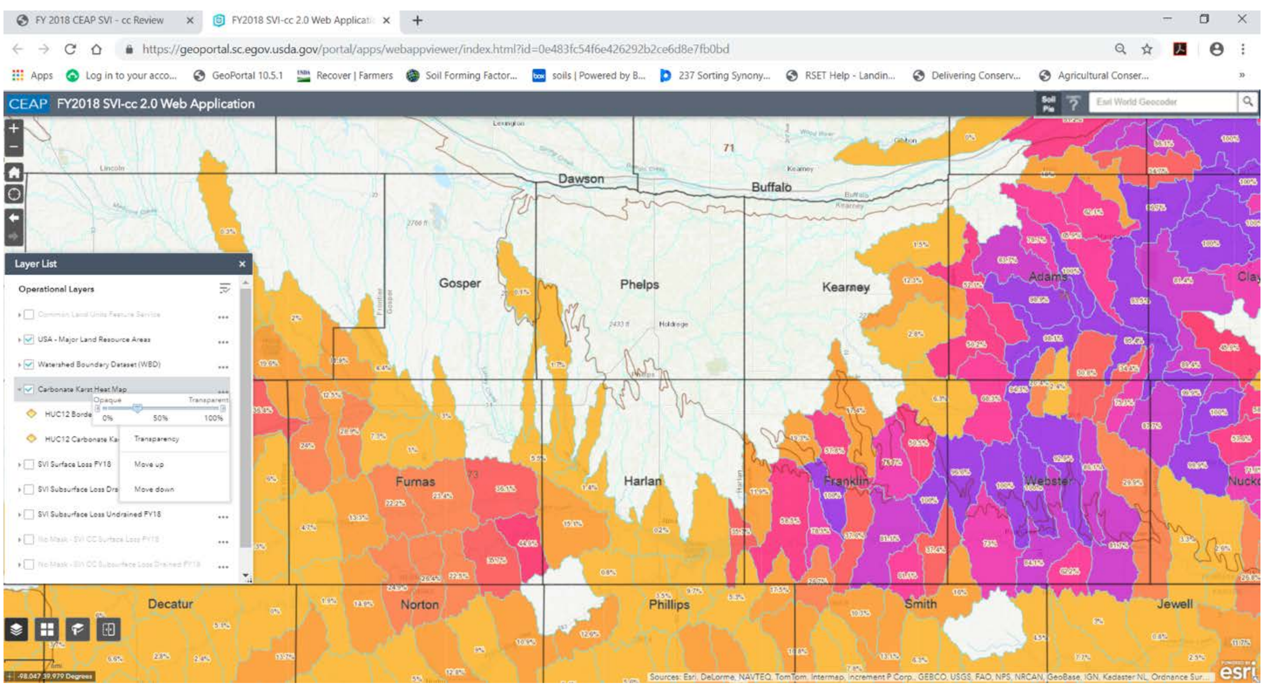


Figure 7. Zoomed in view of HUC12, MLRA, and Carbonate Karst Heat map layers (with percent area of HUC12 with carbonate karst). Note symbology appears when zoomed in more closely to the earth surface. Pink and purple colors indicate high percentages and yellow colors indicate lower percentages of carbonate karst within the HUC12 delineation.



In the Map Layer List, a left click to the right of the map layer name (3 horizontal dots) will bring up map appearance controls. The transparency of the map layer can be changed. Generally, 40-50% transparency is a good start, but adjustments may be needed, depending on the photo image base map.

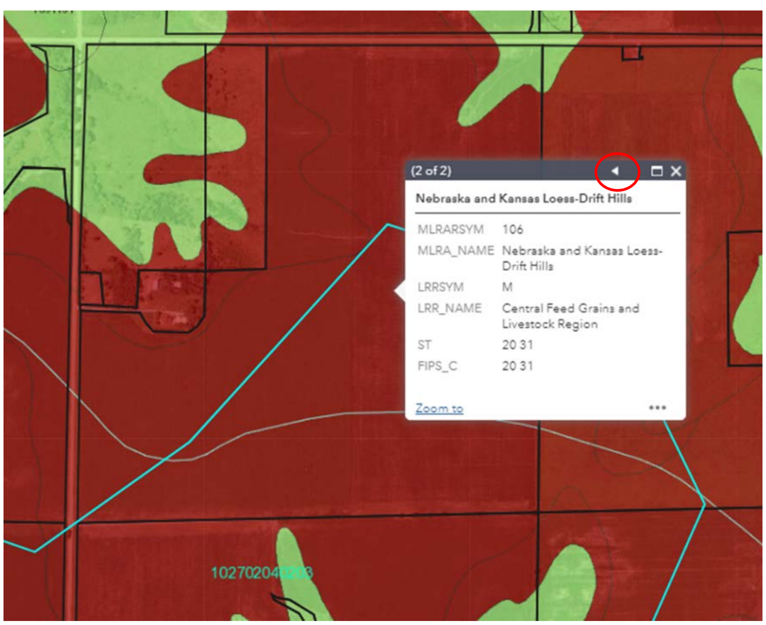
In addition, clicking the small arrow to the left of each map layer will expand to reveal the map legend or additional map layers, and their respective map legends. Clicking the arrow again will cause the legends to collapse and simplify the Layer List.

CLU and MLRA Query

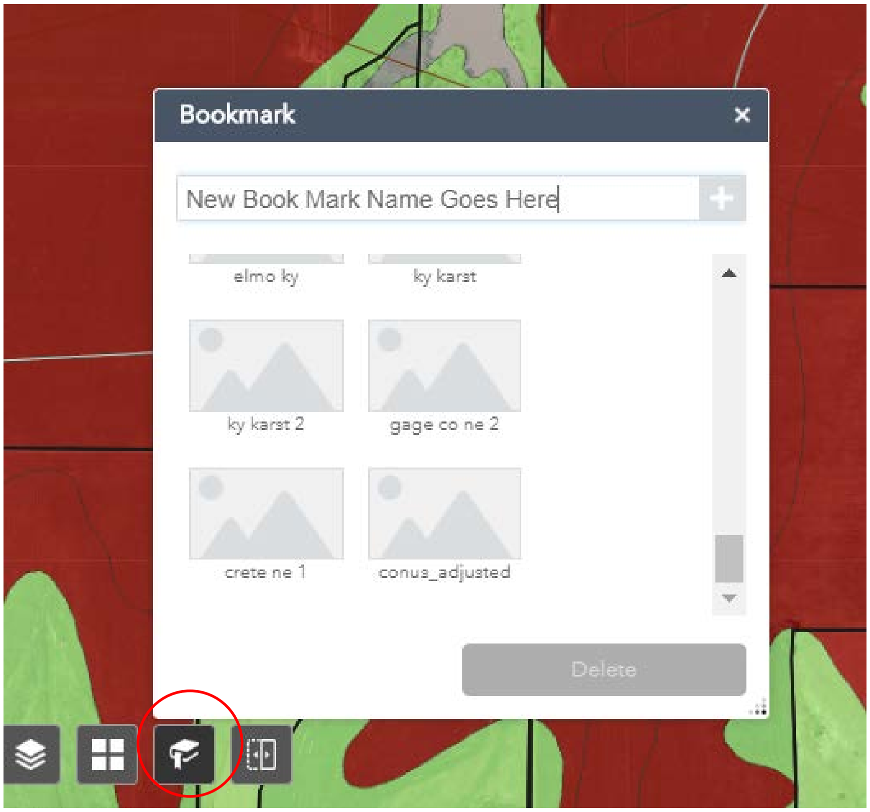
The CLU and MLRA can be queried when visible. The polygon highlight indicates which attributes are being presented. Click arrow in upper right corner of box for second layer attributes.

Figure 8 Query of Common Land Unit (CLU).

Figure 9 Query of Major Land Resource Area (MLRA).



Book Marks



It is helpful to use the Book Mark Widget to name and save a local extent for work projects. This is as simple as clicking on the widget and typing an appropriate name and hitting carriage return. The "Back Button" can go to a previous extent but does not save the extent for future use.

SVI-cc 2.0 Map Layers – Conterminous US View

Figure 8. SVI-cc 2.0 Surface Loss Conterminous U.S.

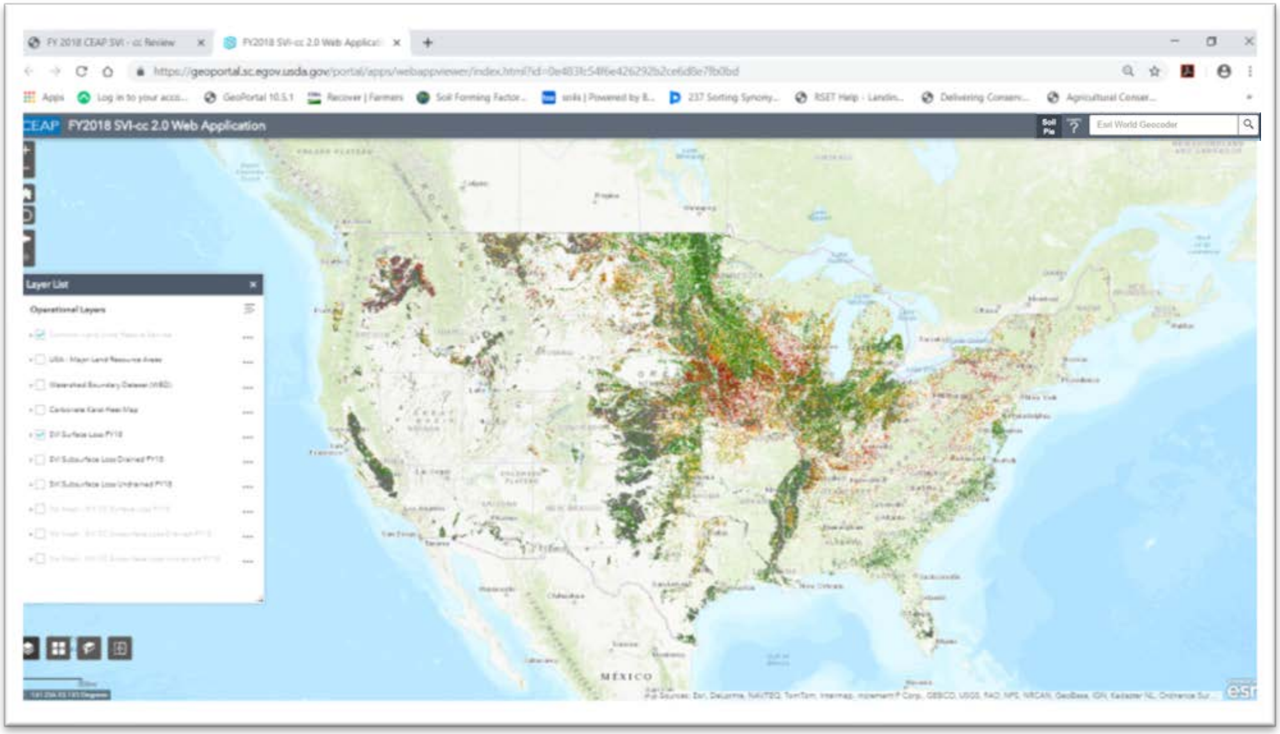


Figure 9. SVI-cc 2.0 Subsurface Loss, Drained Conterminous U.S.

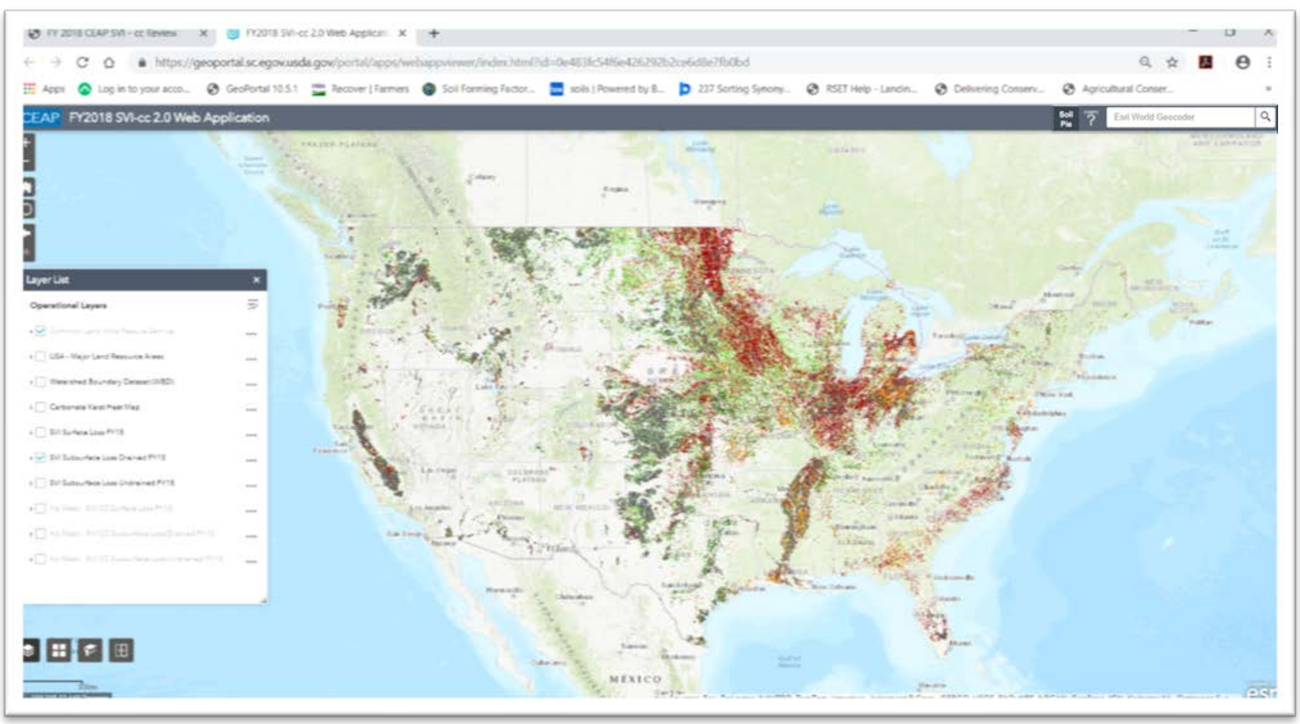
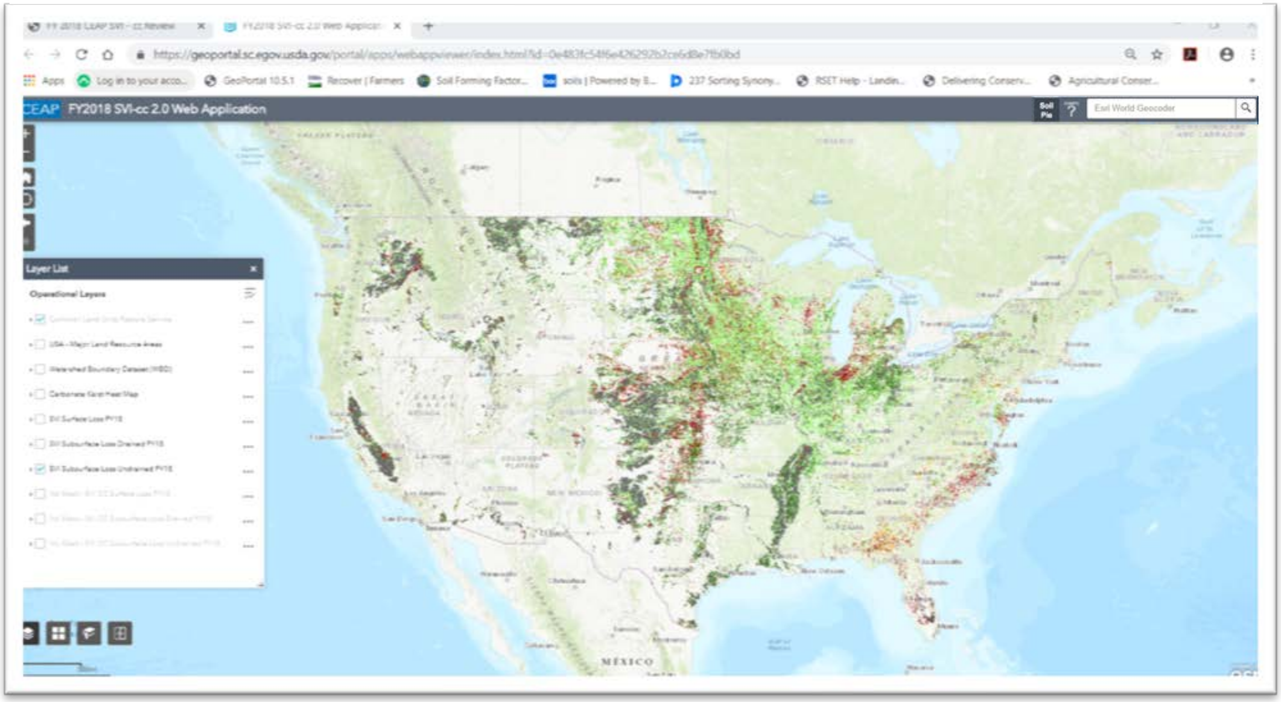


Figure 10. SVI-cc 2.0 Subsurface Loss, Undrained Conterminous U.S.



