Europe – North America Soil Geographic Information for Pesticide Studies (ENASGIPS)

Soil, Climate and Crop Database
Ecoregion Crosswalk Tool
Site Selection Tool

Version 3.0 for ArcGIS 10.1 and 10.2

USER GUIDE

September 2015

OECD

Canada
Health Canada / Santé Canada
Agriculture and Agri-Food Canada / Agriculture et Agroalimentaire Canada

EPA United States Environmental Protection Agency

JRC EUROPEAN COMMISSION

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1. VERY IMPORTANT – PLEASE READ

Europe – North America Soil Geographic Information for Pesticide Studies

1. This ENASGIPS model has been developed by the Pest Management Regulatory Agency - Health Canada and the US Environmental Protection Agency in collaboration with Agriculture and Agri-Food Canada and the EC Joint Research Centre, as part of the OECD project “Harmonized International Guidance for Pesticide Terrestrial Field Dissipation Studies and Crosswalk of North American and European Eco-regions”.

2. Any comments should be directed to Raju_Gangaraju@hc-sc.gc.ca.

3. The ENUSGIPS software is designed for use within
    a. - ArcGIS 10.1 (Windows XP or Windows 7, Windows 8)
    b. - ArcGIS 10.2 (Windows XP or Windows 7, Windows 8)

2. INTRODUCTION

The Ecoregion Crosswalk is a component of an OECD project to maximize the use of pesticide terrestrial field dissipation studies by developing a harmonized international guidance for conducting the studies and identifying comparable North American and European ecoregions.

Pesticide regulatory agencies/departments world-wide require data on pesticide field dissipation/accumulation to determine “what happens to a pesticide when it is used according to label directions in a representative use area and when all the factors of transformation and transport are acting together”. Studies should account for total dissipation, i.e., transformation, persistence, leaching, residue carryover, surface transport, volatilization, plant uptake, transformation products, etc., and also identify the major dissipation routes.

Under global joint reviews as well as national reviews, field dissipation / accumulation data from studies conducted in foreign countries are submitted to regulatory agencies/departments, with a request to consider accepting them to satisfy country-specific data requirements.

The fate and behaviour of a pesticide in a region depend on environmental factors, such as soils and climate. If these environmental factors are similar between areas, then a pesticide is expected to behave in a similar way in those areas.

This approach has the potential of reducing the total number of terrestrial field dissipation / accumulation studies required for global joint reviews and registration, which strengthen regulatory decisions and reduce cost for both regulatory agencies and the pesticide industry.

The Ecoregion Crosswalk consists of a GIS-based model, ENASGIPS (Europe-North America Soil Geographic Information for Pesticide Studies) with the following components:

- A tool for identifying ecoregions with similar soil and climate
- A tool for site selection based on user defined soil, climate and crop criteria
- A tool for displaying crop density (percentage of land covered by crop) for Canada, United States and the European Union
- A tool for identifying field site locations based on coordinates
- A geographic database of soil, climate and crop information

3. INSTALLATION of ENASGIPS

3.1 Installing the Addin for ArcGIS Desktop

Run **ENASGIPSv3.0_AddinInstallation.exe.** This installer will add the Addin files to your system.

Single User Installation of the Addin: This utility will install the Addin for you in the default location, as a user on this computer. Other users will not have the Addin available. The addin will be installed in this default folder:

<Your User Documents Folder>\ArcGIS\Addins\

All Users Installation of the AddIn: If you wish to install the Addin for all users on this computer, change the install location to one of these locations, depending on the version of ArcGIS you have installed:

C:\Program Files (x86)\ArcGIS\Desktop10.1\Bin\Addins
C:\Program Files (x86)\ArcGIS\Desktop10.2\Bin\Addins

If you have installed previous versions of ENASGIPS addin in the same folder, the installation software will delete previous installations. If you have previous installations of the Addin elsewhere, this may cause problems running the latest version, and you will need to delete all copies of previous Addins. Delete any of these files:

ENASGIPS*.dll
Enasgips*.esriaddin
ENASGIPS*.pbd

These files may be located in either of these directories

<Your User Documents Folder>\ArcGIS\Addins\Desktop10.1
C:\Program Files (x86)\ArcGIS\Desktop10.1\Bin\Addins
<Your User Documents Folder>\ArcGIS\Addins\Desktop10.2
C:\Program Files (x86)\ArcGIS\Desktop10.2\Bin\Addins

3.2 Installing the ENASGIPS Database and documents

- Run **ENASGIPSv3.0_DatabaseInstallation.exe.** This will install the database and associated documentation in a directory of your choosing.

- The database will work most efficiently if installed in a local directory. The software access the database very frequently when making queries and drawing maps. A local drive will provide the best performance, for example:

    - C:\ENASGIPS

- The database MUST be installed in a folder where the current user has both read and write privileges.

- Installation of the database on a network drive is possible, as long as current user has read and write privileges on the folder on the network drive, but performance may be less than when installed on a local drive. This will be most noticeable during queries and drawing of maps.

3.3 STARTING THE APPLICATION

Double click on ArcMap document file in your ENASGIPS install folder to open the project within ArcMap.

ENASGIPSV3.0_Arc10_2.mxd (this map document works for either ArcGIS 10.1 or ArcGIS 10.2)

4. ENASGIPS SOFTWARE AND DATABASE OBJECTIVES

The objectives of the ENASGIPS software and database are:

- To provide a tool to compare and identify ecoregions that have similar soil and climate characteristics between North America and the European Union
- To provide a GIS-based Decision Support System to assist the pesticide industry and regulatory authorities in the selection of sites / regions for field studies
- To provide background soil, climate and crop information including location details

4.1 The Ecoregion Concept Overview

Site specific characteristics of soil and climate play a major role in determining the behaviour and fate of pesticides introduced into the environment. Principle soil factors that influence the pesticide behaviour to a large extent are pH, organic carbon and texture, although other properties such as cation exchange capacity (CEC) and topography play a role. Climatic parameters include precipitation and temperature. A chemical is expected to behave similarly in similar ecoregions that are based on soils and climate.

The soil and climate parameters are collectively treated under ecoregions and based on these parameters, the regions are classified into different regional units. If the regions are similar, then a pesticide is expected to behave in a similar way within those regions. A preliminary pilot project conducted by the Pest Management Regulatory Agency (PMRA) and the US Environmental Protection Agency (EPA), in collaboration with Agriculture and Agri-Food Canada (AAFC) and the EC Joint Research Centre (EC JRC) indicated that similar ecoregions exist in North America and Europe (based on a defined set of criteria) and, a terrestrial field study of pesticide dissipation/accumulation conducted in Europe may be considered by the North American regulatory agencies and vice versa.

Previously, no methodology was available to assess the equivalency of European ecoregions to those of North America. This led to the development of the geospatial ecoregions Crosswalk Tool (ERX) to compare and identify similar ecoregions by the PMRA and the US EPA in association with AAFC and the EC JRC, Italy. This crosswalk tool is now ENASGIPS software and database.

Previously, a similar GIS-based model, CANDA US Soil Geographic Information for Pesticide Studies (CANUSGIPS), was developed under the North American Free Trade Agreement (NAFTA) to compare and identify similar ecoregions between Canada and US. For the NAFTA project, the existing North American Ecological Regions Level II (v3) map was used. A similar approach was followed to develop the ENASGIPS model.

5. ECOREGION SIMILARITY

The ENASGIPS model utilizes the World Wildlife Fund Terrestrial ecoregion framework, soil databases from the Harmonized World Soil Database (HWSD), climatic information from the MARS FOODSEC Meteodata climate dataset, and crop data from Europe, Canada and the United States (three separate sources).

A component of the ENASGIPS is the ecoregion Similarity Model (ESM). To assist in identifying ecoregions that have similar soils and climate, a similarity score was calculated between each ecoregion and all other ecoregions. The similarity score is calculated using these parameters:

- Mean annual temperature (1987 to 2011)
- Mean annual precipitation (1987 to 2011)
- Mean soil pH
- Mean soil organic carbon
- Soil texture (rank ordered)

The process of calculating similarity scores is detailed later in this report. Briefly, the process starts with a “Root ecoregion”. For the root ecoregion, the mean and standard deviation of each parameter is calculated. Comparison ecoregions are examined to determine how closely the composition of the comparison ecoregion matches the root ecoregion. For a comparison ecoregion, the difference in each parameter is calculated as a function of standard deviations from the means. Each of the five parameters is scored separately, and then the five scores are combined with equal weighting into an overall Similarity Score.

For comparison of ecoregions, two methods were developed: Holistic Similarity Modeling and Weights of Evidence Modeling

5.1 Holistic Similarity Modeling

Holistic Similarity Modeling is a process to assist in identifying ecoregions that have similar soils and climate conditions. A similarity score was calculated between each ecoregion and all other ecoregions. The similarity score is calculated using all five parameters: Each of the five parameters is scored separately, and then the five scores are combined with equal weighting into an overall Similarity Score. This is referred to as Holistic Ecoregion Similarity as all five parameters are weighted equally. There is an additional option to calculate similarity with any combination of the five parameters, and this process is referred to as Weights of Evidence Similarity.

5.2 Weights of Evidence Similarity Modeling

Weights of Evidence: The Weights of Evidence approach allows the user to select a subset of the 5 standard soil and climate parameters in the similarity calculation. This allows a user to select parameters that are considered important for the behavior of a particular chemical rather than selecting all five parameters. As with the holistic similarity calculations, the means and standard deviations of parameters in the Root Ecoregion are compared with the mean values in all other Comparison Ecoregions, for each parameter. What makes Weights of Evidence similarity different is the way the similarity scores for each parameter are combined. With holistic similarity, the similarity score for all five parameters are averaged (each with a weight of 20%). With Weights of Evidence, the selected parameters are equally weighted in the calculation of the final blended overall similarity score. For example, if only two parameters are chosen, then each contributes 50% weighting to the final similarity score. If four parameters are selected, the similarity score for each parameter is calculated, and the values for the four parameters are averaged (25% weighting for each parameter).

5.3 Site Selection Overview

In addition to identifying similar ecoregions between North America and the European Union, ENASGIPS has a site selection tool that aids in identifying regions that have specific soil, climate and crop characteristics. This is useful when looking for a location for a field study based on specific concerns (worst-case scenarios) as identified in the conceptual model or to select a typical site in a region. For example, if a chemical has a potential to leach and contaminate groundwater, then the selected site should provide ideal conditions for leaching, such as light textured soil, high rainfall, shallow ground water table, etc., or if a chemical forms transformation products of importance under acidic conditions, then the study should be conducted in acid soils.

Site selection process basically has three steps; delineate areas where a pesticide is used (crop-based), use a query procedure to select areas with user defined soil/climate parameters based on concerns identified from the conceptual

model or typical site and then select the convenient area/site for the field study that are acceptable to both North American and European regulators. The resulting map shows areas where the selected crop, soil and climate characteristics occur.

5.4 Crop Density Mapping

In addition a Crop Density tool has been developed to display the percentage of land covered by a particular crop for Canada, United States and the European Union. This classed distribution is displayed for each crop in the area of interest. Crop Density displays areas where the percentage of land covered by a crop is greater than 1% of total area. There are separate crop databases for Canada, the United States and the European Union due to different data sources and crop classifications in each region.

5.5 User Site Mapping

ENASGIPS allows the user to show specific locations on the map. The user can enter site specific coordinate data (latitude and longitude) to display study sites on the map framework. This enables the user to identify a site within an ecoregion or within an area selected by soil, climate and crop parameters. This may be useful in showing locations for existing field studies and then extract site specific information on soils, climate, crops and regions details.

5.6 Information Tools

ENASGIPS includes tools for displaying information about locations on the map. By choosing one of the information tools and then clicking on the map, the user is provided with data from the database corresponding to the location clicked. The four information tools provide data on the following:

- **Ecoregions** – examine the soil and climate averages for an Ecoregion
- **Soil Climate Crop Canada** – examine the detailed soil, climate and crop data for areas displayed on the map using the site selection tools in Canada
- **Soil Climate Crop USA** – examine the detailed soil, climate and crop data for areas displayed on the map using the site selection tools in the USA
- **EU Soil Climate Crop** – examine the detailed soil, climate and crop data for areas displayed on the map using the site selection tools in the EU

5.7 HTML Matrix Table

ENASGIPS includes an HTML format table that lists all the similar ecoregions for each root ecoregion in the study area.

6. ENASGIPS MODELS TOOLBARS AND CONTROLS

6.1 ENASGIPS Addin Toolbar

The following tools are part of the ENASGIPS Addin:

File – used to exit, save, print, etc
Bookmarks – used to zoom to North America, Europe, or Both
Windows – used to access additional ArcGIS Windows

Zoom IN

Zoom OUT

Pan

Zoom to full extent

Identify – the generic ArcGIS Identify tool

Select Features – used to select a root ecoregion for similarity analysis

Clear Selected Features

Go To XY Location tool – used to find a geographic location on the map

Ecoregions information tool – to display attributes of ecoregions

Canada Soil Climate Crop information tool – to display detailed data from site selection results

USA Soil Climate Crop information tool– to display detailed data from site selection results

EU Soil Climate Crop information tool– to display detailed data from site selection results

Draw North American (NATFA) ecoregions as a graphic overlay on the map

Display Matrix of Similarity tool

Display Taxonomy Correspondence Table

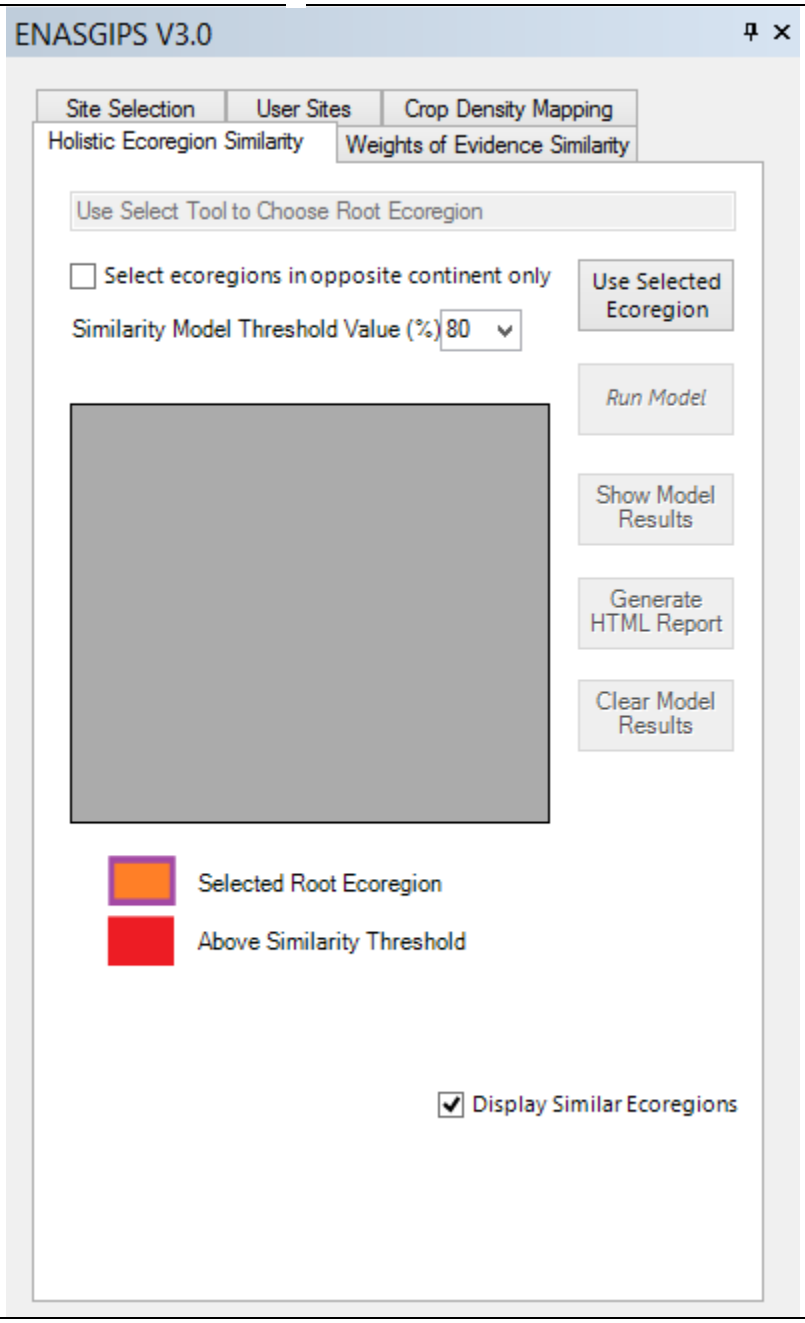
Open Help Documentation tool

Save the current state of the map document

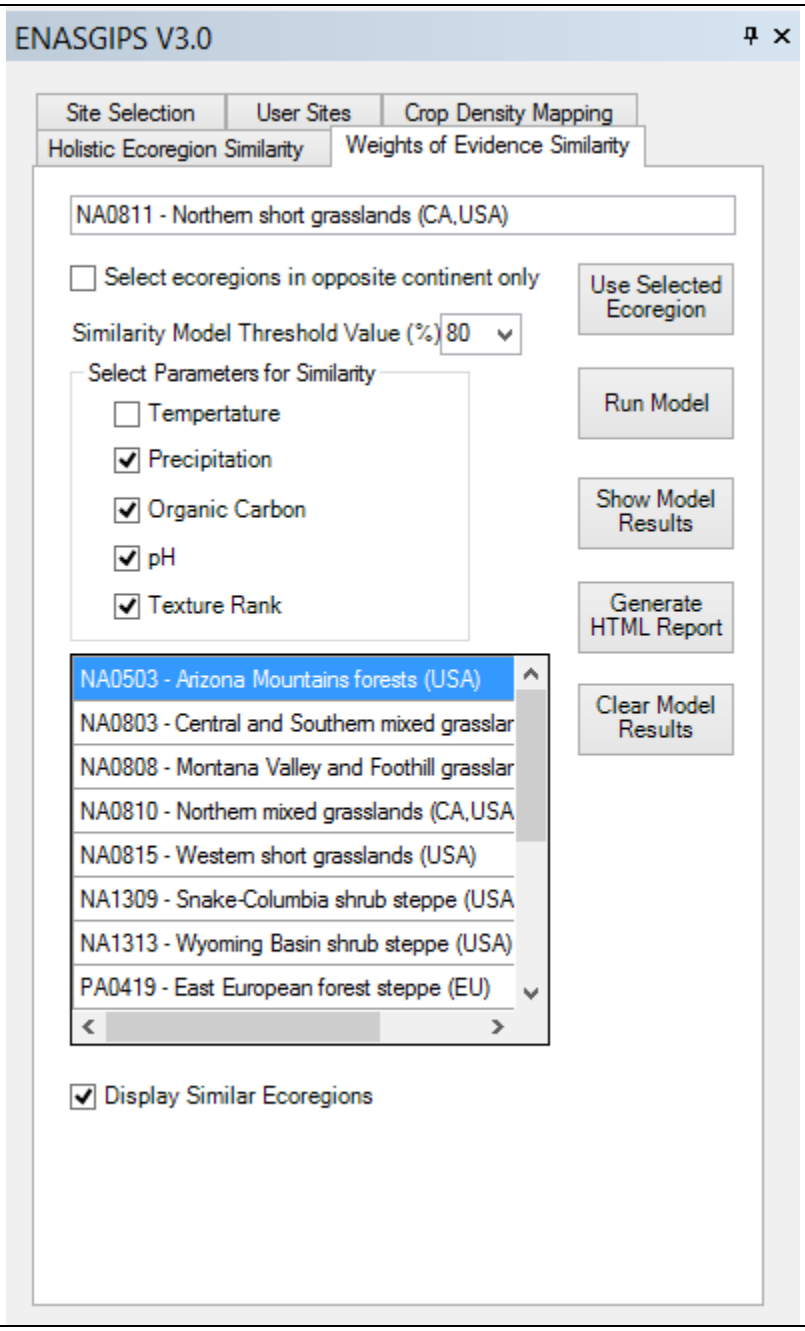
Print Map

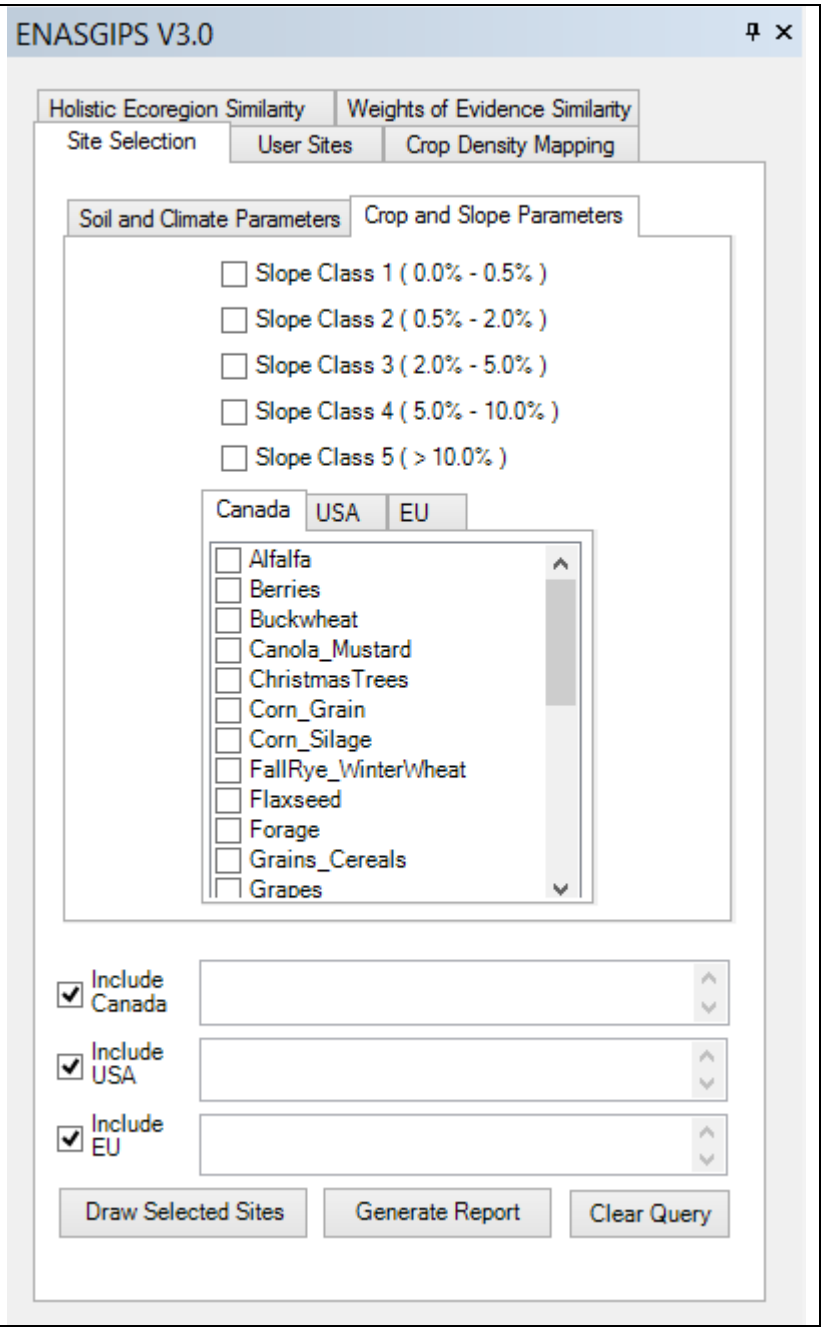
6.2 ENASGIPS Control Panel

The ENASGIPS Control panel has seven TABS:

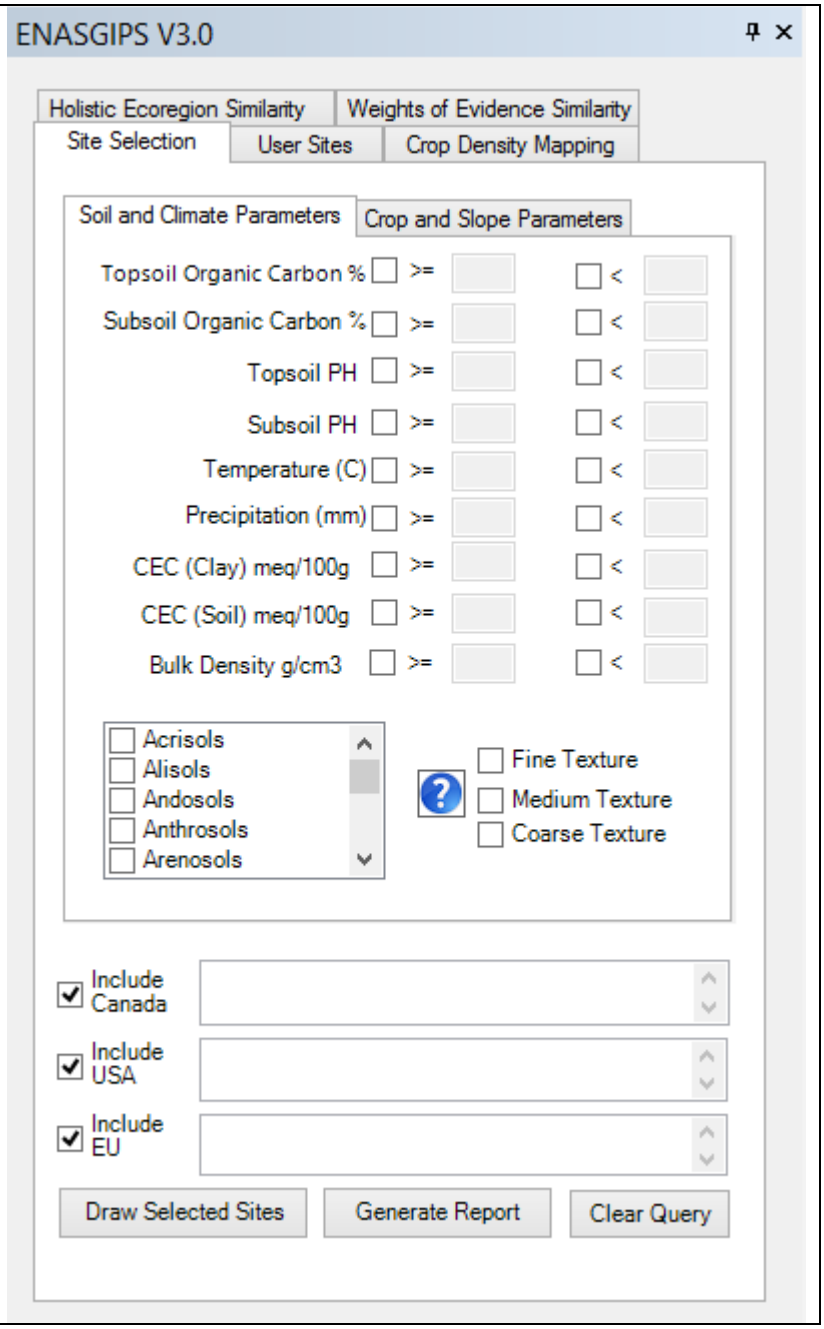
Holistic Ecoregion Similarity: this tab has tools for selecting a root Ecoregion and finding similar Ecoregions based on five soil and climate parameters.	