SVI-cc 2.0 Map Layers – Field View (No Mask) with Widgets

Figure 11. SVI-cc Surface Loss at field scale with results from Soil Pie Chart Widget. Blue highlight indicates selected soil map unit polygon. Note SVI-cc Surface Loss is checked on in Layer List.

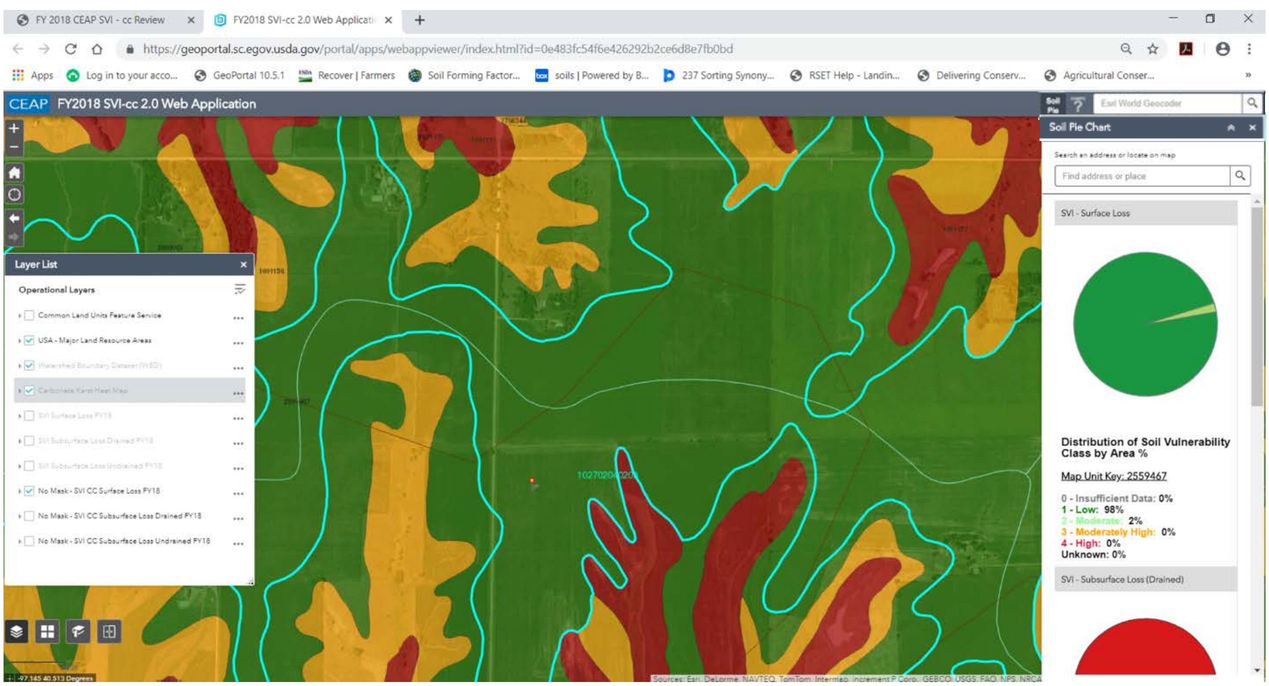


Figure 12. Upon initial selection of polygon with the Soil Pie Chart Widget, the user is shown the full extent of the map unit within the survey area (blue highlight). The user can use the "Back Button" or click a previously saved book mark to return to their area of work or study.

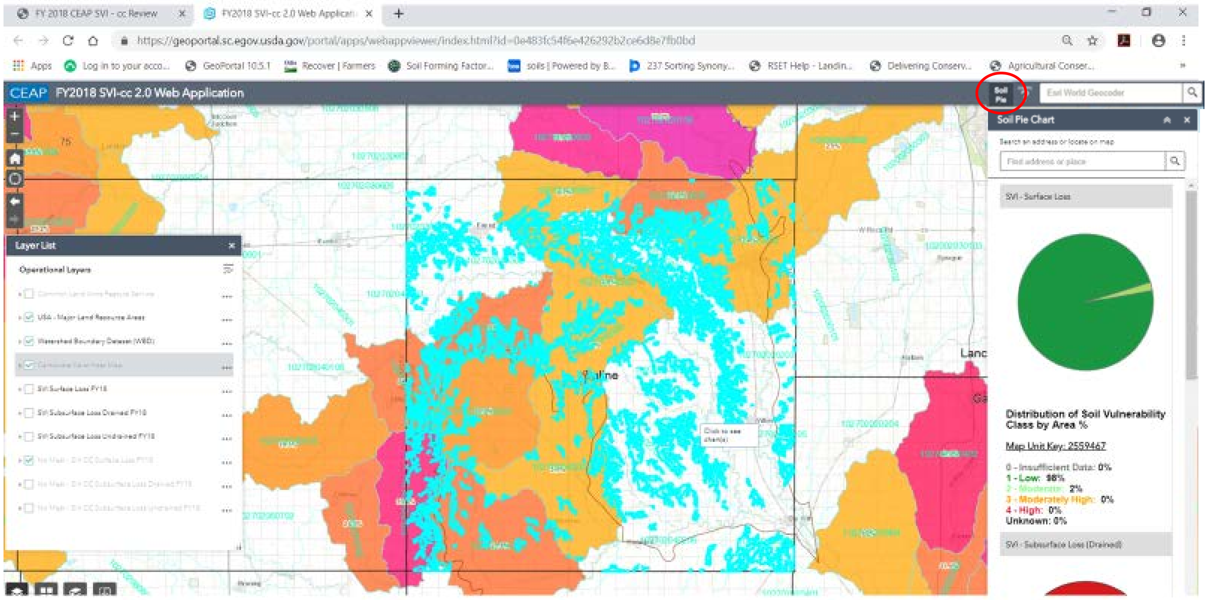


Figure 13. SVI-cc Subsurface Loss, Drained at field scale with results from Soil Pie Chart Widget. Blue highlight indicates selected soil map unit polygon. SVI-cc Subsurface Lose, Drained is checked on in Layer List. User scrolls down to second pie chart for this theme.

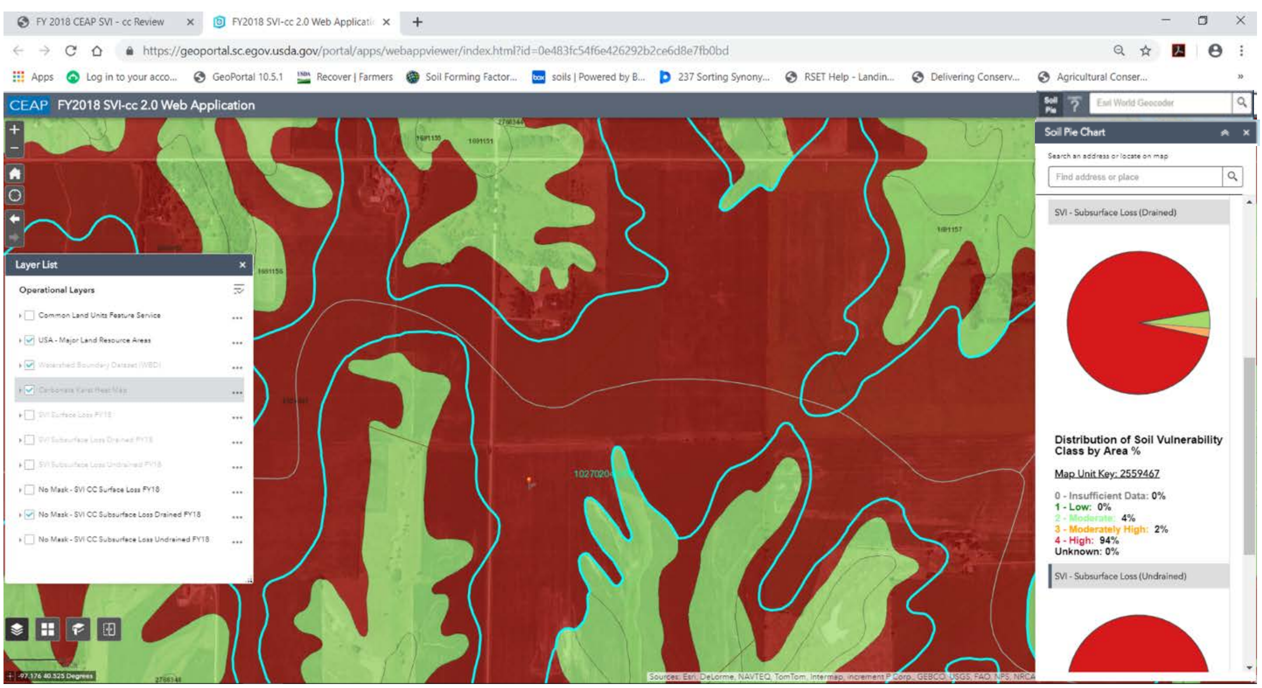


Figure 14. SVI-cc Subsurface Loss, Undrained at field scale with results from the Soil Pie Chart Widget. Blue highlight indicates selected soil map unit polygon. Note: SVI-cc Subsurface Lose, Undrained is checked on in Layer List. User scrolls down to third pie chart for this theme.

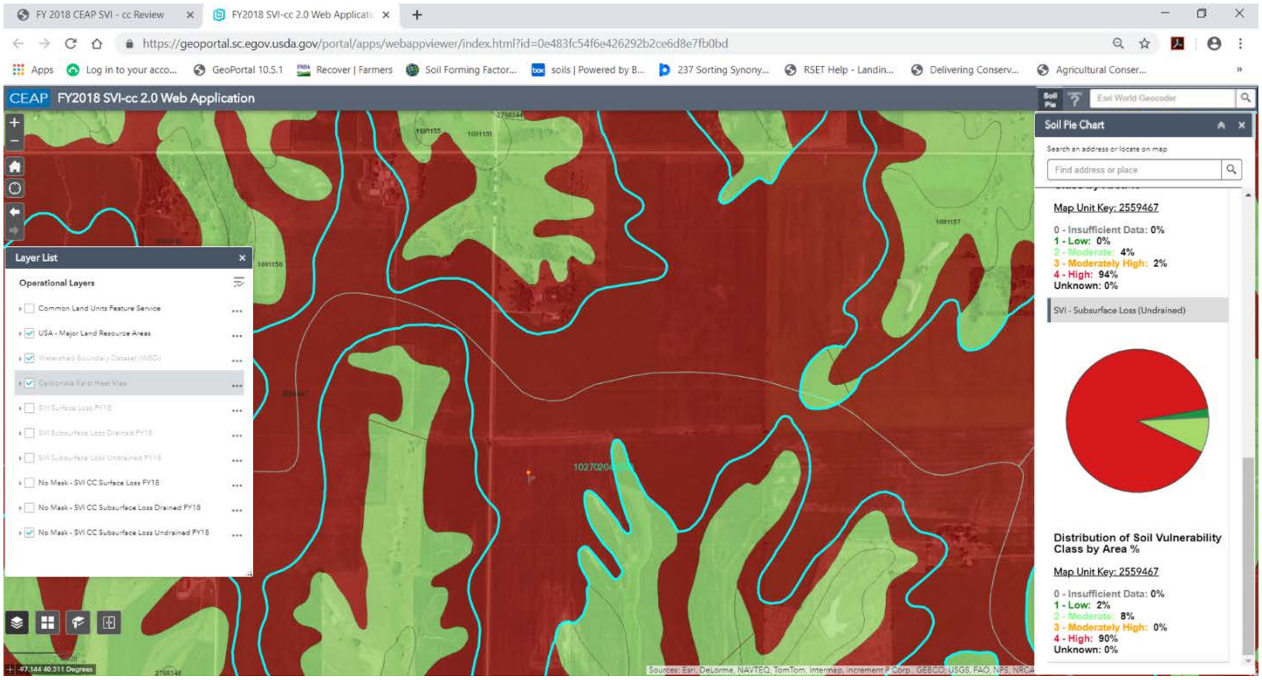


Figure 15. SVI-cc Surface Loss at field scale with results from Soil Component Query Widget. Blue highlight indicates previously selected soil map unit polygon. Note SVI-cc Surface Loss is checked on in Layer List. User clicks on Component Query point and places in the blue highlighted polygon and then clicks green execute button to get component level information about that soil map unit.

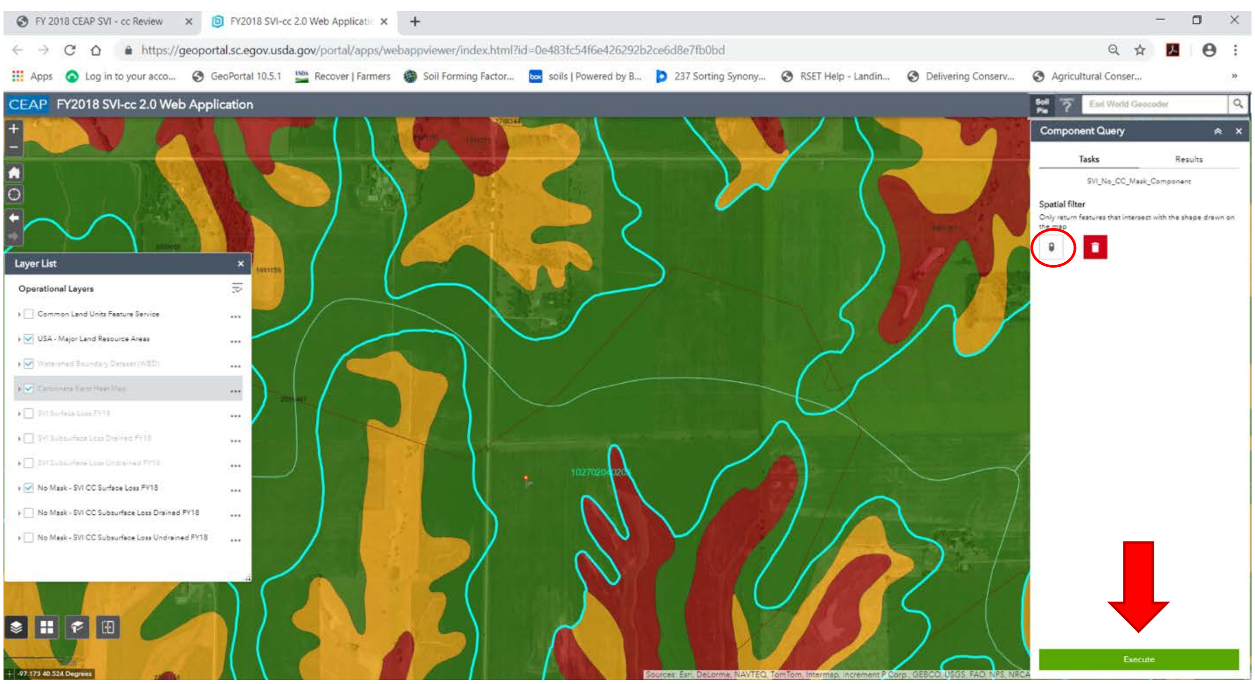


Figure 16. Upon initial selection of polygon with the Soil Component Query Widget, the user is shown the full extent of the map unit within the survey area (pink highlight). The user can use the "Back Button" or click a previously saved book mark to return to their area of work or study.