Weights of Evidence Similarity: this tab has tools for selecting a root ecoregion and finding similar ecoregions**,** based on soil and climate parameters selected by the user**.**

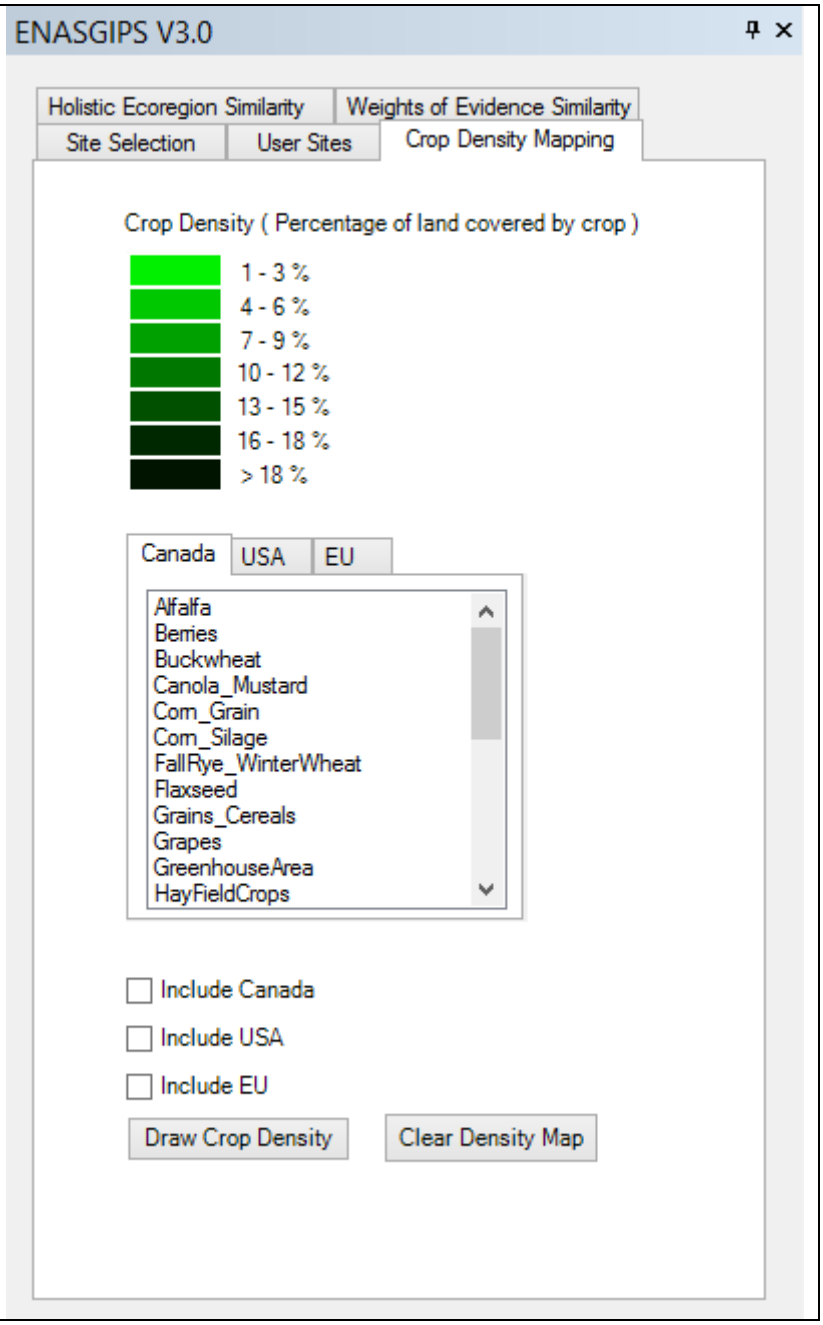


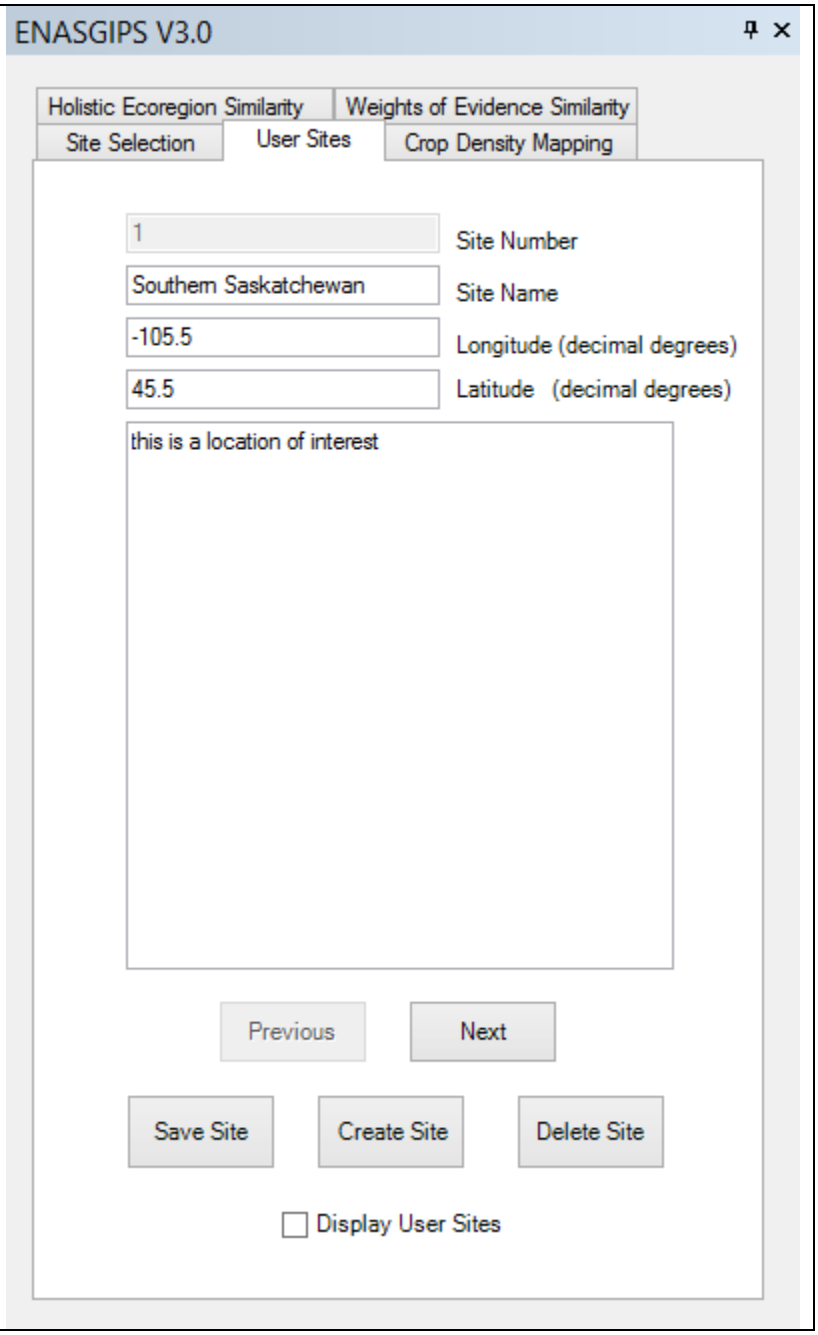
Site Selection Step 1(Crop and Slope Parameters): The Site Selection tab has tools for querying detailed landscape data, and showing the distribution of areas with selected properties. The Crop and Slope sub tab allows the definition of crop and slope parameters for the site selection query.	

Site Selection Step 2 (Soil and Climate Parameters): The Site Selection tab has tools for querying detailed landscape data, and showing the distribution of areas with selected properties.



Crop Density Mapping: this tab has tools for displaying a specific crop distribution (percentage of land covered by crop for Canada, United States and the European Union)



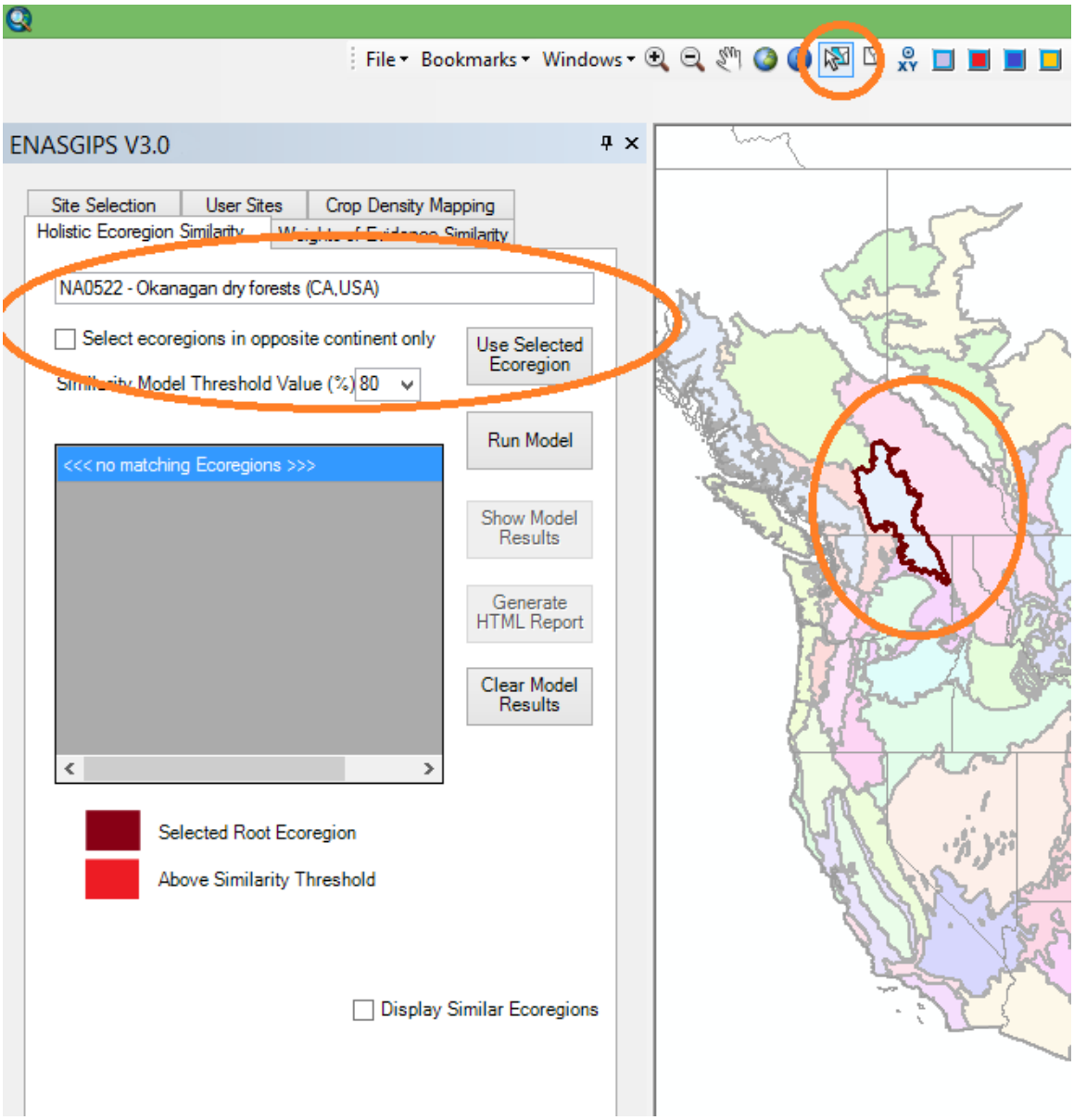
User Sites: this tab has tools for creating and displaying point locations for a user site.	

7. HOLISTIC AND WIEGHTS OF EVIDENCE MODELING - STEPS

7.1 Selecting the Root Ecoregion

To select the root ecoregion, use the Select Features tool. Use the cursor to click on a location/ecoregion that will be the root ecoregion. The root ecoregion can be selected in either North America or the European Union. The selected ecoregion will be highlighted with a red border. This highlighted ecoregion will be used as the starting point in identifying regions in the opposite and/or the same continent that have a user-specified percent threshold match to the root ecoregion.

The “Use Selected Ecoregion” button copies the name of the currently selected ecoregion into the Control Panel, identifying the currently selected ecoregion as the root ecoregion for the Crosswalk model.

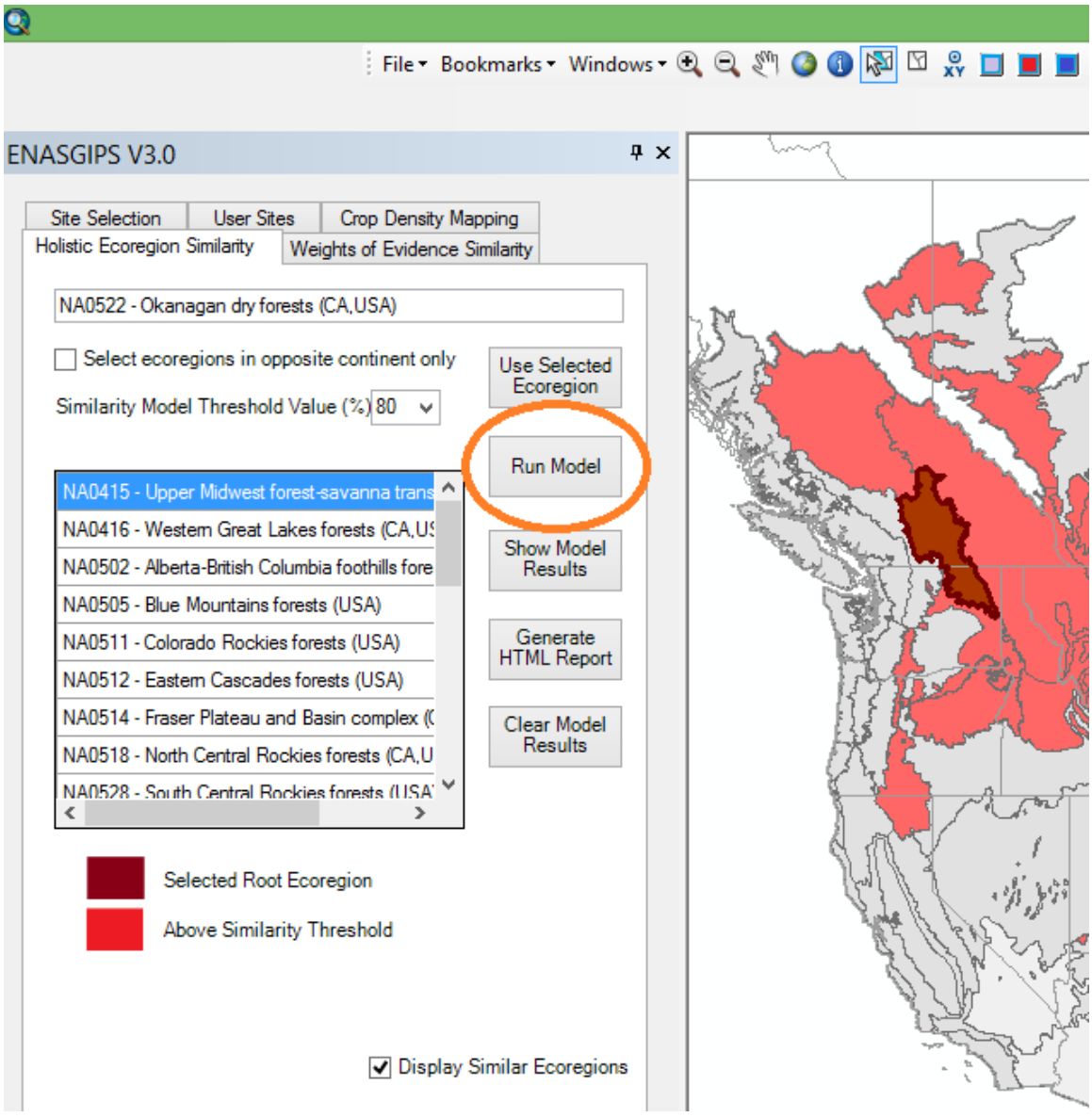

File
Bookmarks
Windows
ENASGIPS V3.0
Site Selection
User Sites
Crop Density Mapping
Holistic Ecoregion Similarity
NA0522 - Okanagan dry forests (CA,USA)
Select ecoregions in opposite continent only
Use Selected Ecoregion
Model Threshold Value (%) 80
Run Model
<<< no matching Ecoregions >>>
Show Model Results
Generate HTML Report
Clear Model Results
Selected Root Ecoregion
Above Similarity Threshold
Display Similar Ecoregions

7.2 Similarity Model Threshold

Enter the percent similarity threshold value you wish to use to find matches between ecoregions – the default value is 80%

7.3 Running Holistic Ecoregion Similarity

Once the root ecoregion has been selected, the Run Model tool is used to run the Ecoregion Similarity Model (ESM) to calculate the matching ecoregions in the opposite continent.

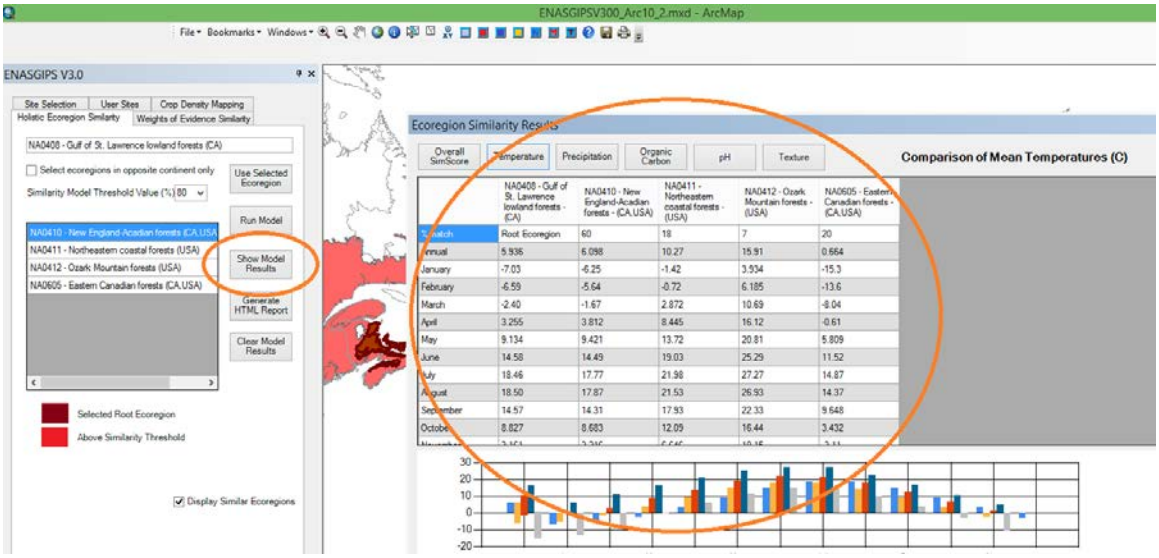


Once the matches have been calculated, the names of matching ecoregions will be added to the Control Panel, and the map will highlight the root and the matching ecoregions with a RED fill colour.

The matches resulting from the calculations will appear in the opposite continent to the root ecoregion. They will be highlighted in red. The root ecoregion is coloured red with a red border. If the option “select ecoregions in opposite continent only” is not selected, similar ecoregion in the native continent are also displayed.

7.4 Show Model Results

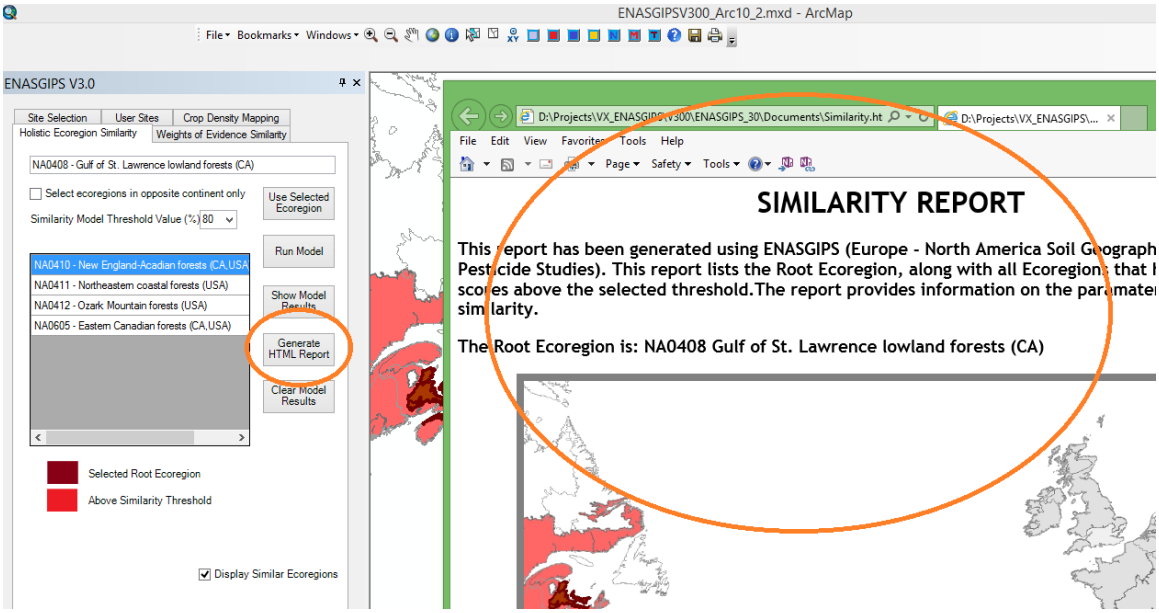
The Similarity Results Interface allows the user to interactively review the data of the matching ecoregion(s). Graphs of the data can also be viewed. Help documentation can be accessed through this interface. The **Show Model Results** button allows the user to view the soil and climate results from the root and match ecoregion(s) in text or graph form.



The Ecoregion Similarity Results window allows you to explore data for each parameter.

7.5 Generate Report

The **Generate HTML Report** button generates an HTML report that includes mean annual temperature (degrees Celsius), total annual precipitation (mm), organic carbon, pH, and Texture for the root ecoregion and the matching ecoregion(s)



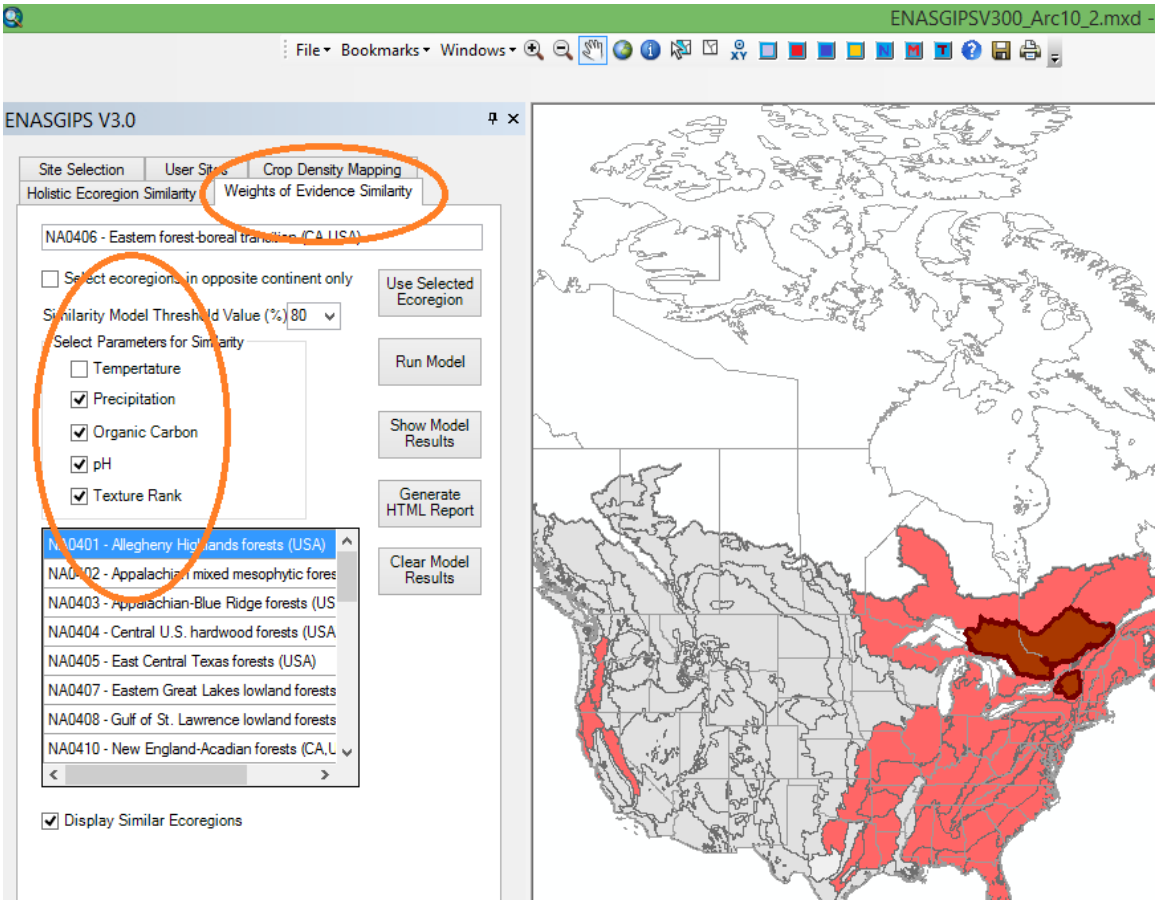
In order to run any of the Generate Results tools, the root ecoregion must have been selected and the ESM has to have been launched.

To print the results from the HTML report, go to File and select print options

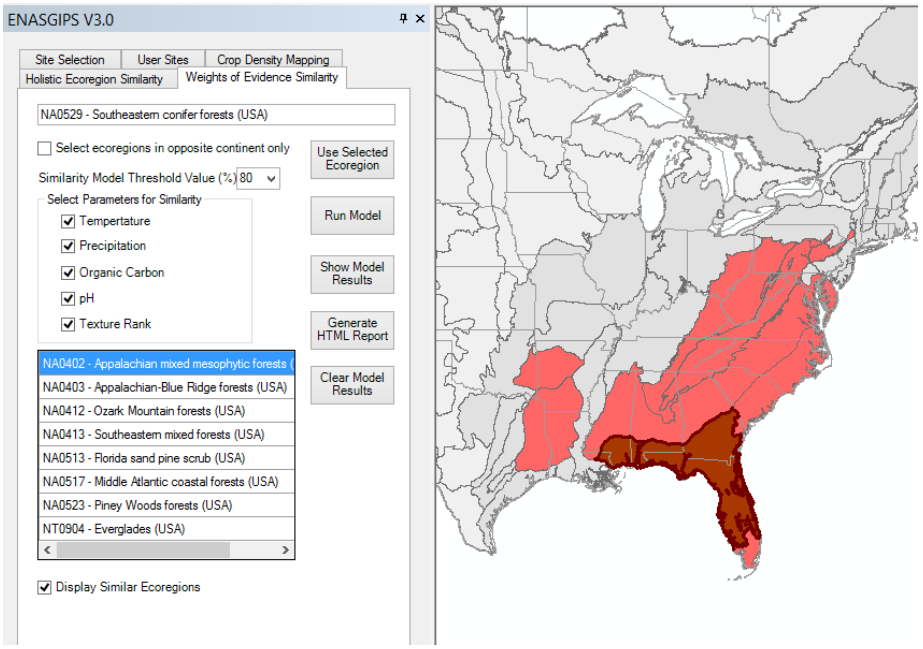
7.6 Running Weights of Evidence Ecoregion Similarity

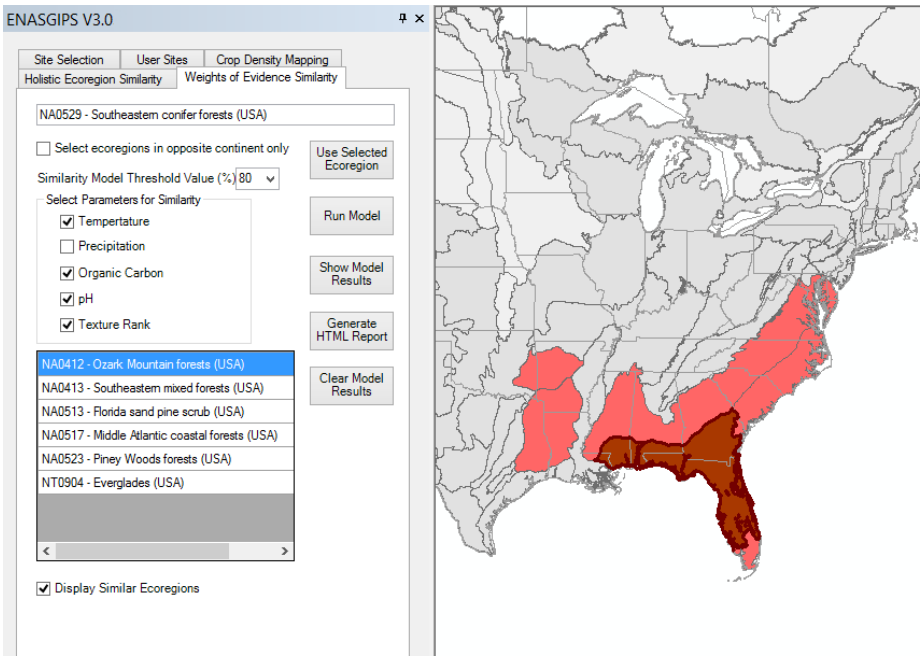
As with the Holistic Ecoregion Similarity, once the Root Ecoregion has been selected, the Run Model tool is used to run the Ecoregion Similarity Model (ESM) to calculate the matching ecoregions.