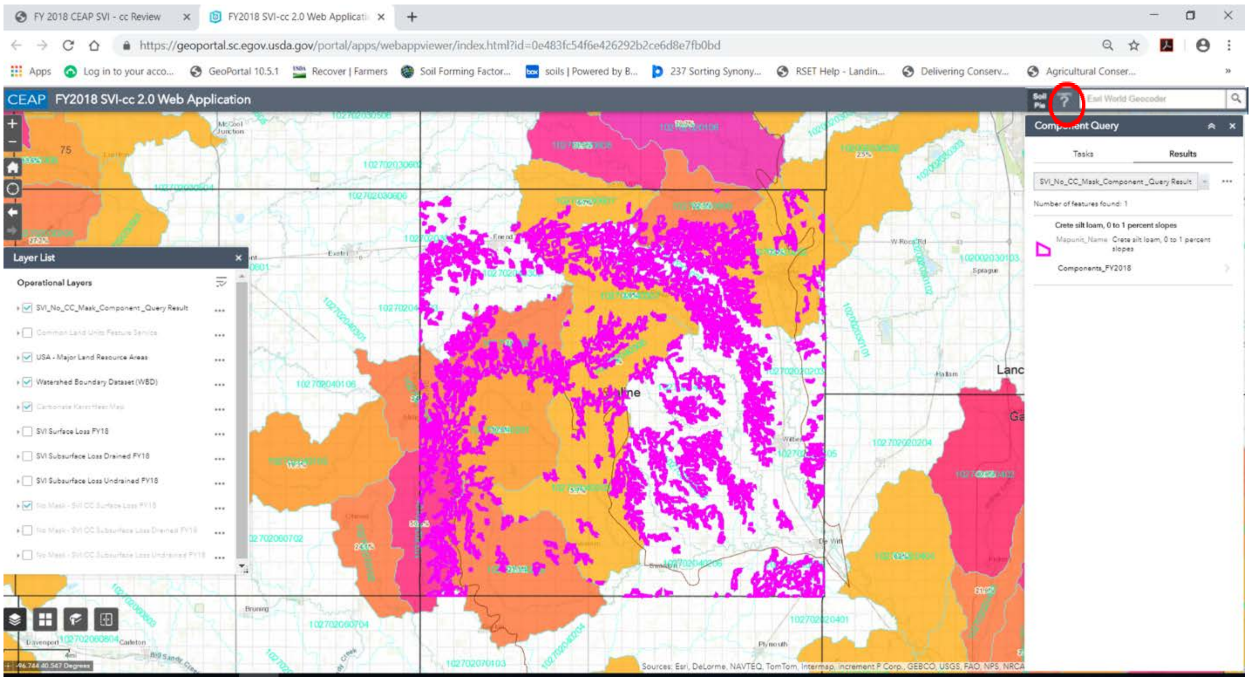


Figure 17. Each FY2018 SSURGO map unit's (has pink highlight) component input and output parameters are presented in collapsible panels (click to open/close). This example SSURGO map unit has 5 individual soil components. Information for Crete is given.

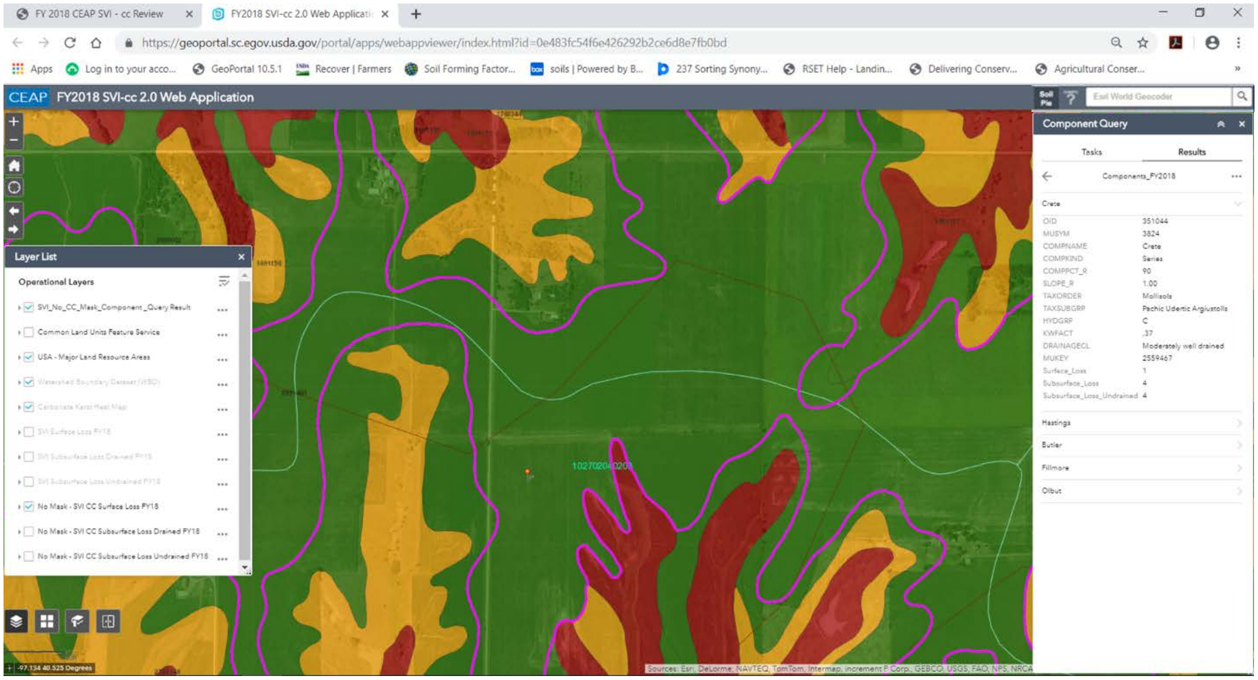


Figure 18. Each FY2018 SSURGO map unit's (has pink highlight) component input and output parameters are presented in collapsible panels (click to open/close). This example SSURGO map unit has 5 individual soil components. Information for Hastings is given.

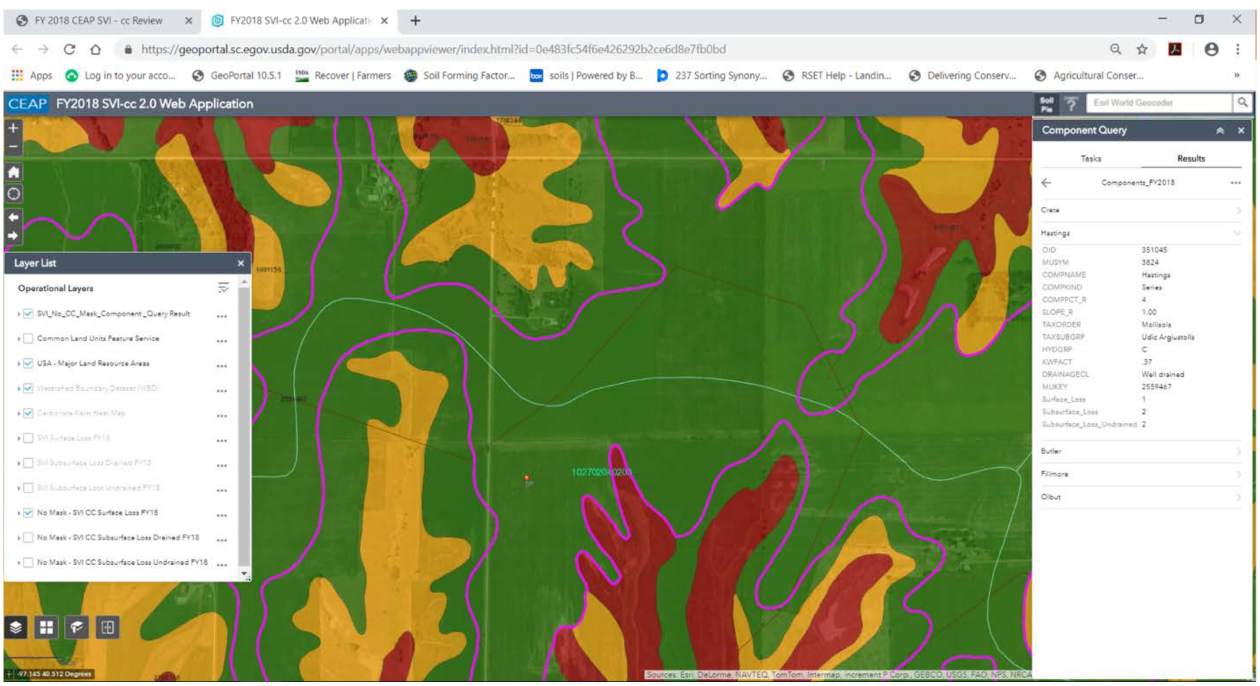
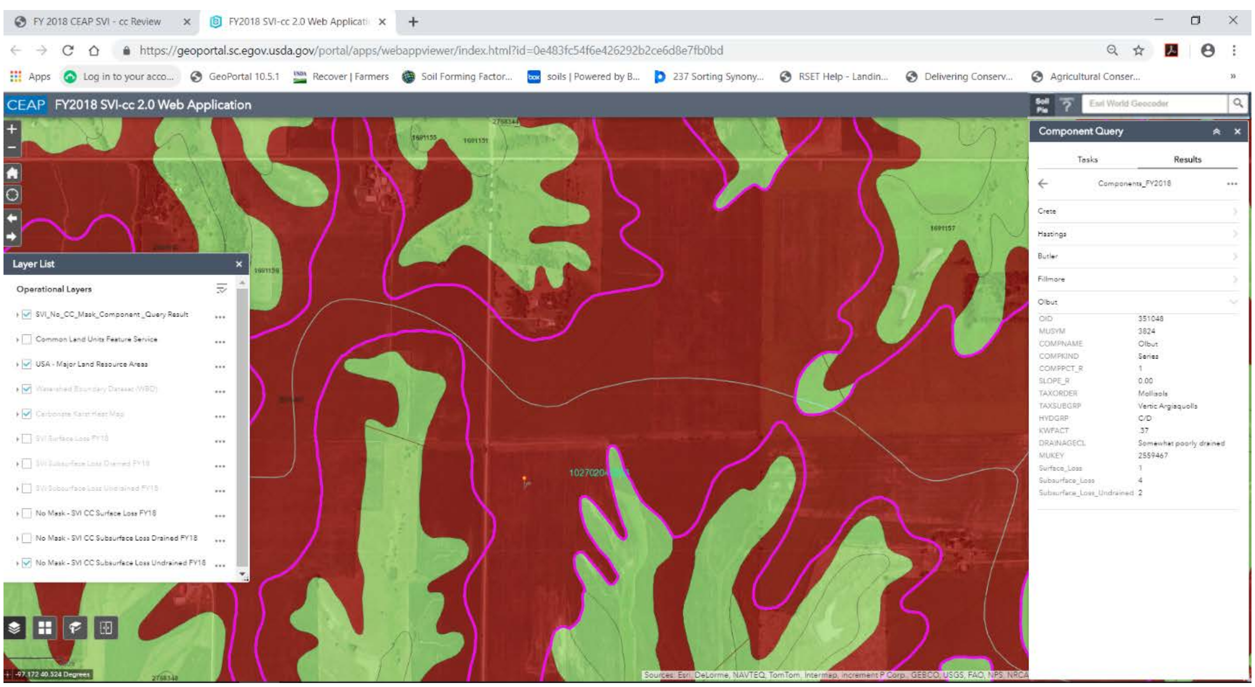
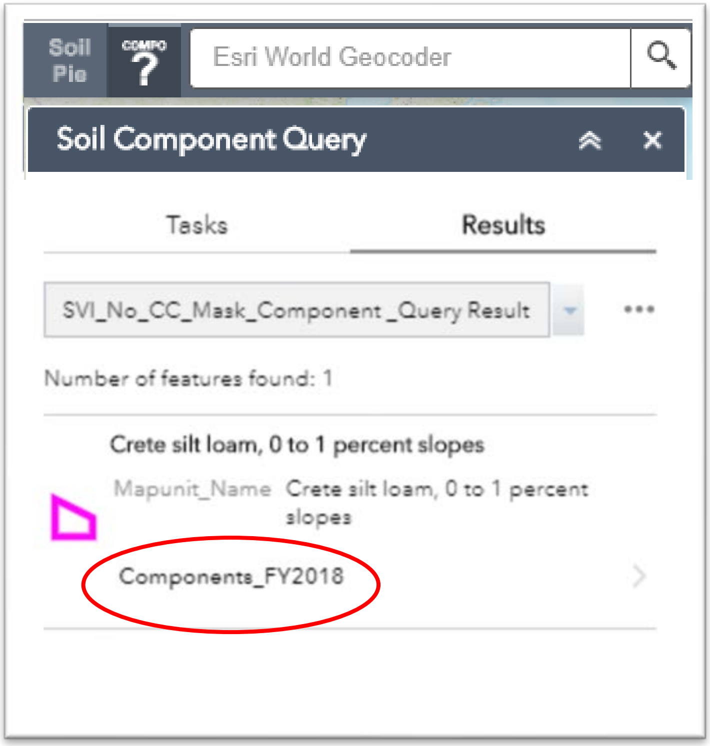


Figure 19. Each FY2018 SSURGO map unit's (has pink highlight) component input and output parameters are presented in collapsible panels (click to open/close). This example SSURGO map unit has 5 individual soil components. Information for Butler is given.

Figure 20. Each FY2018 SSURGO map unit's (has pink highlight) component input and output parameters are presented in collapsible panels (click to open/close). This example SSURGO map unit has 5 individual soil components. Information for Olbut is given.