However, with the Weights of Evidence Similarity, the user has the option to choose which of the five parameters are to be included in the blended calculation of similarity. In the example below, temperature has been turned off, and will not be included in the similarity calculations. With the Eastern forest – boreal transition root ecoregion, this results in an increased number of ecoregions being identified as similar, because temperature is not considered in the evaluation.



Note that reducing the number of parameters used does not necessarily mean a greater number of ecoregion matches will be found. In the example below, the Southern conifer forests matches up with 8 similar ecoregions, but when precipitation is removed, there are only 6 matches. In this particular case the root ecoregion has a wide range of precipitation values, which allows for matches on precipitation with a variety of other ecoregions. When precipitation is not included in the Weights of Evidence model, the remaining four parameters force a more restrictive match.





8. ECOREGION SIMILARITY SCORE CALCULATIONS

For identifying ecoregions that have similar soils and climate, a similarity score is calculated between each ecoregion and all other ecoregions. The similarity score is calculated using these variables:

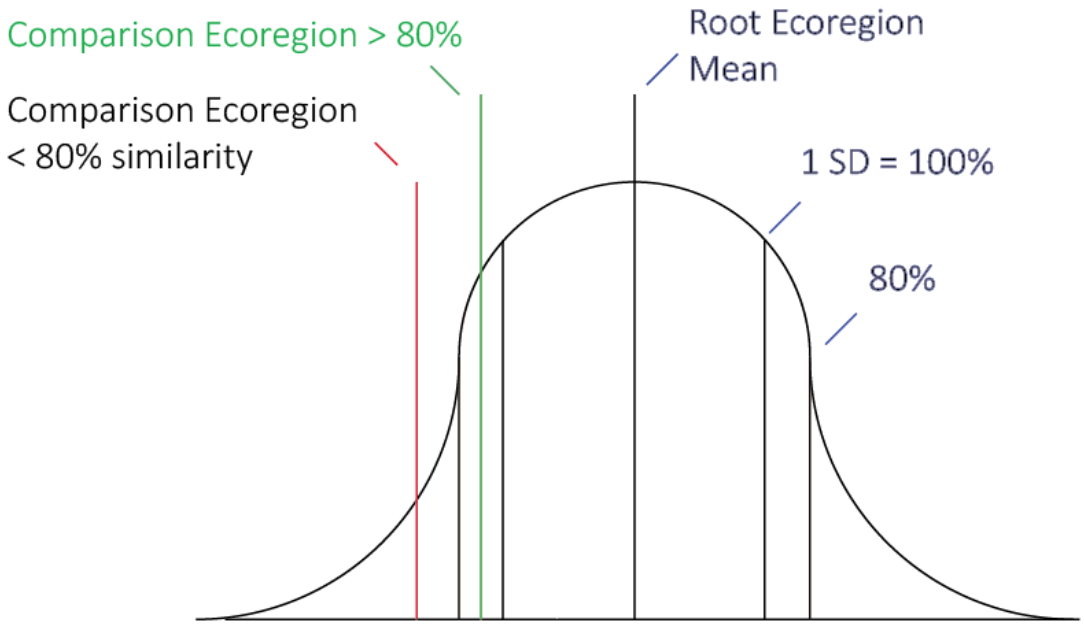
- Mean annual temperature (1987 to 2011)
- Mean annual precipitation (1987 to 2011)
- Mean soil pH
- Mean soil organic carbon
- Soil Texture (rank ordered)

The process of calculating similarity scores starts with a “Root Ecoregion”. For the root ecoregion, the mean and standard deviation of a variable is calculated. The ecoregion mean and standard deviation for MEAN ANNUAL TEMPERATURE is calculated from the detailed soil & climate data layers. Each polygon within an ecoregion is examined, and the mean and standard deviation calculated.

Comparison ecoregions are examined to determine how closely the composition of the comparison ecoregion matches the root ecoregion.

- The value of a variable in a detailed polygon is compared to the mean of that variable in the root ecoregion, and the absolute distance is calculated
- The absolute distance is divided by the root ecoregion standard deviation, calculating a distance in standard deviations for each detailed polygon.
- The distance in standard deviations is multiplied by the area of each detailed polygon, producing a standard distance area value. All these values within an ecoregion are summarized, and then divided by the area of the total ecoregion, thus calculating an Area Weighted Distance in Standard Deviations.
- A value less than 1 indicates a comparison ecoregion variable that falls within 1 standard deviation of the mean of the root ecoregion. This value is then inverted, and is referred to as a Similarity Score
- A Similarity Score of 1.00 (100%) indicates the comparison ecoregion variable falls within 1 standard deviation of the mean of the root ecoregion. A score of less than 1.00 indicates the comparison ecoregion variable falls outside one standard deviation. The further away a comparison

ecoregion's mean values are from the root ecoregion, the lower the similarity score. A score of 0.80 (or 80%) falls somewhat outside 1 standard deviation from the mean of the root ecoregion, and this has been selected as a default threshold for matching ecoregions.

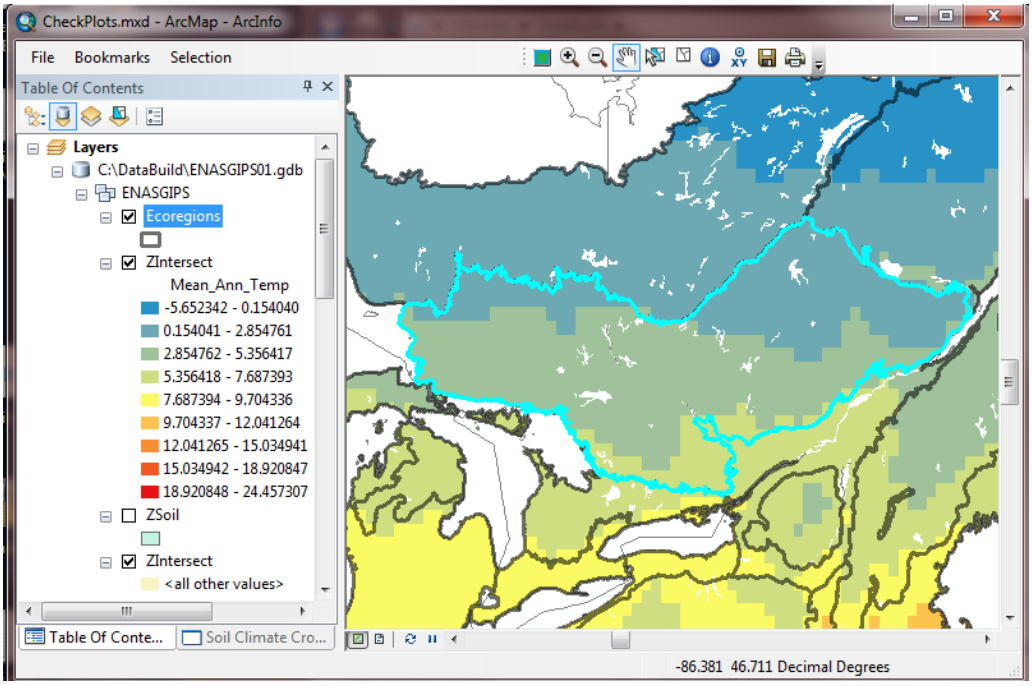


Each of the five variables is scored separately, and then the five scores are combined with equal weighting into an overall Similarity Score.

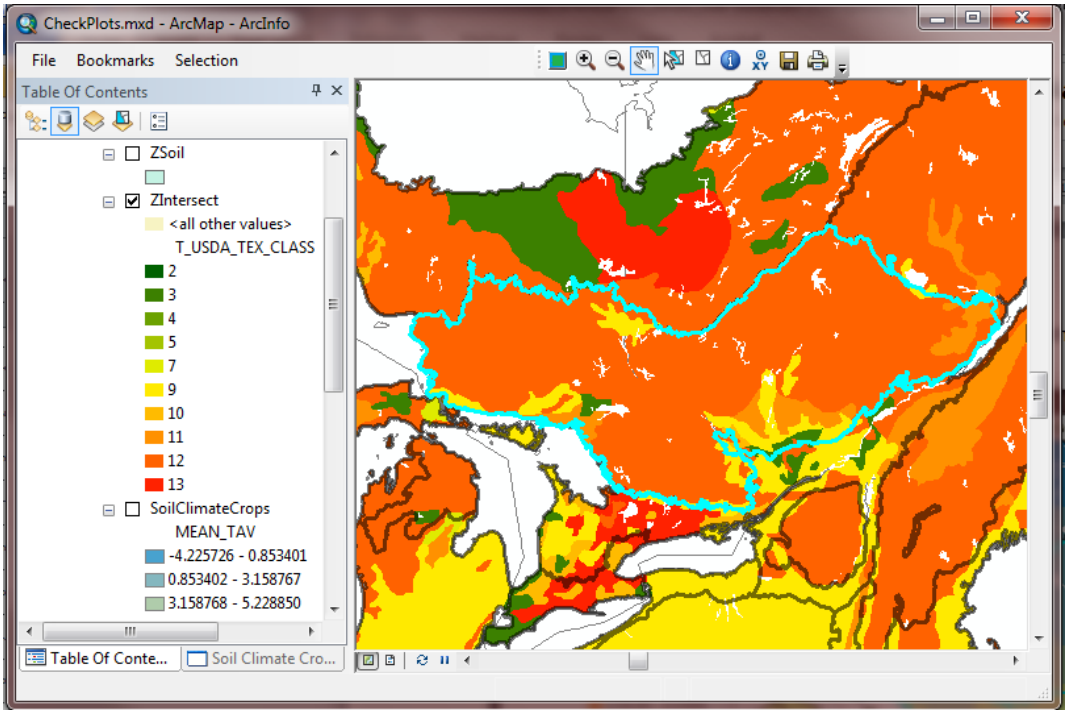
A matrix of similarity scores between each ecoregion and all others has been generated. Summary scores have been joined to the ecoregion feature class in the geodatabase, and a map can be produced showing the ecoregions that score above a given threshold for a particular root ecoregion.

The following example serves to illustrate the calculation of similarity scores.

The map below illustrates the range of Mean Annual Temperatures (mean indicates the average temperature value over the year) within a root ecoregion in central Canada. Each of the detailed areas is examined, and a Mean of Mean Annual Temperature is calculated (here mean refers to the average Mean Annual Temperature throughout the root ecoregion). A standard deviation is also calculated, providing an indication of the variability of temperature in the root ecoregion. This particular ecoregion has a significant north-south extent and is showing a relatively wide variation in temperatures.



The following shows the variety of soil texture classes within the same ecoregion. Each texture class was assigned a numeric ranking from fine to course texture. Within the ecoregion, a mean texture rank is calculated, as well as a standard deviation for texture rank.



This table shows the USDA CODE, Value and Texture Group, along with the TextureRank used in the calculation of similarity. Within a root ecoregion, the mean and standard deviation for TextureRank is calculated. In comparison ecoregions, the individual texture polygons in the detailed data are scored in the same way as other variables, and the area weighted score for texture is calculated. This textural class was used for the Holistic and Weights of Evidence similarity model.

CODE *	VALUE	TextureRank	TextureGroup
1	clay(heavy)	1	FINE
2	silty clay	2	FINE
3	clay (light)	3	FINE
4	silty clay loam	4	FINE
5	clay loam	5	FINE
8	sandy clay	6	FINE
6	silt	7	MEDIUM
7	silt loam	8	MEDIUM
9	loam	9	MEDIUM
10	sandy clay loam	10	MEDIUM
11	sandy loam	11	COARSE
12	loamy sand	12	COARSE
13	sand	13	COARSE

Similar calculations are made for each of the remaining similarity parameters: mean annual precipitation, pH, and organic carbon.

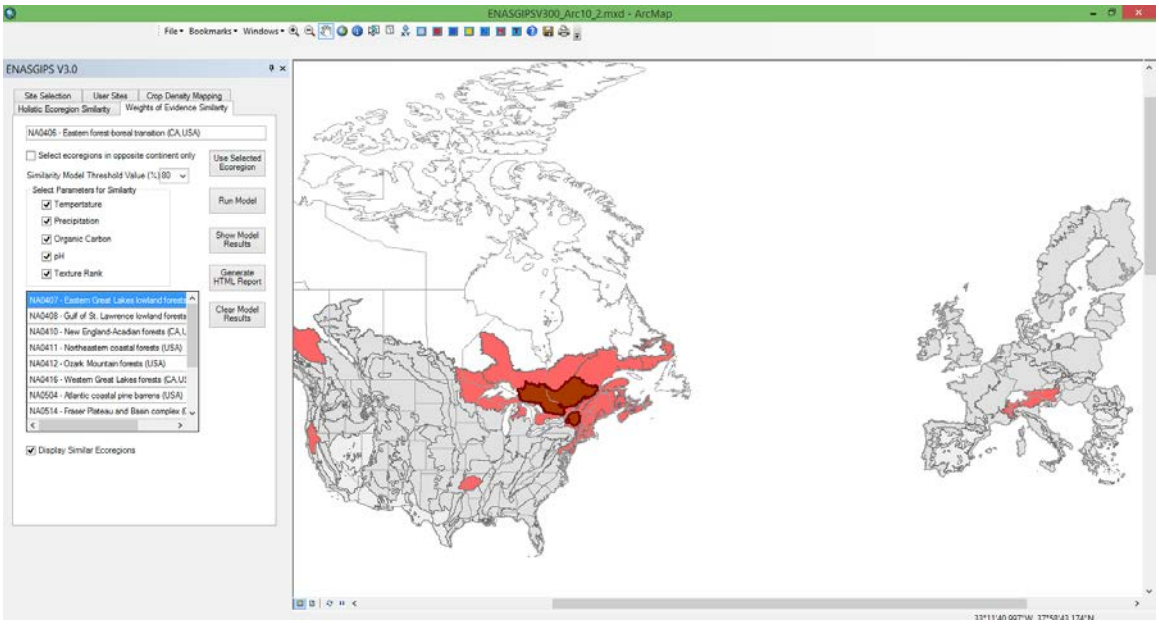
Once each similarity parameter is calculated, all five parameters are equally weighted to produce an overall similarity score.

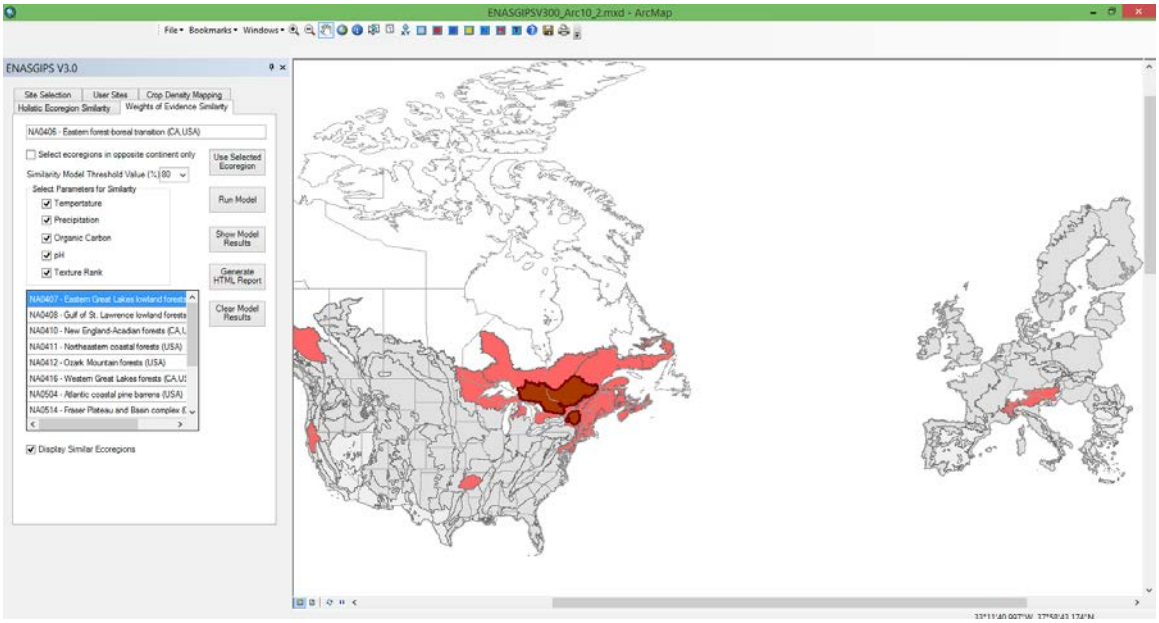
With the optional Weights of Evidence similarity calculations, it is possible to select all five parameters, or any combination of the five parameters. When all five parameters are selected, the calculations and the results are the same as holistic similarity calculations.

Ecoregion Similarity is calculated only for areas where the soil organic carbon is less than 17%. In some geographic regions, there is a presence of soils with very high organic carbon content, and this leads to wide standard deviations resulting in significantly higher matches for ecoregion similarity. The use of a log transformation of organic carbon values has been evaluated. In addition, the exclusion of “organic soils” from the similarity calculations has also been evaluated. It has been determined that the most appropriate approach is to exclude areas with “organic soils” from similarity calculations. For this purpose, organic soils are defined as those soils with greater than 17% organic carbon (30% Organic matter). Similarity scores are, therefore, based only in areas where soils have <17% organic carbon. Ecoregion Similarity is calculated on the topsoil attributes only.

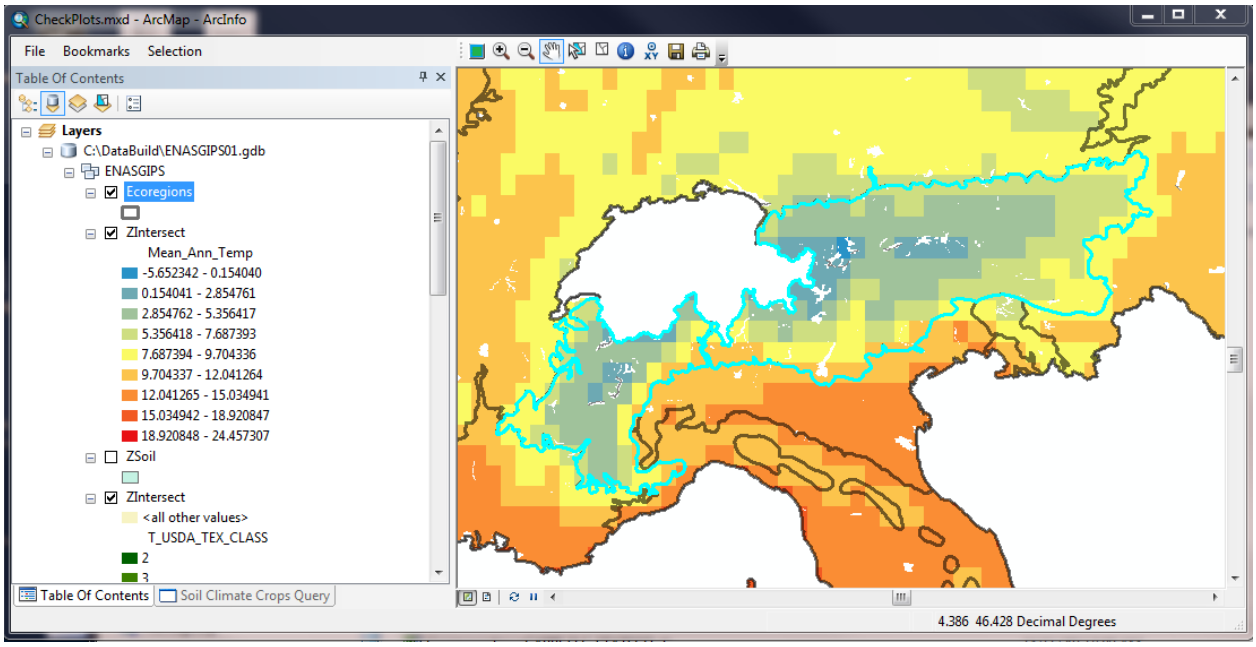
Once a root ecoregion is selected, and the user clicks “Run Model”, ENASGIPS will highlight in red all the other ecoregions whose overall similarity score is higher than the selected threshold, which by default is 80%

The following shows two maps illustrating all ecoregions that scored higher than 80 similarity score relative to the root ecoregion, as well as a list of those matching ecoregions within the control panel. In the first example all five parameters are used (Holistic similarity). In the second, the Weights of Evidence Similarity was calculated using all parameters except temperature. Note the significant increase in the number of matches with the Weights of Evidence approach.





The following shows one of the matching ecoregions in Europe, illustrating similar Mean Annual Temperature values. For each Comparison Ecoregion, an area-weighted mean value is calculated, and that mean value is compared to the mean of the root ecoregion. As described earlier, the comparison is measured as a function of the mean and standard deviation of the root ecoregion. If the mean temperature value for this comparison ecoregion falls close enough (80% default threshold) to 1 standard deviation from the mean of the root ecoregion it is considered similar.



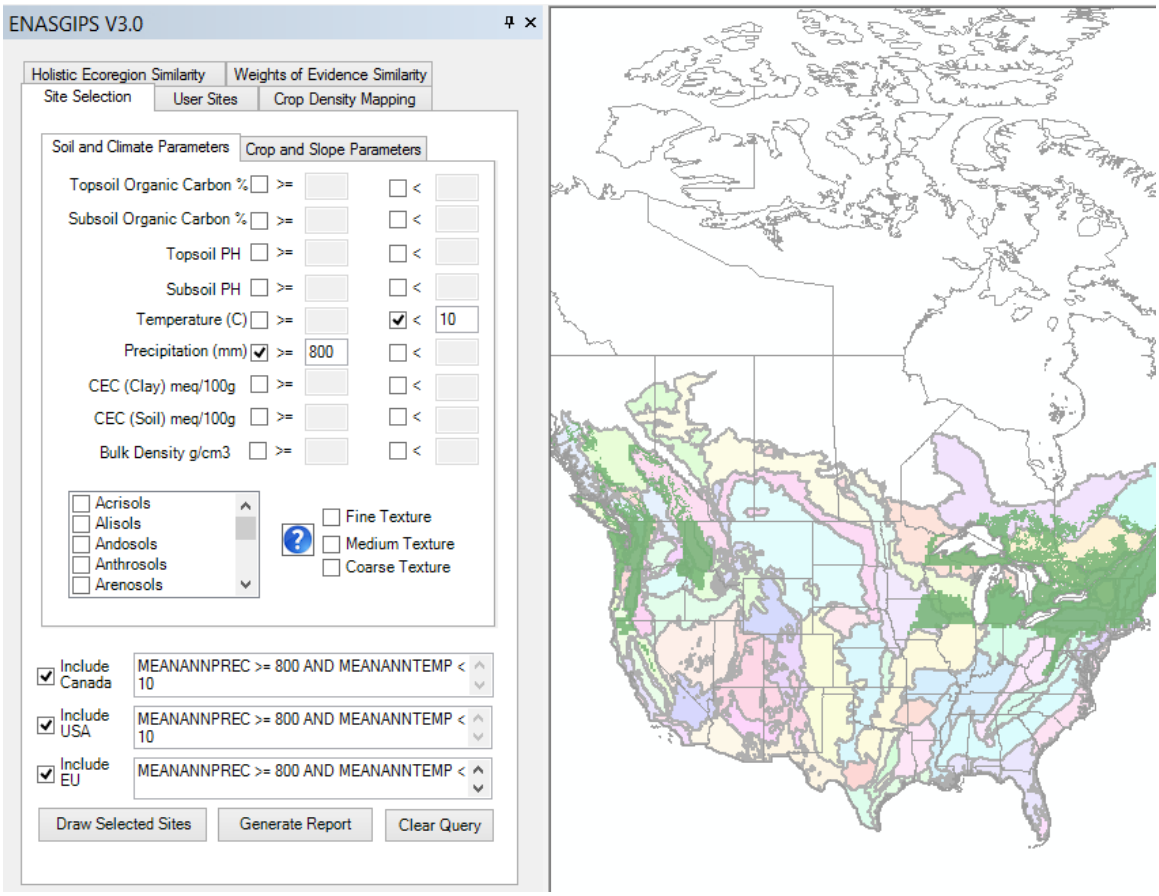
9. SITE SELECTION

The **Site Selection tools** provides a method for site selection based on user defined criteria. The Query Tool button allows the user to query the data by inputting user-defined soil, climate and crop parameters.

The Site Selection Tool can be used to select soil and climatic parameters, based on concerns identified in the conceptual model (pesticide properties and fate studies). This tool will display geographic locations that fit these parameters using the detailed data on soil, climate and crops.

The first step in site selection process is to delineate areas where a pesticide is going to be used, i.e., crop growing areas. This is done using the crop selection query. Next, input user defined soil and climate parameters based on concerns and worst-case scenarios, and the model delineates areas that meet the user defined parameters. The user can then select a convenient site in the delineated areas.

The user can also select the corresponding ecoregions and run the similar model to see whether the selected sites/ecoregions have similar ecoregions in the opposite continent. This procedure helps to identify sites which can be considered by both North American and European regulators.

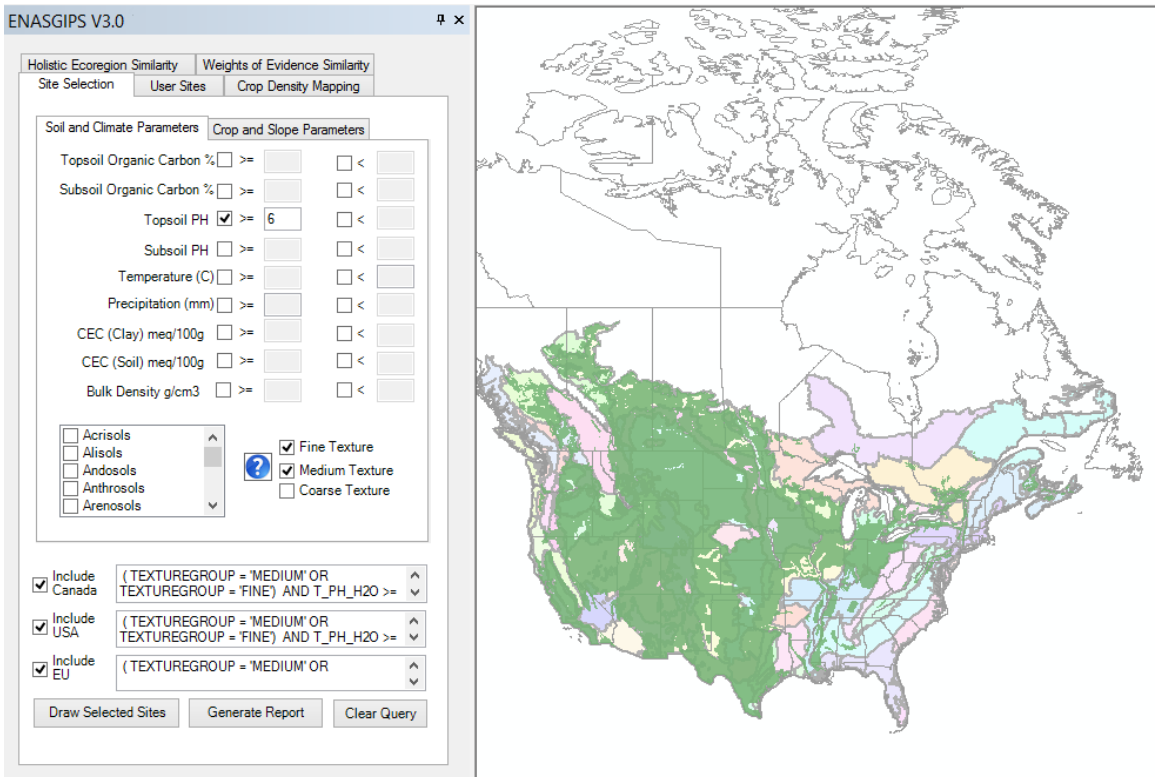


Please note that drawing the detailed Soil / Climate / Crop layer can take some time to draw.