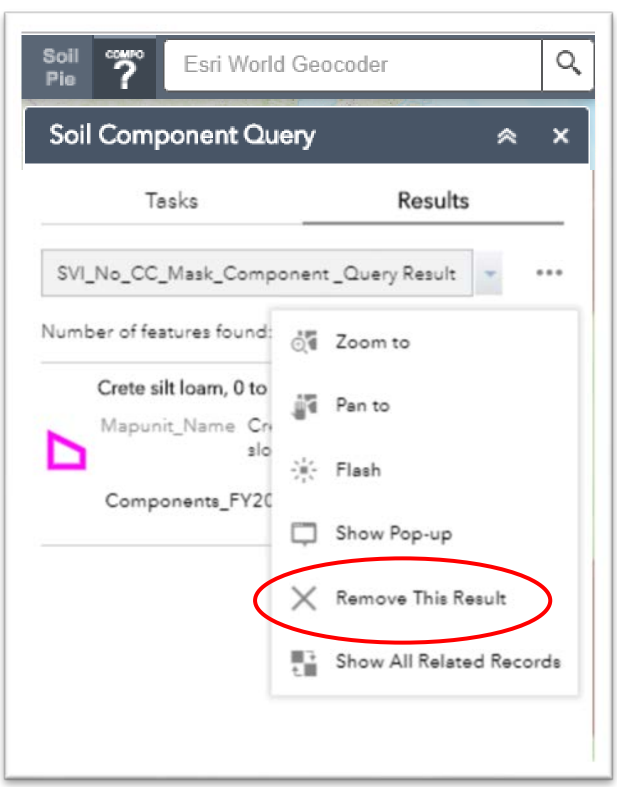


Using the Soil Component Query Widget



The Soil Component Query Widget has two modes: Tasks and Results. The Tasks tab shows the name of the soil map unit and the "Components_FY2018" heading. Click this heading to see individual soil component SVI-cc input parameters and results.

To clear the selected set in the Soil Component Query Widget, click on the 3 dots in the upper right portion of the screen to reveal the pull down menu. Select "Remove This Result" and the pink highlight will be removed indicating the selected set has been cleared. The query result will also be removed from the Layer List box after this is done.



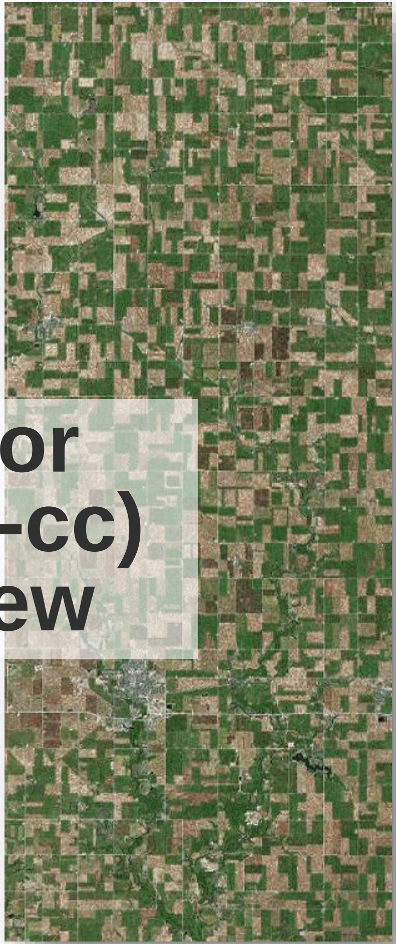
Appendix C

2018 Peer Review Results

The following Appendix summarizes the results of the 2018 SVI-cc peer review and reflect input from NRCS scientists representing the lower 48 States.

CEAP Soil Vulnerability for Cultivated Cropland (SVI-cc) NRCS Internal Peer Review

Wednesday, October 31, 2018



56

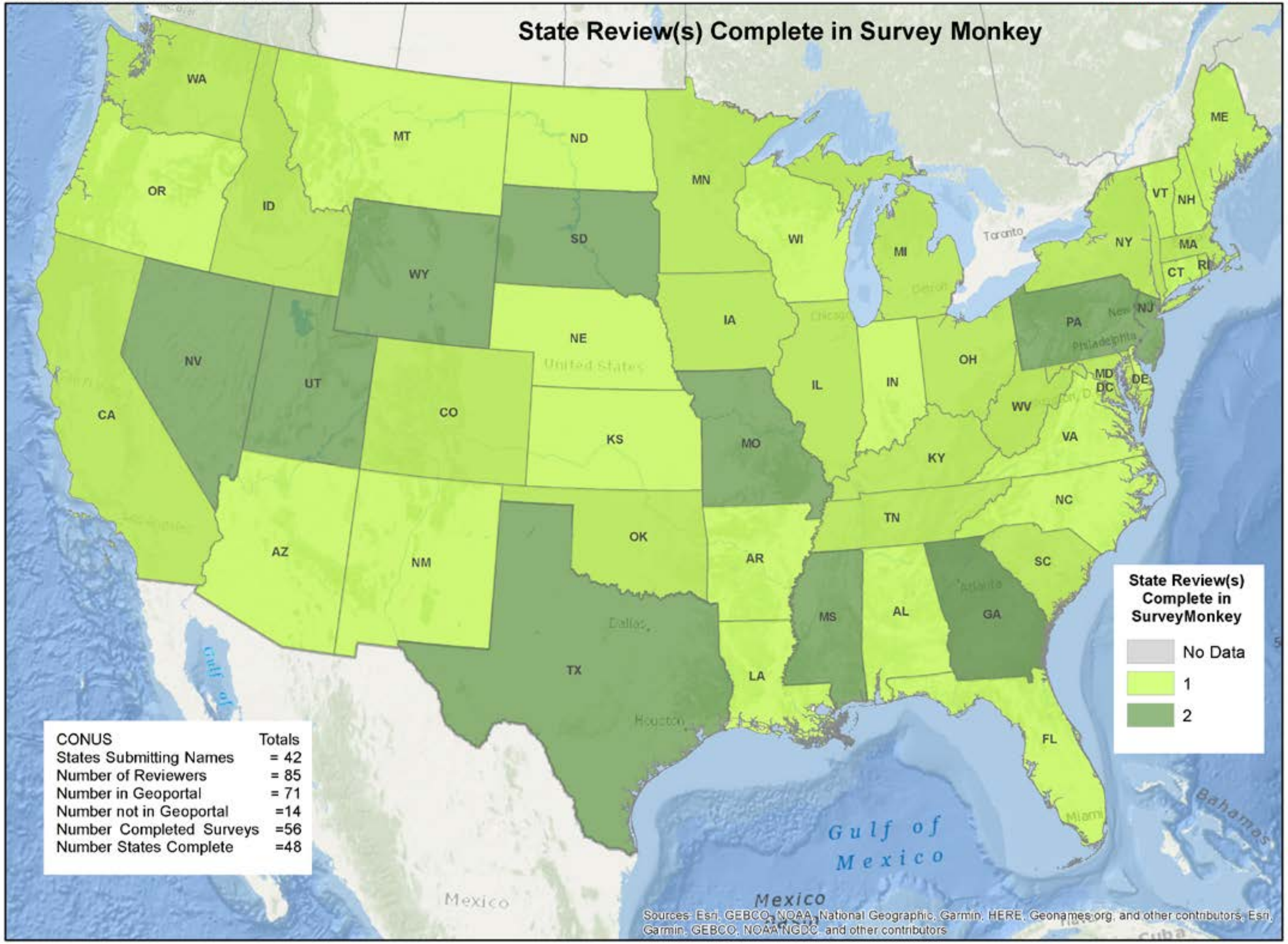
Total Responses

Date Created: Tuesday, May 30, 2017

Completed: Wednesday, October 31, 2018

Complete Responses: 56

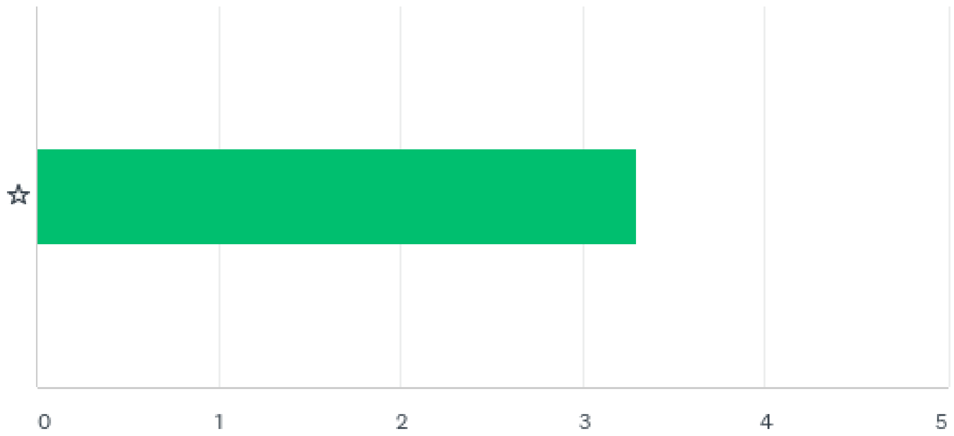
USDA NRCS SVI-cc Peer Review



USDA-Natural Resources Conservation Service - Resource Assessment Division, Beltsville, MD kevin.ingram@wdc.usda.gov Map # 20181031-3538-3

Q1: How well does the cultivated cropland map layer estimate managed cropland (including hay/pasture in rotation plus CRP) in your county, state, or region?

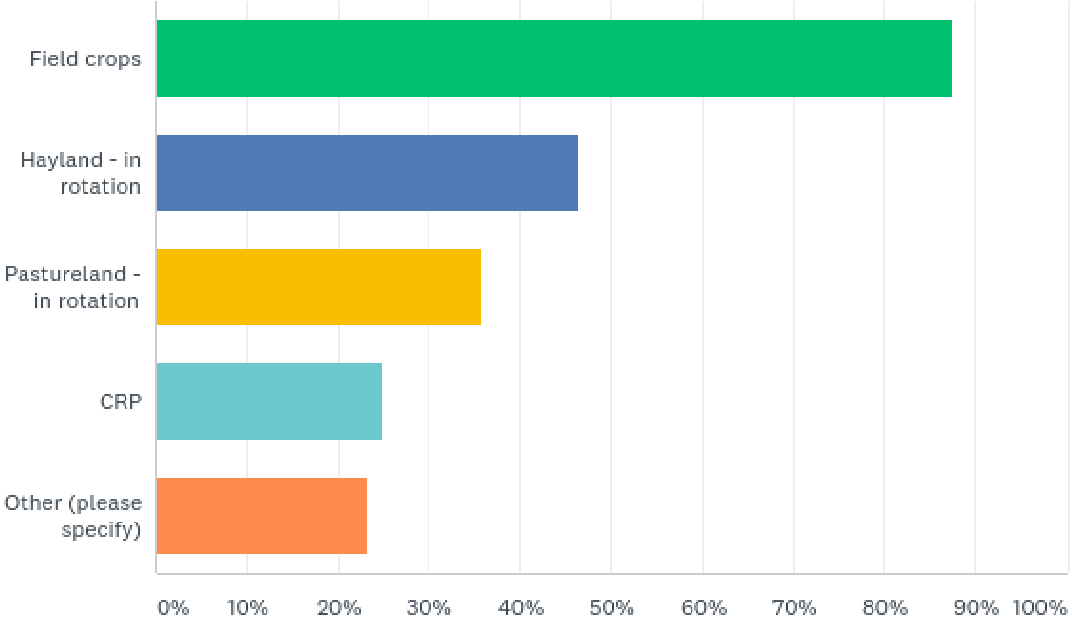
Answered: 56   Skipped: 0



	BAD	NOT SO GOOD	OK	GOOD	VERY GOOD	N/A	TOTAL	WEIGHTED AVERAGE
☆	3.57% 2	14.29% 8	37.50% 21	35.71% 20	7.14% 4	1.79% 1	56	3.29

Q2: What land uses are well represented by the cultivated cropland layer? Choose all that apply

Answered: 56 Skipped: 0



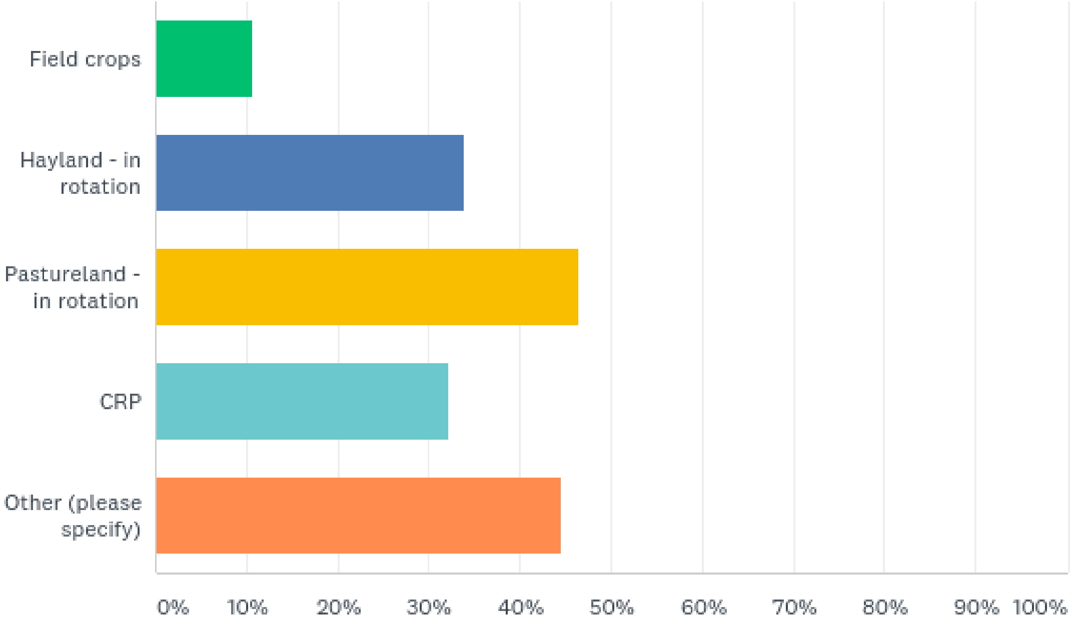
Q2: What land uses are well represented by the cultivated cropland layer? Choose all that apply

Answered: 56   Skipped: 0

ANSWER CHOICES	RESPONSES	
Field crops	87.50%	49
Hayland - in rotation	46.43%	26
Pastureland - in rotation	35.71%	20
CRP	25.00%	14
Other (please specify)	23.21%	13
Total Respondents: 56		

Q3: What land uses are NOT well represented by the cultivated cropland map layer?

Answered: 56   Skipped: 0



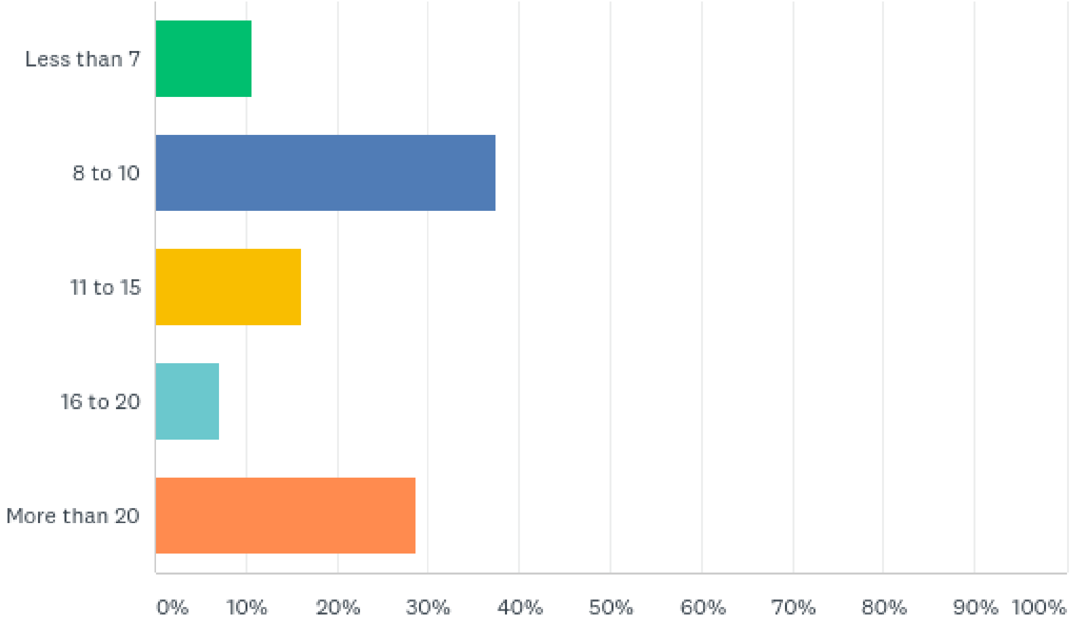
Q3: What land uses are NOT well represented by the cultivated cropland map layer?