9.1 Soil and climate properties filters

You can define a query that limits the resulting map display to only those areas that meet all the soil and climate filters. In the example below, the area of the map highlighted will be limited to those locations where ALL of the filters are true:

(ALFALFA > 0) AND (TEXTUREGROUP = 'MEDIUM' OR TEXTUREGROUP = 'FINE') AND T_PH_H2O >= 6



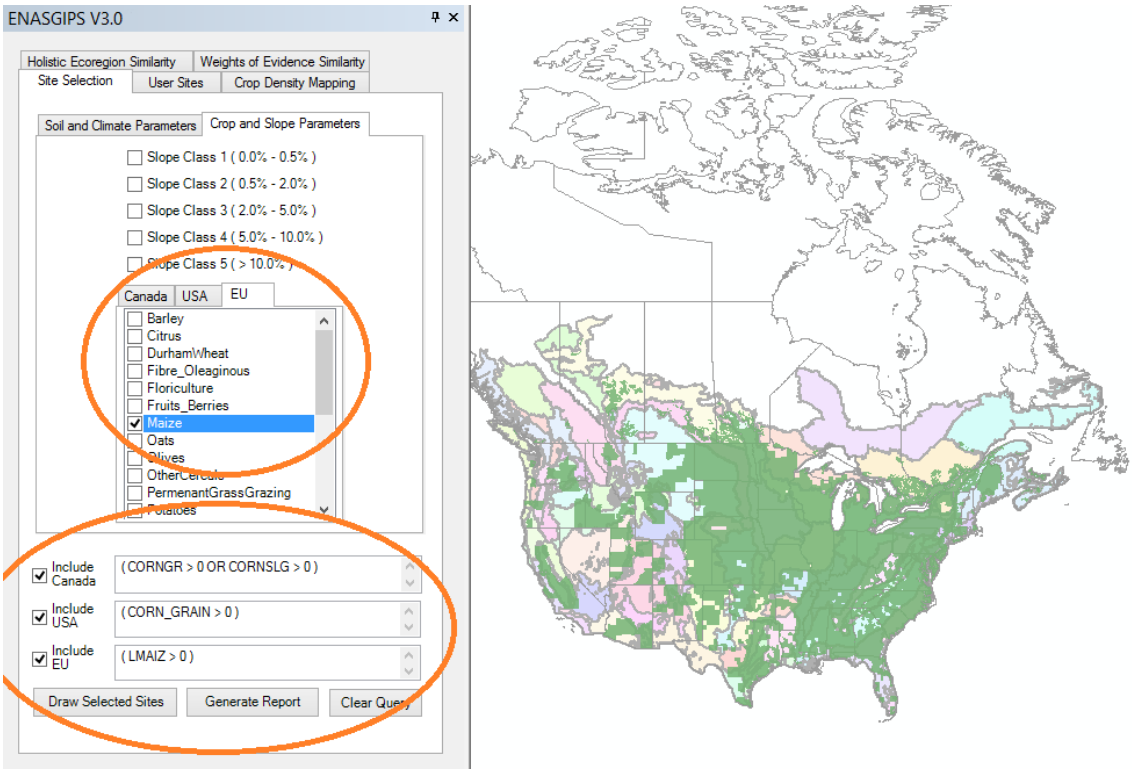
Filtering for more conditions will **reduce** the area of the map that is highlighted

9.2 Expanding the results with multiple crop selections

You can define a query that limits the resulting map display to only those areas that meet certain crop types. In the example below, the area of the map highlighted will be limited to those locations where ONE OR MORE of the crop types is present:

(CORNGR > 0 OR CORNSLG > 0)

Adding more crop types to the query will **increase** the area of the map that is highlighted



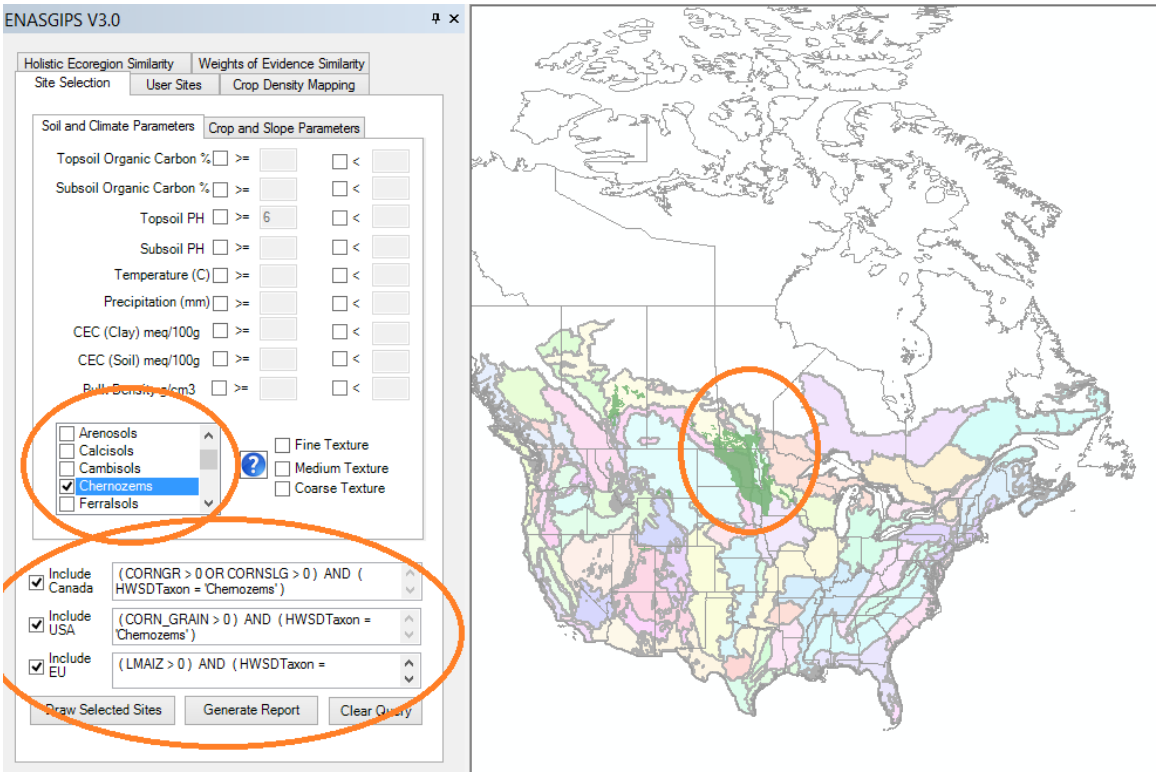
9.3 Soil & Climate Filters with Crop Selections

The Site Selection tool allows for the selection of multiple crops. When selecting multiple crops, the logical OR is applied. Thus, adding additional crops will likely increase the geographic are delineated.

Combining the Crop Selection with Soil or Climate parameters uses the logical AND operator. This will likely reduce the geographic area delineated.

In the example below, both Grain Corn and Silage Corn are selected. The geographic area is then filtered to those areas that also have soil taxonomy of Chernozems.

(CORNGR > 0 OR CORNSLG > 0) AND (HWSDTaxon = ‘Chernozems’)

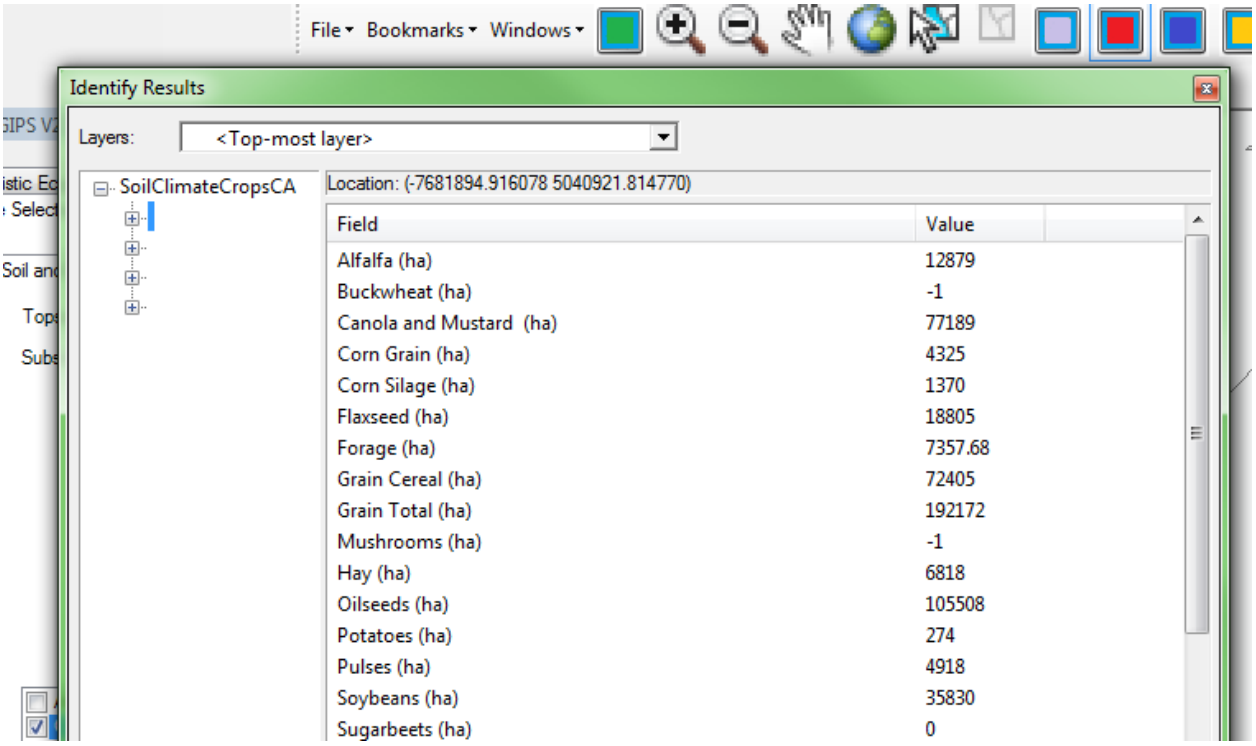


9.4 INFORMATION TOOLS

ENASGIPS includes tools for displaying site specific and region information on the map. By choosing one of the information tools, and then clicking on the map, the user is provided with data corresponding to the ecoregion or site specific information. The four information tools provide data on the following:

- Ecoregions
- Canada Soil Climate Crop
- USA Soil Climate Crop
- EU Soil Climate Crop

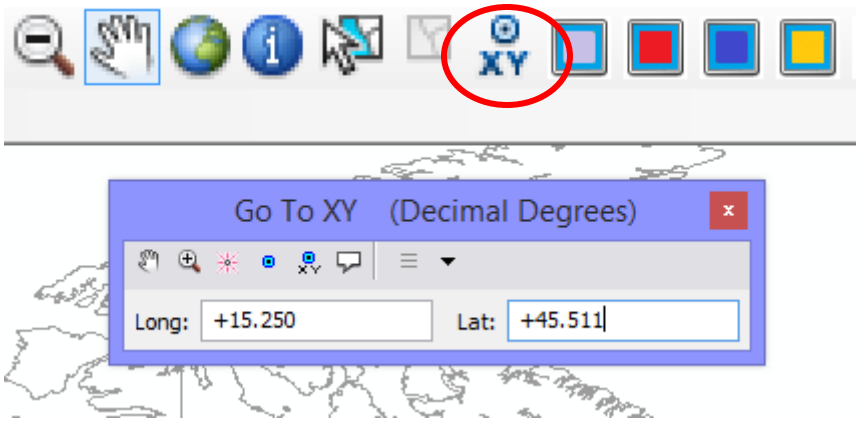
These tools will report data in agricultural areas only. When a query has been executed, clicking in the green shaded area of each region will provide detailed information on soil, climate, crops and location. Metadata on the database fields is provided in Appendix 1.



9.5 MISCELLANEOUS TOOLS

9.5.1 Go To XY tool

This tool helps determine a specific location on the map using latitude and longitude.



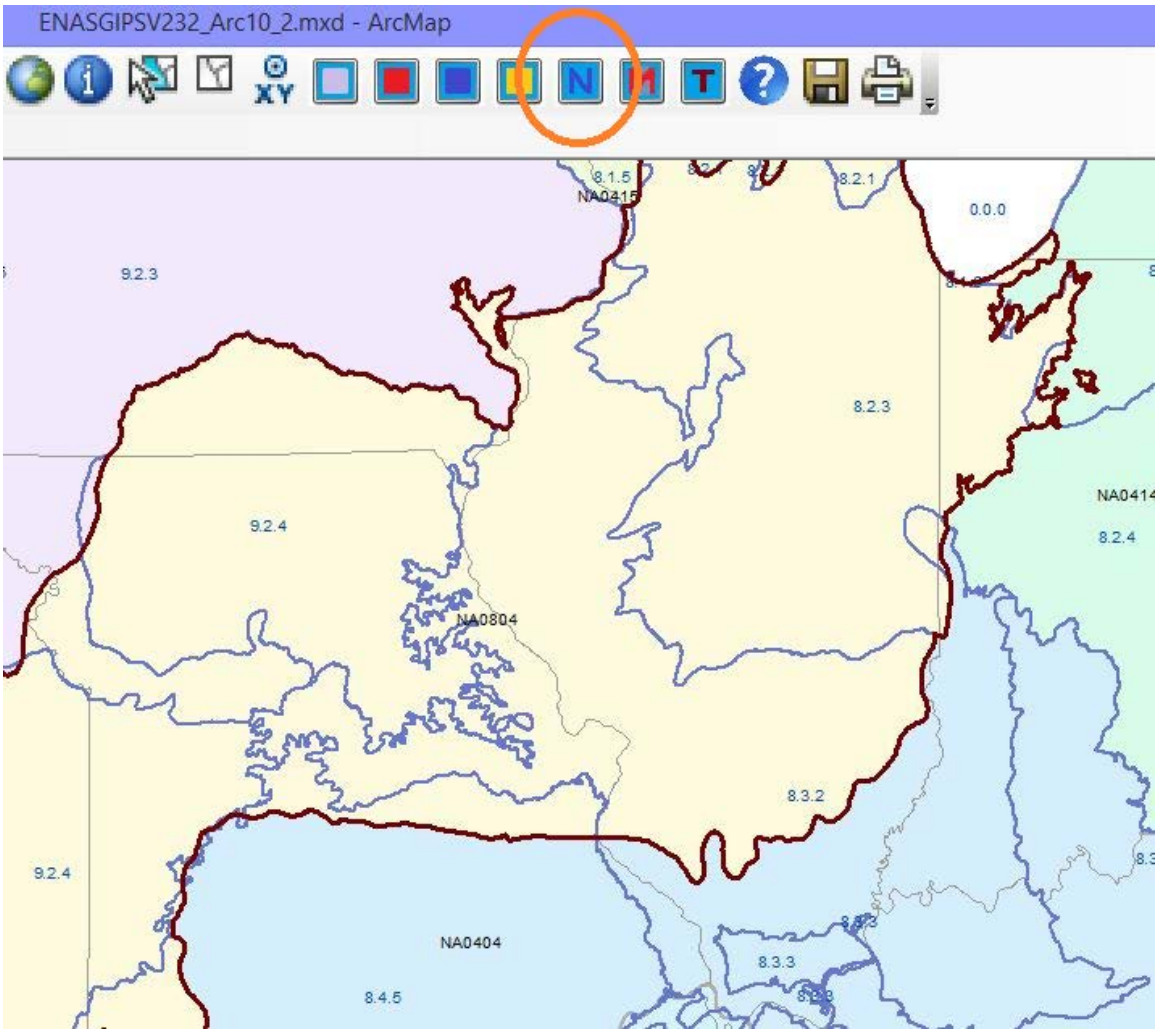
Type in longitude and latitude, and this tool will show where that location is on the map. NOTE THAT LONGITUDE COMES BEFORE LATITUDE IN THIS TOOL. You can enter longitude and latitude in various formats, and the tool converts the coordinates to decimal degrees. For example:

Decimal Degrees with numeric sign for geographic quadrant	+15.250 +45.551	Positive longitude is east of the prime meridian. Positive latitude is north of the equator
Degree and Decimal Minutes with numeric sign	-75 12.25 +45 30.123	The negative longitude puts this point in North America
Degrees Minutes Seconds with numeric sign	-75 30 20 + 48 23 59	
Degrees minutes seconds with directional letters	75 30 20w 48 23 59n	W = west, e=east, n=north, s=south

After typing in longitude and latitude values, hit the enter key, or one of the tools on the toolbar that Flash, Add Point, Add labelled point, or Add Callout. These tools put temporary markers on the map. If you do not save your map document, these markers will not persist.