Answered: 56   Skipped: 0

ANSWER CHOICES	RESPONSES	
Field crops	10.71%	6
Hayland - in rotation	33.93%	19
Pastureland - in rotation	46.43%	26
CRP	32.14%	18
Other (please specify)	44.64%	25
Total Respondents: 56		

Q4: How many site locations were visited (physically in the field OR virtually using web map application) during your evaluation? **CEAP researchers recommend a minimum of 7-11 site location be visited. Site locations can be easily bookmarked for reference using the web map application.**

Answered: 56 Skipped: 0



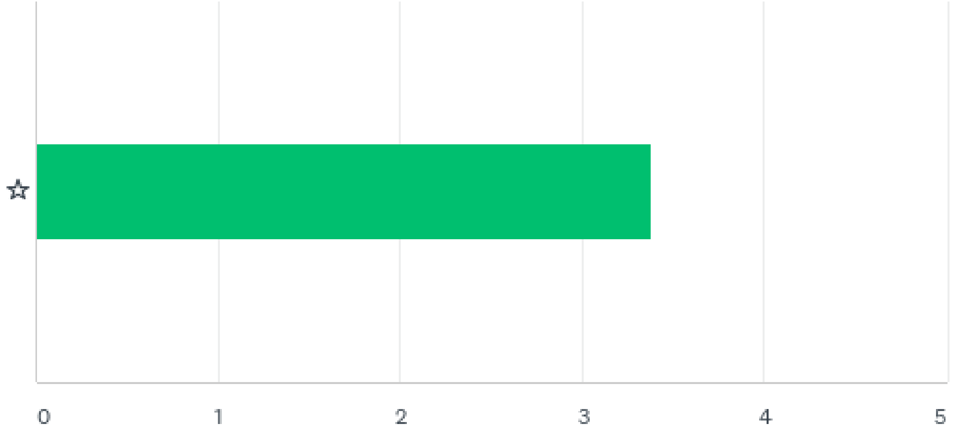
Q4: How many site locations were visited (physically in the field OR virtually using web map application) during your evaluation? CEAP researchers recommend a minimum of 7-11 site location be visited. Site locations can be easily bookmarked for reference using the web map application.

Answered: 56 Skipped: 0

ANSWER CHOICES	RESPONSES	
Less than 7	10.71%	6
8 to 10	37.50%	21
11 to 15	16.07%	9
16 to 20	7.14%	4
More than 20	28.57%	16
Total Respondents: 56		

Q6: How well does the SVI-cc-RUNOFF classification rank the cultivated soils for vulnerability to RUNOFF of sediment and excess nutrients/biological hazards into surface waters in your county, state, or region?

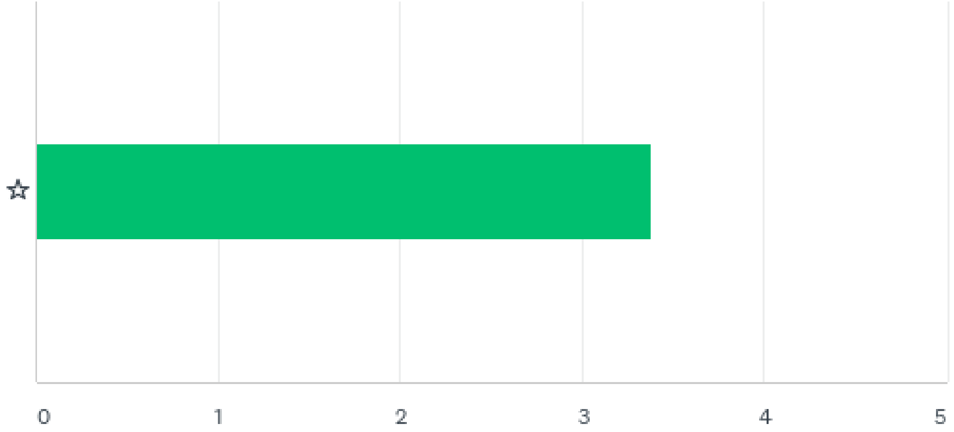
Answered: 56   Skipped: 0



	BAD	NOT SO GOOD	OK	GOOD	VERY GOOD	TOTAL	WEIGHTED AVERAGE
☆	1.79% 1	10.71% 6	42.86% 24	37.50% 21	7.14% 4	56	3.38

Q7: How well does the SVI-cc-RUNOFF identify soils that are MOST vulnerable to RUNOFF of sediment and excess nutrients/biological hazards into surface waters in your county, state, or region?

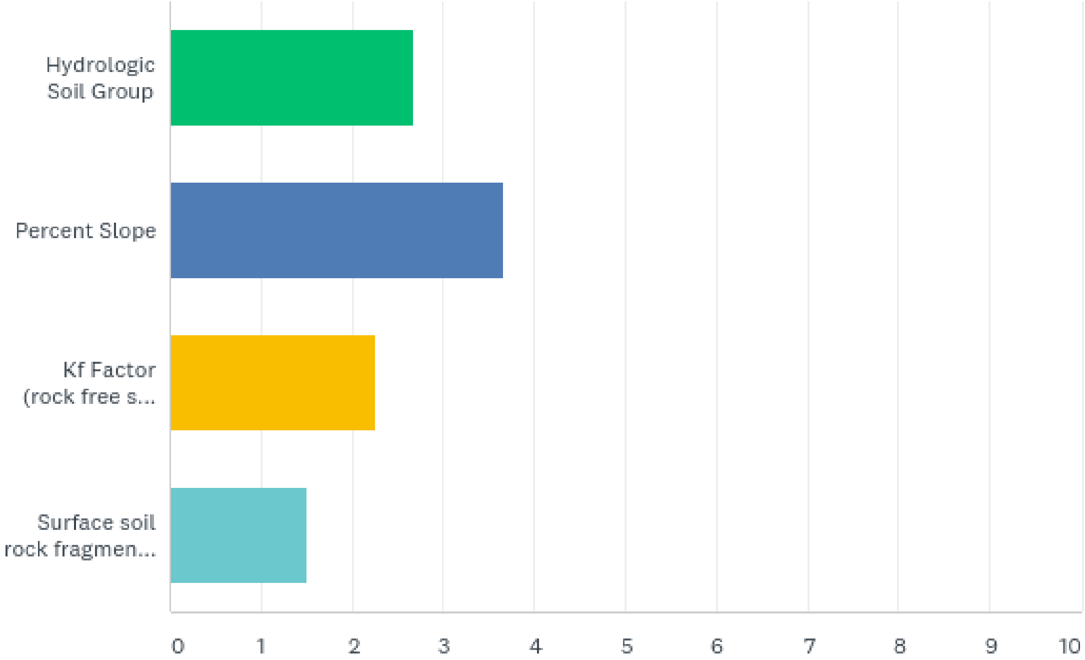
Answered: 56   Skipped: 0



	BAD	NOT SO GOOD	OK	GOOD	VERY GOOD	TOTAL	WEIGHTED AVERAGE
☆	1.79% 1	16.07% 9	33.93% 19	39.29% 22	8.93% 5	56	3.38

Q8: SVI-cc RUNOFF classification rules use detailed soil survey (SSURGO/gSSURGO) component information, including Hydrologic Soil Group, Percent Slope, Kf Factor, and Surface Rock Fragment content. See SVI-RUNOFF Rules Figure in User Guide ranges of values for each class. Please rank the importance of each factor (1 = most important, 4= least important)

Answered: 56 Skipped: 0



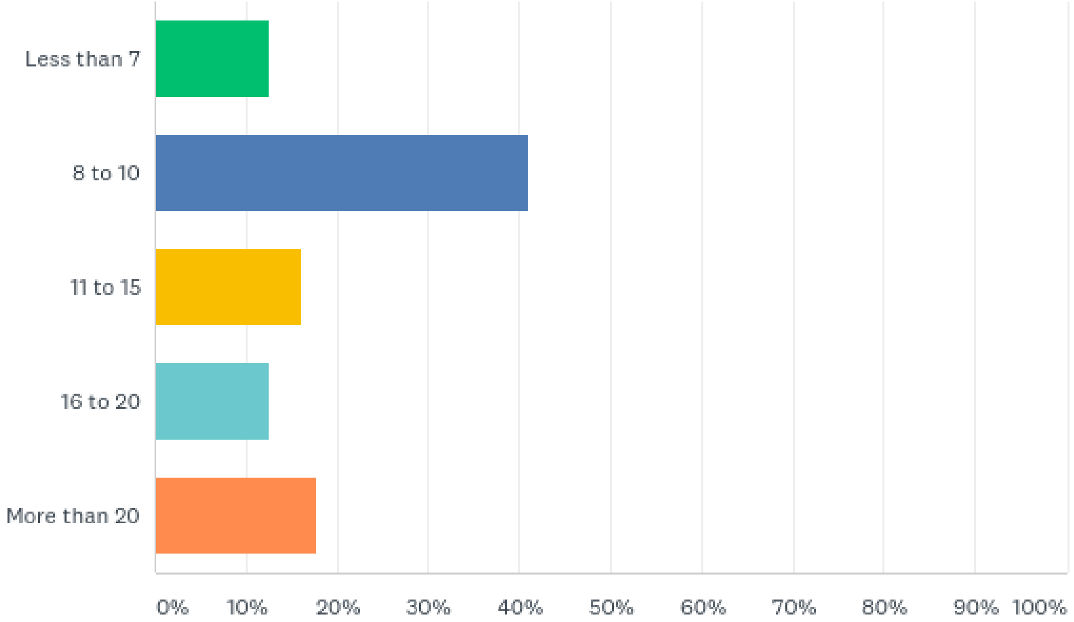
Q8: SVI-cc RUNOFF classification rules use detailed soil survey (SSURGO/gSSURGO) component information, including Hydrologic Soil Group, Percent Slope, Kf Factor, and Surface Rock Fragment content. See SVI-RUNOFF Rules Figure in User Guide ranges of values for each class. Please rank the importance of each factor (1 = most important, 4= least important)

Answered: 56 Skipped: 0

	1	2	3	4	N/A	TOTAL	SCORE
Hydrologic Soil Group	25.00% 14	35.71% 20	8.93% 5	23.21% 13	7.14% 4	56	2.67
Percent Slope	66.07% 37	28.57% 16	1.79% 1	0.00% 0	3.57% 2	56	3.67
Kf Factor (rock free soil erodibility factor)	3.57% 2	25.00% 14	57.14% 32	8.93% 5	5.36% 3	56	2.25
Surface soil rock fragment content	1.79% 1	7.14% 4	26.79% 15	55.36% 31	8.93% 5	56	1.51

Q11: How many site locations were visited (physically in the field OR virtually using web map application) during your evaluation? CEAP researchers recommend a minimum of 7-11 site location be visited. Site locations can be easily bookmarked for reference using the web map application.

Answered: 56 Skipped: 0



Q11: How many site locations were visited (physically in the field OR virtually using web map application) during your evaluation? CEAP researchers recommend a minimum of 7-11 site location be visited. Site locations can be easily bookmarked for reference using the web map application.

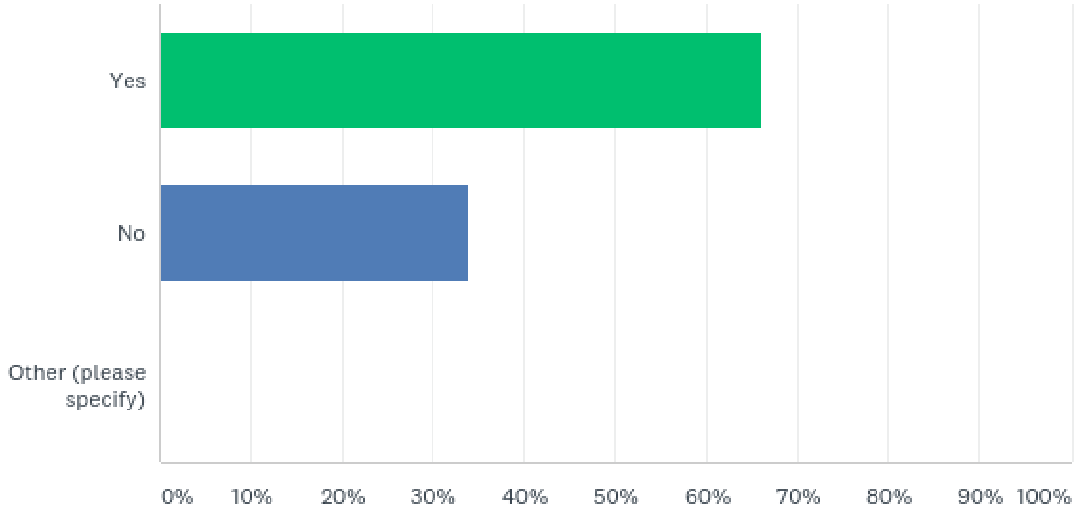
Answered: 56 Skipped: 0

ANSWER CHOICES	RESPONSES	
Less than 7	12.50%	7
8 to 10	41.07%	23
11 to 15	16.07%	9
16 to 20	12.50%	7
More than 20	17.86%	10
Total Respondents: 56		

Q12: Should presence/absence of carbonate karst within the 12-digit HUC or watershed be considered in adjusting SVI-cc RUNOFF rulesets for landscapes where carbonate karst is found?

Note: "The term "karst" has traditionally been used to refer solely to regions of exposed soluble bedrock having an abundance of surface landforms, such as sinkholes, sinking streams, and springs, that reflect the presence of subsurface voids or caves (Ford and Williams, 2007)", from Weary, D.J., and Doctor, D.H., 2014, Karst in the United States: A digital map compilation and database: U.S. Geological Survey Open-File Report 2014–1156, 23 p., http://dx.doi.org/10.3133/ofr20141156.

Answered: 56   Skipped: 0



Q12: Should presence/absence of carbonate karst within the 12-digit HUC or watershed be considered in adjusting SVI-cc RUNOFF rulesets for landscapes where carbonate karst is found?

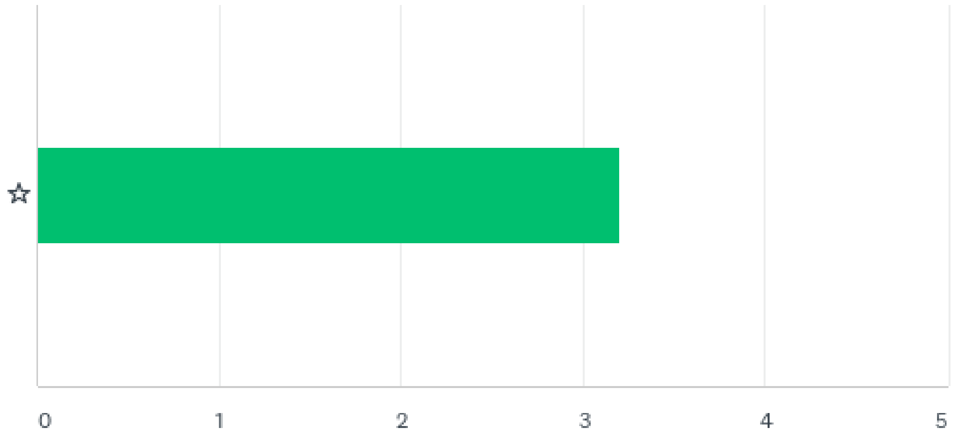
Note: "The term “karst” has traditionally been used to refer solely to regions of exposed soluble bedrock having an abundance of surface landforms, such as sinkholes, sinking streams, and springs, that reflect the presence of subsurface voids or caves (Ford and Williams, 2007)", from Weary, D.J., and Doctor, D.H., 2014, Karst in the United States: A digital map compilation and database: U.S. Geological Survey Open-File Report 2014–1156, 23 p., http://dx.doi.org/10.3133/ofr20141156.

Answered: 56 Skipped: 0

ANSWER CHOICES	RESPONSES	
Yes	66.07%	37
No	33.93%	19
Other (please specify)	0.00%	0
TOTAL		56

Q14: How well does the SVI-cc-LEACHING classification rank the cultivated soils for vulnerability to leaching of excess nutrients/biological hazards into surface or ground waters in your county, state, or region?

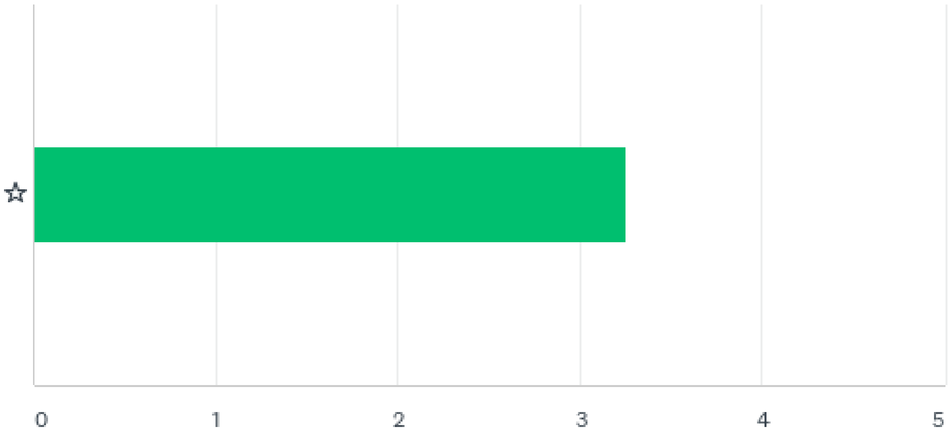
Answered: 56   Skipped: 0



	BAD	NOT SO GOOD	OK	GOOD	VERY GOOD	TOTAL	WEIGHTED AVERAGE
☆	1.79% 1	12.50% 7	51.79% 29	32.14% 18	1.79% 1	56	3.20

Q15: How well does the SVI-cc-LEACHING identify soils that are MOST vulnerable to LEACHING of excess nutrients/biological hazards into surface and ground waters in your county, state, or region?

Answered: 56 Skipped: 0

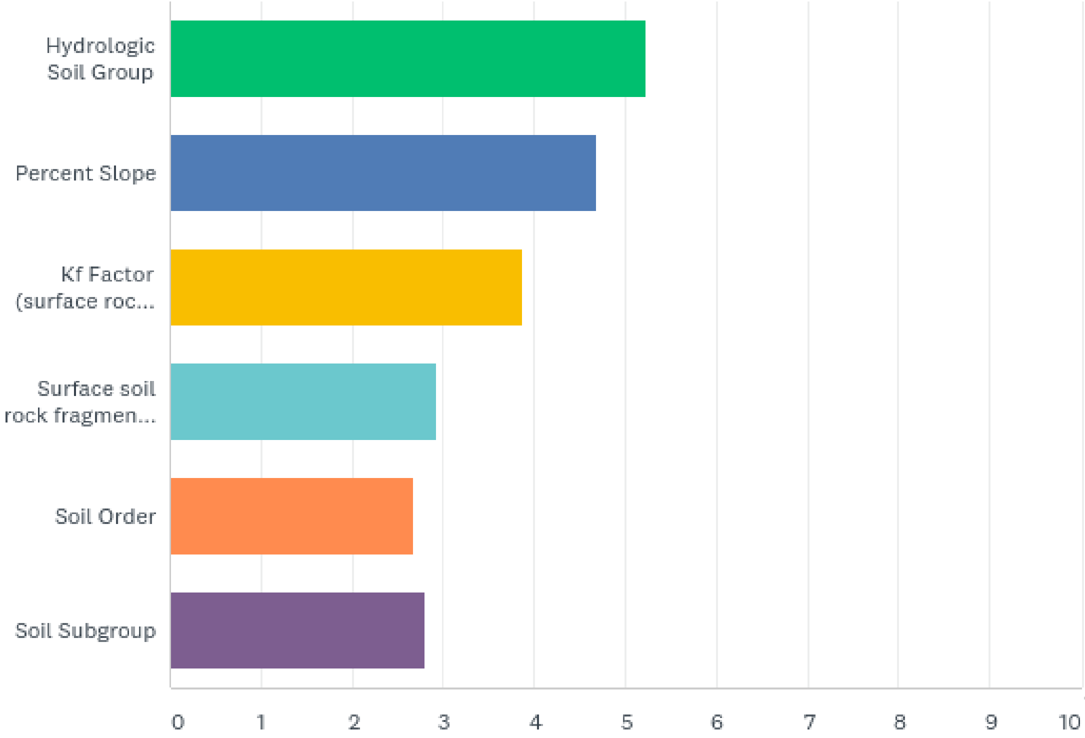


	BAD	NOT SO GOOD	OK	GOOD	VERY GOOD	TOTAL	WEIGHTED AVERAGE
☆	3.57% 2	8.93% 5	50.00% 28	33.93% 19	3.57% 2	56	3.25

Q16: SVI-cc LEACHING classification rules use detailed soil survey

(SSURGO/gSSURGO) component information, including Soil Taxonomic Order, Soil Taxonomic Subgroup, Hydrologic Soil Group, Percent Slope, Kf Factor, and Surface Rock Fragment content. See SVI-cc LEACHING Rules Figure in User Guide for ranges of values for each class. **Please rank the importance of each factor (1 = most important, 6= least important)**

Answered: 56 Skipped: 0



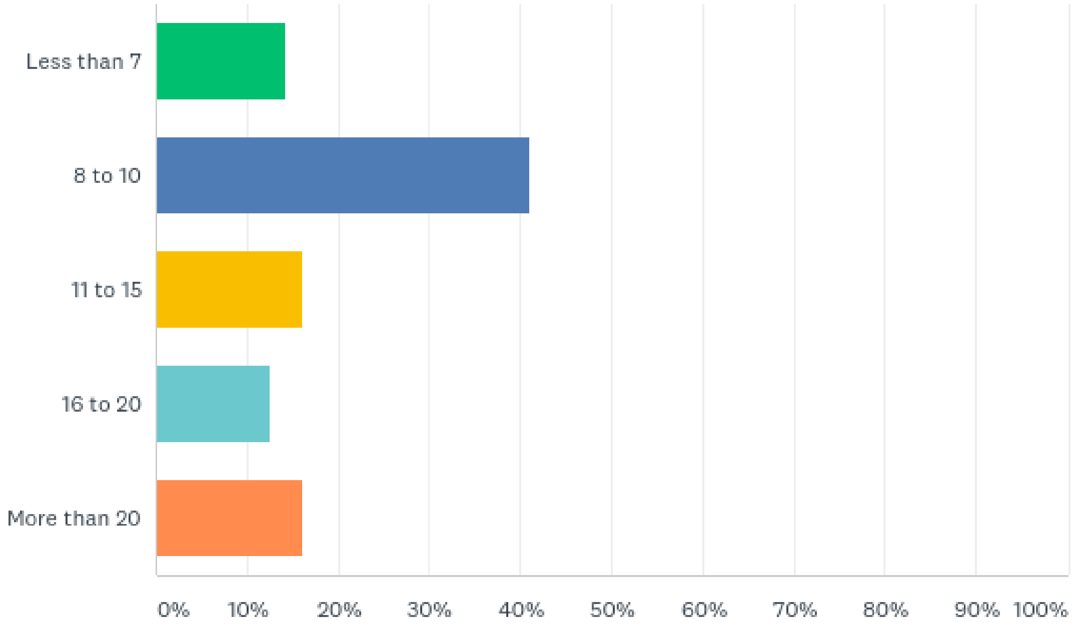
Q16: SVI-cc LEACHING classification rules use detailed soil survey Please rank the importance of each factor (1 = most important, 6= least important)

Answered: 56   Skipped: 0

	1	2	3	4	5	6	N/A	TOTAL	SCORE
Hydrologic Soil Group	57.14% 32	10.71% 6	5.36% 3	8.93% 5	0.00% 0	3.57% 2	14.29% 8	56	5.23
Percent Slope	19.64% 11	48.21% 27	16.07% 9	5.36% 3	5.36% 3	1.79% 1	3.57% 2	56	4.69
Kf Factor (surface rock free soil erodibility factor)	10.71% 6	14.29% 8	26.79% 15	7.14% 4	14.29% 8	3.57% 2	23.21% 13	56	3.86
Surface soil rock fragment content	0.00% 0	7.14% 4	16.07% 9	30.36% 17	7.14% 4	14.29% 8	25.00% 14	56	2.93
Soil Order	5.36% 3	7.14% 4	8.93% 5	16.07% 9	23.21% 13	21.43% 12	17.86% 10	56	2.67
Soil Subgroup	1.79% 1	8.93% 5	17.86% 10	14.29% 8	21.43% 12	17.86% 10	17.86% 10	56	2.80

Q19: How many site locations were visited (physically in the field OR virtually using web map application) during your evaluation? CEAP researchers recommend a minimum of 7-11 site location be visited. Site locations can be easily bookmarked for reference using the web map application.

Answered: 56 Skipped: 0



Q19: How many site locations were visited (physically in the field OR virtually using web map application) during your evaluation? CEAP researchers recommend a minimum of 7-11 site location be visited. Site locations can be easily bookmarked for reference using the web map application.

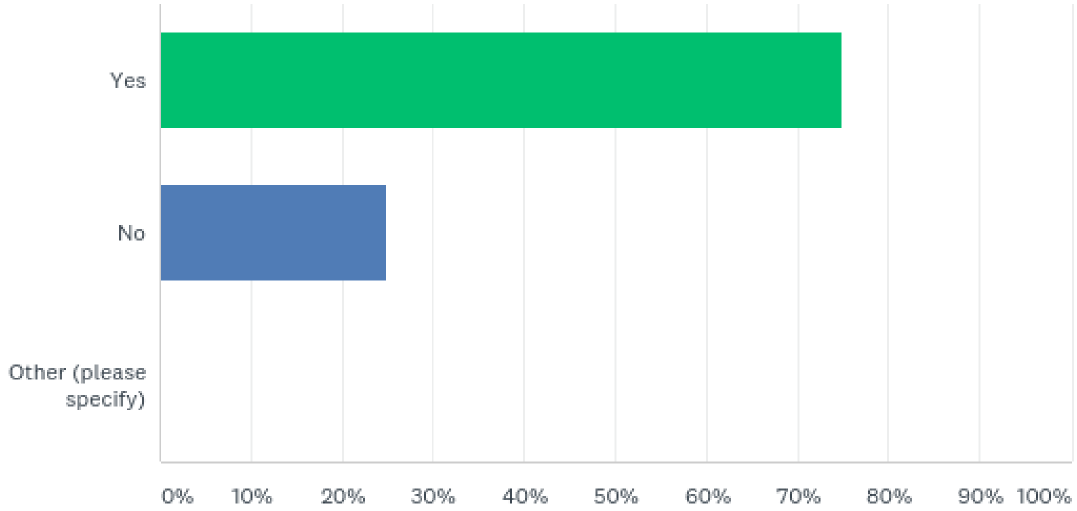
Answered: 56 Skipped: 0

ANSWER CHOICES	RESPONSES	
Less than 7	14.29%	8
8 to 10	41.07%	23
11 to 15	16.07%	9
16 to 20	12.50%	7
More than 20	16.07%	9
Total Respondents: 56		

Q20: Should presence/absence of carbonate karst within the 12-digit HUC or watershed be considered in adjusting SVI-cc LEACHING rulesets for landscapes where carbonate karst is found?

Note: "The term “karst” has traditionally been used to refer solely to regions of exposed soluble bedrock having an abundance of surface landforms, such as sinkholes, sinking streams, and springs, that reflect the presence of subsurface voids or caves (Ford and Williams, 2007)", from Weary, D.J., and Doctor, D.H., 2014, Karst in the United States: A digital map compilation and database: U.S. Geological Survey Open-File Report 2014–1156, 23 p., http://dx.doi.org/10.3133/ofr20141156.

Answered: 56 Skipped: 0



Q20: Should presence/absence of carbonate karst within the 12-digit HUC or watershed be considered in adjusting SVI-cc LEACHING rulesets for landscapes where carbonate karst is found?

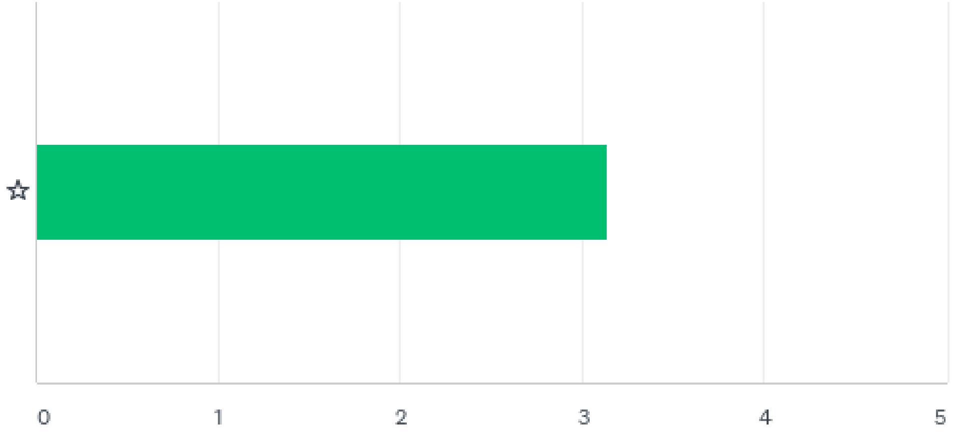
Note: "The term “karst” has traditionally been used to refer solely to regions of exposed soluble bedrock having an abundance of surface landforms, such as sinkholes, sinking streams, and springs, that reflect the presence of subsurface voids or caves (Ford and Williams, 2007)", from Weary, D.J., and Doctor, D.H., 2014, Karst in the United States: A digital map compilation and database: U.S. Geological Survey Open-File Report 2014–1156, 23 p., http://dx.doi.org/10.3133/ofr20141156.

Answered: 56 Skipped: 0

ANSWER CHOICES	RESPONSES	
Yes	75.00%	42
No	25.00%	14
Other (please specify)	0.00%	0
TOTAL		56

Q22: How well does the SVI-cc-LEACHING, MANAGED classification rank the cultivated soils for vulnerability to leaching of excess nutrients/biological hazards into surface or ground waters when ag land drainage systems are used in your county, state, or region?

Answered: 56   Skipped: 0



Q22: How well does the SVI-cc-LEACHING, MANAGED classification rank the cultivated soils for vulnerability to leaching of excess nutrients/biological hazards into surface or ground waters when ag land drainage systems are used in your county, state, or region?

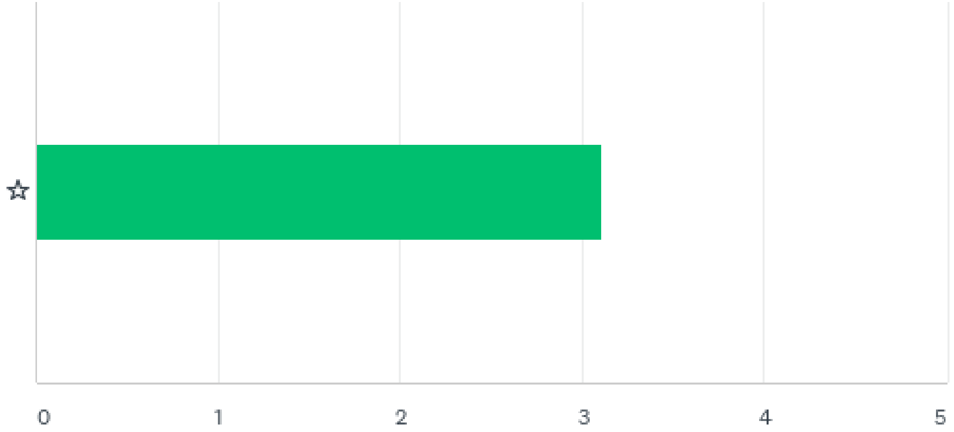
Answered: 56 Skipped: 0

	BAD (1)	NOT SO GOOD (2)	OK (3)	GOOD (4)	VERY GOOD (5)	TOTAL	WEIGHTED AVERAGE
☆	5.36% 3	12.50% 7	46.43% 26	33.93% 19	1.79% 1	56	3.14

BASIC STATISTICS				
Minimum 1.00	Maximum 5.00	Median 3.00	Mean 3.14	Standard Deviation 0.85

Q23: How well does the SVI-cc-LEACHING, MANAGED identify soils that are MOST vulnerable to leaching of excess nutrients/biological hazards into surface and ground waters when ag land drainage systems are used in your county, state, or region?

Answered: 56 Skipped: 0



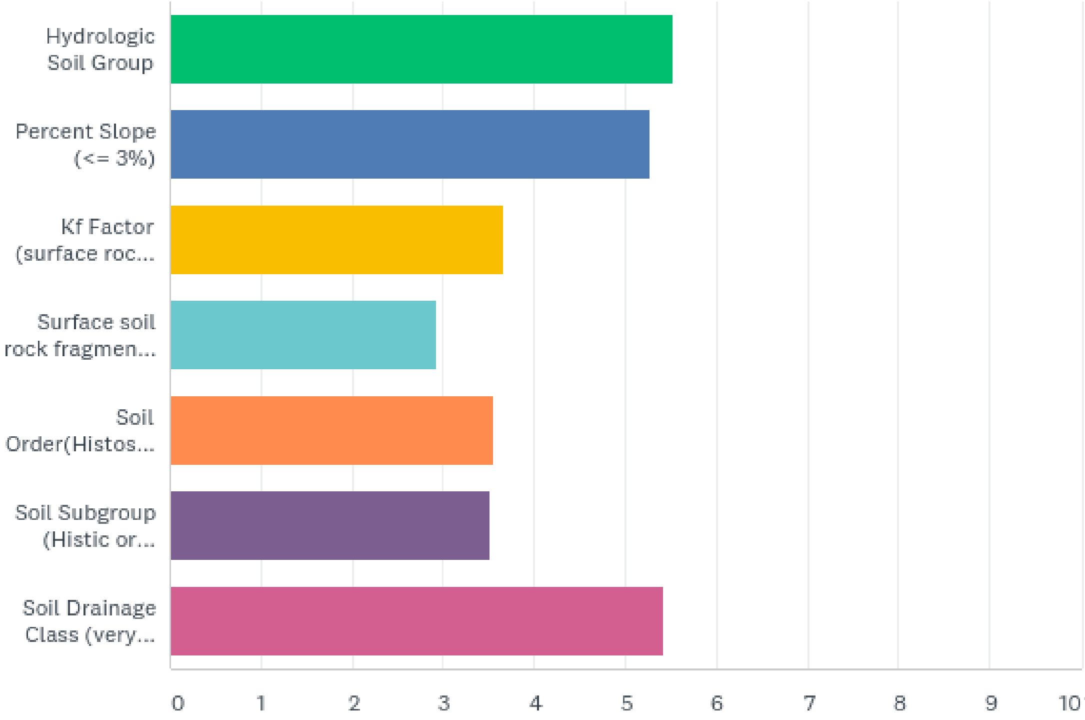
Q23: How well does the SVI-cc-LEACHING, MANAGED identify soils that are MOST vulnerable to leaching of excess nutrients/biological hazards into surface and ground waters when ag land drainage systems are used in your county, state, or region?

Answered: 56 Skipped: 0

	BAD	NOT SO GOOD	OK	GOOD	VERY GOOD	TOTAL	WEIGHTED AVERAGE
☆	5.36% 3	14.29% 8	46.43% 26	32.14% 18	1.79% 1	56	3.11

Q24: SVI-cc LEACHING, MANAGED classification rules use detailed soil survey (SSURGO/gSSURGO) component information, including Soil Taxonomic Order, Soil Taxonomic Subgroup, Hydrologic Soil Group, Percent Slope, Soil Drainage Class, Surface Kf Factor, and Surface Rock Fragment content. See SVI-cc LEACHING, MANAGED Rules Figure in User Guide for ranges of values for each class. **Please rank the importance of each factor (1 = most important, 7= least important)**

Answered: 56 Skipped: 0



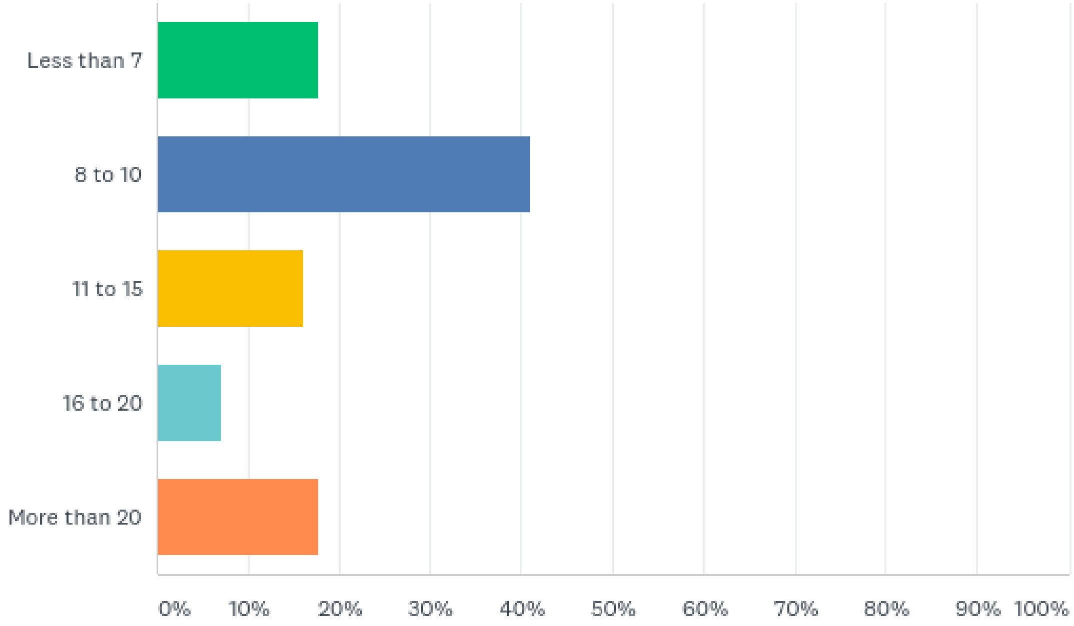
Q24: SVI-cc LEACHING, MANAGED classification rules use detailed soil survey (SSURGO/gSSURGO) component information, including Soil Taxonomic Order, Soil Taxonomic Subgroup, Hydrologic Soil Group, Percent Slope, Soil Drainage Class, Surface Kf Factor, and Surface Rock Fragment content. See SVI-cc LEACHING, MANAGED Rules Figure in User Guide for ranges of values for each class. Please rank the importance of each factor (1 = most important, 7= least important)

Answered: 56 Skipped: 0

	1	2	3	4	5	6	7	N/A	TOTAL	SCORE
Hydrologic Soil Group	32.14% 18	16.07% 9	10.71% 6	17.86% 10	3.57% 2	3.57% 2	0.00% 0	16.07% 9	56	5.53
Percent Slope (<= 3%)	17.86% 10	32.14% 18	25.00% 14	3.57% 2	12.50% 7	1.79% 1	1.79% 1	5.36% 3	56	5.28
Kf Factor (surface rock free soil erodibility factor)	5.36% 3	7.14% 4	14.29% 8	16.07% 9	5.36% 3	16.07% 9	10.71% 6	25.00% 14	56	3.67
Surface soil rock fragment content	0.00% 0	7.14% 4	3.57% 2	10.71% 6	26.79% 15	8.93% 5	17.86% 10	25.00% 14	56	2.93
Soil Order(Histosol/non-Histosol)	7.14% 4	5.36% 3	8.93% 5	14.29% 8	14.29% 8	14.29% 8	10.71% 6	25.00% 14	56	3.55
Soil Subgroup (Histic or non-Histic)	3.57% 2	12.50% 7	8.93% 5	8.93% 5	14.29% 8	14.29% 8	12.50% 7	25.00% 14	56	3.52
Soil Drainage Class (very poorly, poorly, and somewhat poorly)	28.57% 16	12.50% 7	17.86% 10	14.29% 8	5.36% 3	3.57% 2	0.00% 0	17.86% 10	56	5.41

Q27: How many site locations were visited (physically in the field OR virtually using web map application) during your evaluation? CEAP researchers recommend a minimum of 7-11 site location be visited. Site locations can be easily bookmarked for reference using the web map application.

Answered: 56 Skipped: 0



Q27: How many site locations were visited (physically in the field OR virtually using web map application) during your evaluation? CEAP researchers recommend a minimum of 7-11 site location be visited. Site locations can be easily bookmarked for reference using the web map application.

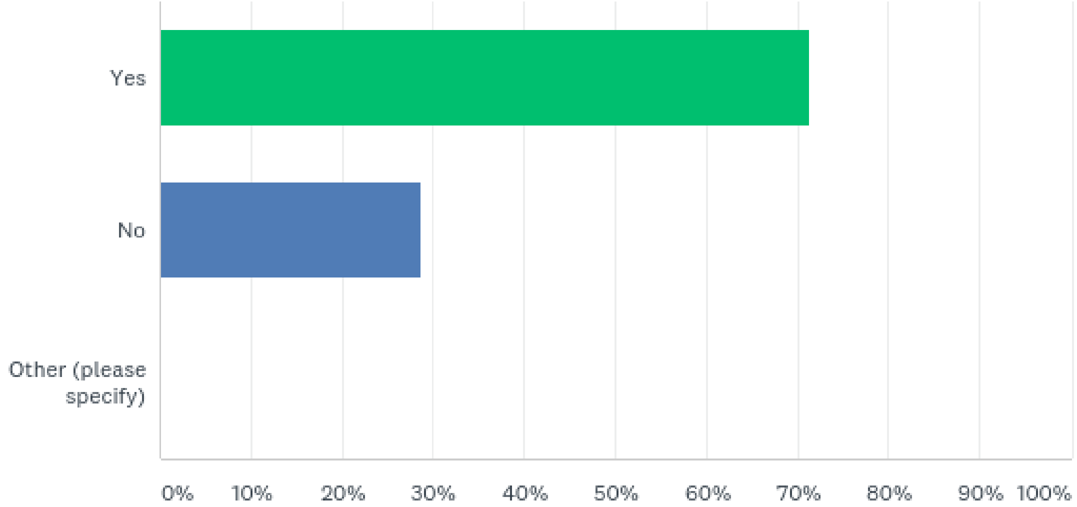
Answered: 56   Skipped: 0

ANSWER CHOICES	RESPONSES	
Less than 7	17.86%	10
8 to 10	41.07%	23
11 to 15	16.07%	9
16 to 20	7.14%	4
More than 20	17.86%	10
Total Respondents: 56		

Q28: Should presence/absence of carbonate karst within the 12-digit HUC or watershed be considered in adjusting SVI-cc LEACHING, MANAGED rulesets for landscapes where carbonate karst is found?

Note: "The term “karst” has traditionally been used to refer solely to regions of exposed soluble bedrock having an abundance of surface landforms, such as sinkholes, sinking streams, and springs, that reflect the presence of subsurface voids or caves (Ford and Williams, 2007)", from Weary, D.J., and Doctor, D.H., 2014, Karst in the United States: A digital map compilation and database: U.S. Geological Survey Open-File Report 2014–1156, 23 p., http://dx.doi.org/10.3133/ofr20141156.

Answered: 56 Skipped: 0



Q28: Should presence/absence of carbonate karst within the 12-digit HUC or watershed be considered in adjusting SVI-cc LEACHING, MANAGED rulesets for landscapes where carbonate karst is found?

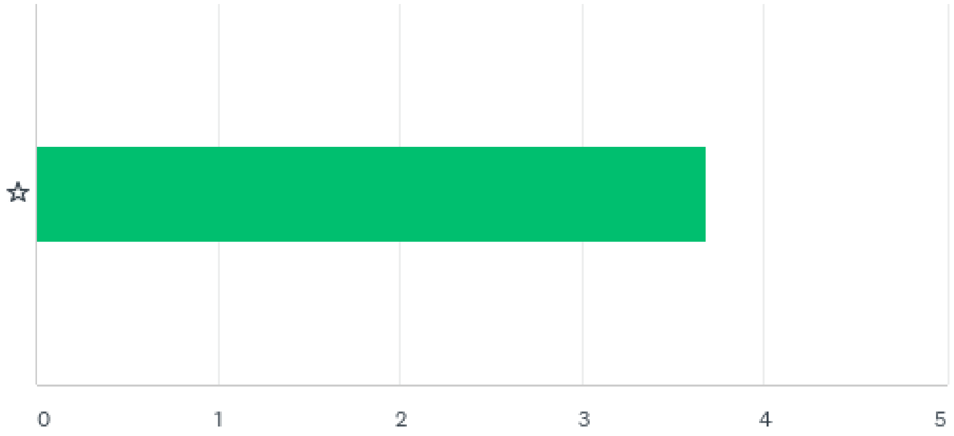
Note: "The term “karst” has traditionally been used to refer solely to regions of exposed soluble bedrock having an abundance of surface landforms, such as sinkholes, sinking streams, and springs, that reflect the presence of subsurface voids or caves (Ford and Williams, 2007)", from Weary, D.J., and Doctor, D.H., 2014, Karst in the United States: A digital map compilation and database: U.S. Geological Survey Open-File Report 2014–1156, 23 p., http://dx.doi.org/10.3133/ofr20141156.

Answered: 56   Skipped: 0

ANSWER CHOICES	RESPONSES	
Yes	71.43%	40
No	28.57%	16
Other (please specify)	0.00%	0
TOTAL		56

Q31: Please rate how easy it was for you to navigate around the SVI-CC web map application.

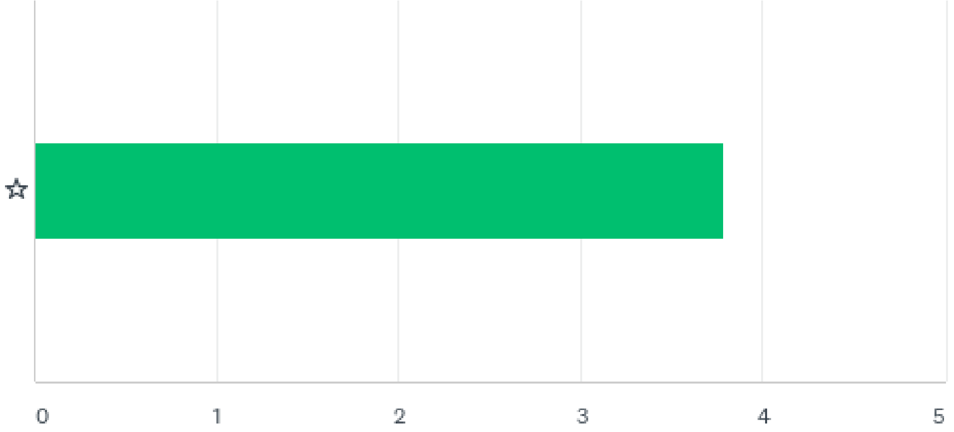
Answered: 56   Skipped: 0



	NOT EASY	NOT SO EASY	OK	EASY	VERY EASY	N/A	TOTAL	WEIGHTED AVERAGE
☆	1.79% 1	16.07% 9	17.86% 10	41.07% 23	23.21% 13	0.00% 0	56	3.68

Q32: Please rate the loading speed and performance of the SVI-CC web map application.

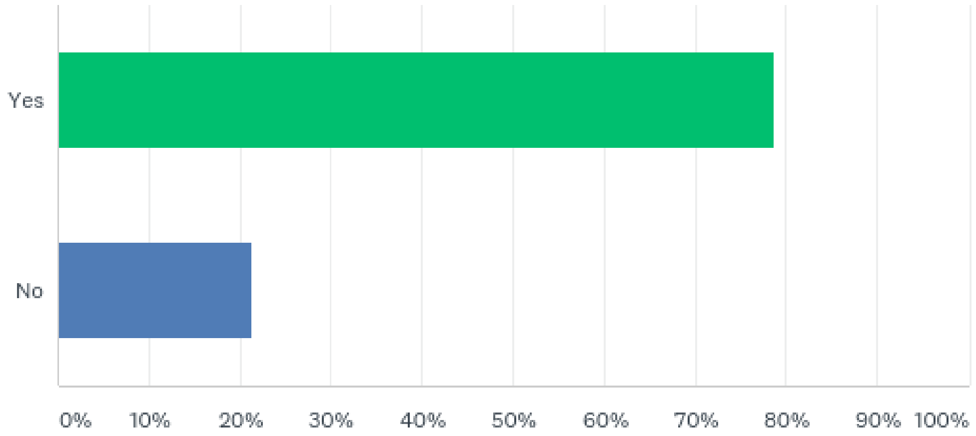
Answered: 56   Skipped: 0



	VERY SLOW	SLOW	MODERATE	FAST	VERY FAST AND SNAPPY	N/A	TOTAL	WEIGHTED AVERAGE
☆	0.00% 0	7.14% 4	19.64% 11	60.71% 34	12.50% 7	0.00% 0	56	3.79

Q34: Did you find the SVI-CC web map application to be useful?

Answered: 56   Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	78.57%	44
No	21.43%	12
TOTAL		56

Summary of Open-ended Questions

Open-ended Survey Monkey Questions and Responses

The SurveyMonkey Survey included eleven open-ended questions where participants could record a narrative response. The total number of individual responses was 67.

Each of these open-ended questions are given in Table 1. These questions are identified as OE 1 for open-ended question 1, OE 2. for open-ended question 2, etc.

Although each OE question was targeted to a given topic, responses could relate to a different topic. All responses were reviewed and placed into one of the following 21 categories, regardless of the associated OE question. The 21 response categories are described in Table 2.

Full response results for each OE question are also available in spreadsheet format (see SVI-cc 2.0 SharePoint site).

Table 1. There were 9 open-ended questions answered by 67 individual respondents from 48 States.

Open-ended Question
OE 1. Please share any additional comments regarding the CEAP Cultivated Cropland map layer.
OE 2. What additional soil properties or characteristics should be added to the SVI-cc RUNOFF ruleset?
OE 3. What additional landscape properties or characteristics should be added to the SVI-cc RUNOFF ruleset?
OE 4. Please share any additional comments regarding the CEAP SVI-cc RUNOFF ruleset and/or map layer or karst landscape consideration.
OE 5. What additional soil properties or characteristics should be added to the SVI-cc LEACHING ruleset?
OE 6. What additional landscape properties or characteristics should be added to the SVI-cc LEACHING ruleset?
OE 7. Please share any additional comments regarding the CEAP SVI-cc LEACHING ruleset and/or map layer or karst landscape consideration.
OE 8. What additional soil properties or characteristics should be added to the SVI-cc LEACHING, MANAGED ruleset?
OE 9. What additional landscape properties or characteristics should be added to the SVI-cc LEACHING, MANAGED ruleset?
OE 10. Please share any additional comments regarding the CEAP SVI-cc LEACHING, MANAGED ruleset and/or map layer or karst landscape consideration.
OE 11. How could the SVI-CC web map application be improved, and the user interface enhanced?

Table 2. Twenty-one response categories were used to summarize open-ended question responses from 56 respondents. The codes are shown below by number, color and description.

Response Group	Response Group Color	Response Group Description
1	1	Custom Cultivated Cropland Layer
2	2	Histosols incorrectly classed for SVI-cc Runoff
3	3	Combine SVI-cc leaching with SVI-cc leaching, managed
4	4	SVI-cc Runoff/Leaching parameters - only use properties
5	5	SVI-cc Leaching parameter (with managed) - only use properties
6	6	How to handle irrigation and wind erosion in the West?
7	7	Can we include "somewhat poorly drained" in the "managed ruleset"?
8	8	Leaching is really not leaching when drainage is applied (tiles or ditches)
9	9	Miscellaneous
10	10	Don't know…
11	11	Use high resolution field level data (LiDAR terrain parameters, local land use, drainage systems, etc.)
12	12	Use regional or landscape level parameters (proximity to well heads and aquifer recharge zones, MAP, etc.)
13	13	What about flooding/ponding?
14	14	Runoff vs. Erosion (Kf vs. Kw) - language adjustment (runoff vs. surface loss, etc.)
15	15	Recommend not including cultivated cropland mask
16	16	Problems navigating web application in Geoportal.
17	17	All comments related to Karst.
18	18	Comments/questions related to rice production concerns.
19	19	All other comments related to web application in Geoportal.
20	20	See separate on-line or attached documents for comments

Each OE question is summarized below with number and percentage of responses for given response categories. Some respondents provided detailed online documents rather than a short narrative. The presence of these documents was noted by category 20. These documents were shared with CEAP researchers for their review and consideration. OE question tables have a descending sort based on the Percent of Responses column. Rounding was done to produce a whole number percent value and error given/taken from the NULL response category to sum to 100 percent.

OE 1. Please share any additional comments regarding the CEAP Cultivated Cropland map layer.

Response Category	Percent of Responses	Number of Responses
1	**34**	**23**
NULL	**32**	**22**
15	**18**	**12**
9	**9**	**6**
16	**3**	**2**
19	**2**	**1**
20	**2**	**1**
Total	**100**	**67**

The majority of 45 responses indicated that the 2011 custom cultivated cropland layer mask did not coincide with their local cultivated land use pattern as shown by current aerial photo imagery web map services and local knowledge. This resulted in some cultivated cropland and CRP lands being excluded from the mask and therefore excluding the SVI-cc classification information for obviously cultivated lands. For this reason, it was determined to remove the mask at 1:24,000 and finer map scales. In the web application, an updated mask (derived from 2017 sources) will be applied at map scales coarser than 1:24,000 and for use for prescribed National and regional resource assessments that require an estimate of cultivated cropland. There were 22 NULL responses.

OE 2. What additional soil properties or characteristics should be added to the SVI-cc RUNOFF ruleset?

Response Category	Percent of Responses	Number of Responses
NULL	**39**	**26**
4	**34**	**23**
11	**7**	**5**
13	**6**	**4**
6	**4**	**3**
12	**4**	**3**
2	**2**	**1**
14	**2**	**1**
20	**2**	**1**
Total	**100**	**67**

The majority of 41 responses stated that basic soil properties should be substituted for the SVI-cc input parameters citing NASIS protocols. In addition, the inclusion of high resolution soil landscape information was recommended. The high resolution information included LiDAR derived land forms and slope estimation as well as known ag drainage networks. Several responses asked why flooding was not considered. There were 26 NULL responses.

OE 3. What additional landscape properties or characteristics should be added to the SVI-cc RUNOFF ruleset?

Response Category	Percent of Responses	Number of Responses
NULL	**52**	**36**
11	**31**	**21**
9	**3**	**2**
12	**3**	**2**
17	**3**	**2**
2	**2**	**1**
10	**2**	**1**
15	**2**	**1**
20	**2**	**1**
Total	**100**	**67**

The majority of 31 responses indicated that high resolution soil landscape information should be included (LiDAR derived landforms, slope gradient, land use etc.). There were 36 NULL responses.

OE 4. Please share any additional comments regarding the CEAP SVI-cc RUNOFF ruleset and/or map layer or karst landscape consideration.

Response Category	Percent of Responses	Number of Responses
NULL	**45**	**31**
17	**25**	**17**
9	**9**	**6**
6	**6**	**4**
10	**4**	**3**
2	**3**	**2**
11	**2**	**1**
13	**2**	**1**
15	**2**	**1**
20	**2**	**2**
Total	**100**	**67**

The majority of 36 responses suggested the presence of karst should be considered during the SVI-cc classification process. Those respondents that did not have karst landscapes to manage felt it was not needed. Several other comments included incorrect classification of Histosols which lead to correction of the Histosol rule to in SVI-cc 2.0. There were 31 NULL responses

OE 5. What additional soil properties or characteristics should be added to the SVI-cc LEACHING ruleset?

Response Category	Percent of Responses	Number of Responses
5	**48**	**32**
NULL	**36**	**25**
9	**4**	**3**
10	**3**	**2**
11	**3**	**2**
12	**2**	**1**
13	**2**	**1**
20	**2**	**1**
Total	**100**	**67**

The majority of 42 responses stated that basic soil properties should be substituted for the SVI-cc input parameters citing NASIS protocols. Several responses also recommended use of high resolution soil landscape information such as LiDAR derived landforms and slope gradient, plus some regional information like mean annual precipitation, proximity to well head intakes. Also mentioned was consideration of flooding conditions. There were 25 NULL responses.

OE 6. What additional landscape properties or characteristics should be added to the SVI-cc LEACHING ruleset?

Response Category	Percent of Responses	Number of Responses
NULL	**61**	**42**
11	**21**	**14**
12	**8**	**5**
17	**6**	**4**
9	**2**	**1**
20	**2**	**1**
Total	**100**	**67**

The majority of 25 responses recommended adding high resolution soil landscape information such as LiDAR derived landforms and slope gradient, plus some regional information like mean annual precipitation, proximity to well head intakes. Also mentioned was importance of presence of karst landscapes. There were 42 NULL responses.

OE 7. Please share any additional comments regarding the CEAP SVI-cc LEACHING ruleset and/or map layer or karst landscape consideration.

Response Category	Percent of Responses	Number of Responses
NULL	**54**	**38**
9	**15**	**10**
17	**15**	**10**
5	**3**	**2**
12	**3**	**2**
2	**2**	**1**
6	**2**	**1**
10	**2**	**1**
13	**2**	**1**
15	**2**	**1**
Total	**100**	**67**

The majority of 29 responses includes discussion of importance of presence of karst and various miscellaneous comments. In addition, some comments included questions about how to handle irrigation waters as well as flooding. Also mentioned was the need to remove the custom cultivated cropland mask. There were 38 NULL responses.

OE 8. What additional soil properties or characteristics should be added to the SVI-cc LEACHING, MANAGED ruleset?

Response Category	Percent of Responses	Number of Responses
NULL	**48**	**33**
5	**34**	**23**
10	**6**	**4**
9	**4**	**3**
3	**2**	**1**
11	**2**	**1**
12	**2**	**1**
13	**2**	**1**
Total	**100**	**67**

The majority of 34 responses stated that basic soil properties should be substituted for the SVI-cc input parameters citing NASIS protocols. These basic soil properties include: saturated hydraulic conductivity, depth to water table, cation exchange capacity, effective cation exchange capacity, depth to a restrictive feature, and soil organic matter. Several respondents indicated they did not know or were not certain how to answer. Others indicated that high resolution and/or regional soil landscape information should be considered, as well as flooding conditions. There were 33 NULL responses.

OE 9. What additional landscape properties or characteristics should be added to the SVI-cc LEACHING, MANAGED ruleset?

Response Category	Percent of Responses	Number of Responses
NULL	**64**	**44**
11	**12**	**8**
12	**9**	**6**
17	**4**	**3**
9	**3**	**2**
5	**2**	**1**
10	**2**	**1**
18	**2**	**1**
20	**2**	**1**
Total	**100**	**67**

The majority of 23 responses recommended adding high resolution soil landscape information such as LiDAR derived landforms and slope gradient or regional landscape position such as flat plain geomorphology and hillslope. There were also comments related to inclusion of karst as well as how to handle rice production (flooded conditions). There were 44 NULL responses.

OE 10. Please share any additional comments regarding the CEAP SVI-cc LEACHING, MANAGED ruleset and/or map layer or karst landscape consideration.

Response Category	Percent of Responses	Number of Responses
NULL	**57**	**39**
9	**12**	**8**
17	**10**	**7**
8	**4**	**3**
10	**4**	**3**
14	**3**	**2**
3	**2**	**1**
6	**2**	**1**
7	**2**	**1**
15	**2**	**1**
20	**2**	**1**
Total	**100**	**67**

The majority of 28 responses dealt with various miscellaneous comments. However, several dealt with combining the managed and unmanaged rulesets into a single ruleset. In addition, comments took exception with the use of the term “leaching. It was suggested that that when tile drainage is used it is more runoff. This led to the change in terminology in SVI-cc 2.0 to treat leaching in a more general way as “subsurface loss”. Also mentioned was inclusion of karst plus how best to handle runoff from irrigated fields within the SVI-cc. There were 39 NULL responses.

OE 11. How could the SVI-CC web map application be improved, and the user interface enhanced?

Response Category	Percent of Responses	Number of Responses
19	**28**	**28**
NULL	**23**	**17**
16	**13**	**13**
9	**3**	**2**
10	**3**	**2**
4	**2**	**1**
6	**2**	**1**
12	**2**	**1**
15	**2**	**1**
20	**1**	**1**
Total	**100**	**67**

The majority of 39 responses dealt with overall positive comments concerning the SVI-cc web application offering constructive additions and changes. However, several comments also reported a negative assessment of the web application. The balance of responses reflected overall comments from the OE 1 though OE 10 questions. There were 28 NULL responses.