9.5.2 *Display North American Ecoregions as Graphic Map Overlay*

This tool will draw the North American (NAFTA) Ecoregions as a graphic map overlay, on top of the World Wildlife Federation (WWF)ecoregions. Note that the ecoregion framework used in ENASGIPS similarity will remain as the WWF ecoregions. The North American ecoregion overlay can display graphically the relationship between WWF and NAFTA ecoregions. For example, in the map below, several North American ecoregions intersect the WWF Ecoregion NA0804.



9.5.3 Display Matrix of Similarity tool

The Ecoregion Similarity tool has been used to generate a table that lists ecoregions where a match value greater than 80% is found. This table is in

HTML format, and can be found at the root of the ENASGIPS folder. Clicking this button will launch the Similarity Matrix in Internet Explorer.

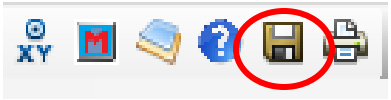
9.5.4 Display Taxonomy Correspondence Table

An HTML file listing the correspondences between soil Taxonomies of the US, Canada and EU has been provided. This tool will open the table.

9.5.5 Open Help Documentation tool

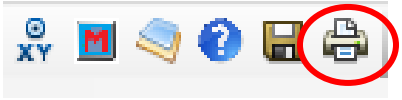
Clicking this tool will launch the ENASGIPSV300_Arc10x_User_Guide.PDF in MS Word.

9.5.6 Save



This tool will save the ArcMap Map document, and all current settings of ArcMap. The current settings of the ENASGIPS extension are not saved.

9.5.7 Print



This tool will print the current map

10. DATABASES

10.1 Soil, Climate and Crop Databases

ENASGIPS includes a geographic database containing soil, climate and crop data for North America and Europe. The ENASGIPS database has been compiled at an Ecoregion scale, and at a more detailed “regional” scale. The database has been compiled from the following sources.

North American Data

Soil: HWSD (Harmonized World Soil Database) V1.1

Slope: HWSD Supplementary Data, Global Terrain Slope and Aspect Data

Climate: MARS FOODSEC ERA-Interim Meteodata – 1978 to 2011

Crop: Interpolated Census of Agriculture (2006) - Canada

CENSTATS/Census of Agriculture 2007 – United States

Ecoregions: WWF – World Wildlife Fund Terrestrial Ecoregions

European Union Data

Soil: HWSD (Harmonized World Soil Database) V1.1

Slope: HWSD Supplementary Data, Global Terrain Slope and Aspect Data

Climate: MARS FOODSEC ERA-Interim Meteodata – 1978 to 2011

Crop: Homogeneous Spatial Mapping Units for EU15 and EU12 countries with CAPRI land use allocation

Ecoregions: WWF – World Wildlife Fund Terrestrial Ecoregions

10.2 European Union Soil, Climateand Crop Combined Feature Class

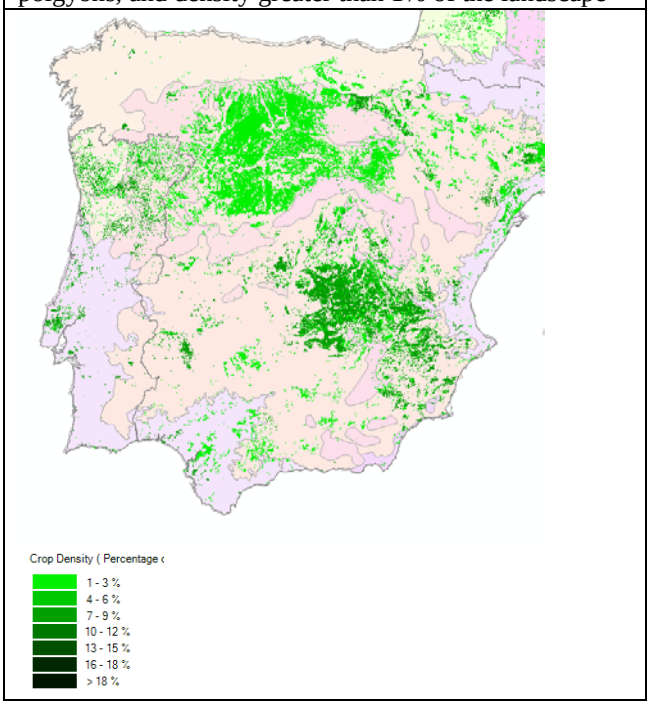
Crop data for Europe is sourced from the CAPRI landcover classification project. The geographic scale of the CAPRI data is very detailed when compared to the source crop data for Canada and the USA. When used by itself for crop density mapping (image on the right) the CAPRI data draws quickly. However, when an intersected feature class is created to combine soil, climate and crop data, the resulting feature class has too many polygons to draw efficiently.

The combined soil, climate and crop feature class is used in the Site Selection tool. In order to optimize the drawing of the combined feature class, the data was generalized to 0.25 degree grid cells corresponding with the climate data grid cells (image on the left)

The Site Selection tool draws any polygon matching the user's query. When drawing a query that includes one or more crops, the query tool delineates any reported crop presence (Crop > 0 hectares)

The Crop Density Mapping tool draws a single crop density map, but only shows areas where the crop covers > = 1% of the land area. This suits the purpose of the Crop Density Mapping tool, which is to identify areas of intensive farming of a particular crop.

Density of Vineyards, based on detailed CAPRI polgyons, and density greater than 1% of the landscape



10.3 Slope Data

Slope data sourced from HWSD Supplementary data is derived from 30 arc-second summaries of Shuttle Radar Topography Mission (SRTM) data. This highly detailed data was further summarized to each HWSD mapping unit polygon. Summaries were calculated for each of these classes:

- ☐ Slope Class 1 (0.0% - 0.5%)
- ☐ Slope Class 2 (0.5% - 2.0%)
- ☐ Slope Class 3 (2.0% - 5.0%)
- ☐ Slope Class 4 (5.0% - 10.0%)
- ☐ Slope Class 5 (> 10.0%)

10.4 Data Specification Table

DATA TYPE	DATA SPECIFICATIONS	CANADA	UNITED STATES OF AMERICA	EUROPEAN UNION
SOIL	**Name**	**HWSD**	**HWSD**	**HWSD**
	Resolution	30 arc-seconds or ~1km or 0.0083333 decimal degrees	30 arc-seconds or ~1km or 0.0083333 decimal degrees	30 arc-seconds or ~1km or 0.0083333 decimal degrees
	Source	IIASA – International Institute for Applied Systems Analysis, Luxembourg Austria	IIASA – International Institute for Applied Systems Analysis, Luxembourg Austria	IIASA – International Institute for Applied Systems Analysis, Luxembourg Austria
	Spatial Representation	Raster GRID	Raster GRID	Raster GRID
	Year	V1.1 March 2009	V1.1 March 2009	V1.1 March 2009
SLOPE	**Name**	Slope	Slope	Slope
	Resolution	30 arc-seconds or ~1km or 0.0083333 decimal degrees	30 arc-seconds or ~1km or 0.0083333 decimal degrees	30 arc-seconds or ~1km or 0.0083333 decimal degrees
	Source	HWSD Supplementary Data, Global Terrain Slope and Aspect Data	HWSD Supplementary Data, Global Terrain Slope and Aspect Data	HWSD Supplementary Data, Global Terrain Slope and Aspect Data
	Year	2006	2006	2006
CLIMATE	**Name**	**MARS FOODSEC – ERA INTERIM Meteodata**	**MARS FOODSEC – ERA INTERIM Meteodata**	**MARS FOODSEC – ERA INTERIM Meteodata**
	Resolution	0.25 decimal degrees	0.25 decimal degrees	0.25 decimal degrees
	Source	European Commission - JRC	European Commission - JRC	European Commission - JRC
	Spatial Representation	Vector	Vector	Vector
	Year	1978 to 2011 (1978 to 1988 data was interpolated from 1.0 degree points to 0.25 degree points)	1978 to 2011 (1978 to 1988 data was interpolated from 1.0 degree points to 0.25 degree points)	1978 to 2011 (1978 to 1988 data was interpolated from 1.0 degree points to 0.25 degree points)
CROPS	**Name**	**Interpolated Census of agriculture to soil landscapes**	**U.S. Agricultural Census -**	**Agricultural Landuse 2000 EU15+EU12** Homogeneous Spatial Mapping Units for EU15 and EU12 countries with **CAPRI land use allocation**
	Resolution/Scale	1:1,000,000	1:250,000	250m raster/1:100,000 vector
	Source	Agriculture and Agri-food Canada	United States Department of Agriculture, National Agricultural Statistics Service	EC JRC Institute for Environment and Sustainability (IES)
	Spatial Representation	Vector	Vector	Vector
	Year	V3.1 – Released 2008	2007	2000

10.5 Data Definitions

HWSD SOIL PROPERTIES

The following information was taken from the HWSD documentation – please see appendix 1 for source information

T_USDA_TEXTURE_CLASS (Ranked):

The Harmonized World Soil Database includes a classification of texture based on the USDA texture classes. These classes were ranked in order of particle size. This table shows the USDA CODE, Value and Texture Group, along with the TextureRank used in the calculation of similarity. Within a root ecoregion, the mean and standard deviation for TextureRank is calculated. In comparison ecoregions, the individual texture polygons in the detailed data are scored in the same way as other variables, and the area weighted score for texture is calculated. This textural class was used for the Holistic and Weights of Evidence similarity model.

CODE *	VALUE	TextureRank	TextureGroup
1	clay(heavy)	1	FINE
2	silty clay	2	FINE
3	clay (light)	3	FINE
4	silty clay loam	4	FINE
5	clay loam	5	FINE
8	sandy clay	6	FINE
6	silt	7	MEDIUM
7	silt loam	8	MEDIUM
9	loam	9	MEDIUM
10	sandy clay loam	10	MEDIUM
11	sandy loam	11	COARSE
12	loamy sand	12	COARSE
13	sand	13	COARSE

T_TEXTURE (top soil texture class):

Topsoil textural class refers to the simplified textural classes for 0–30cm used in the Soil Map of the World (FAO/Unesco, 1970-1980). Because of the scale of the map (1:5 million) only three simplified textural classes were used.

Coarse textured: sands, loamy sands and sandy loams with less than 18 percent clay and more than 65 percent sand.

Medium textured: sandy loams, loams, sandy clay loams, silt loams, silt, silty clay loams and clay loams with less than 35 % clay and less than 65 % sand; the sand fraction may be as high as 82 percent if a minimum of 18 percent of clay is present.

Fine textured: clays, silty clays, sandy clays, clay loams and silty clay loams with more than 35 percent clay.

CODE	T_TEXTURE
0	None
1	Coarse
2	Medium
3	Fine

This classification was used in the Site Selection process.

T_OC and S_OC:

This field gives the percentage of organic carbon in top and subsoil.

Moderate to high amounts of organic carbon are associated with a good soil structure. Soils with an organic matter content of less than 0.6% are considered poor in organic matter.

NOTE: the site selection database contains soils with a full range of organic carbon content, but the Ecoregion Similarity calculations use only soils with <17% organic carbon content.

T_PH_H_2O and S_PH_H_2O -log(H+):

This field gives the soil reaction of top and subsoil. pH, measured in a soil-water solution, is a measure for the acidity and alkalinity of the soil.

Cation Exchange Capacity (CEC)

T_CEC_CLAY Topsoil CEC (clay) meq/100 g

S_CEC_CLAY Subsoil CEC (clay) meq/100 g

Bulk Density

T_REF_BULK_DENSITY Topsoil Reference Bulk Density kg/dm3

MARS FOODSEC INTERIM METEODATA CLIMATE PROPERTIES:

The following information was taken from the MARS FOODSEC ERA-Interim meteodata documentation – please see appendix 1 for source information:

FOODSEC regularly receives daily, 10-day and monthly outputs of the ECMWF (European Centre for Medium-Range Weather Forecast) global circulation model.

The original global data at a 0.25 degree resolution are pre-processed by Meteoconsult (Nl) and additional parameters such as global radiation and evapotranspiration are calculated.

The ERA Interim data are resampled to 0.25 degree grid cells in order to be comparable with the real time data.

MARS FOODSEC ERA INTERIM parameters - 0.25 degree:

TAV - average temperature (°C)
RRR - precipitation sum (mm)

For information on processing please see metadata. For further database information please refer to the database source links in Appendix 1.

APPENDIX 1 - LINKS TO SOURCES

1. NORTH AMERICAN AND EUROPEAN UNION ECOREGION DATA:
   - Source: Terrestrial Ecoregion Data – Published by World Wildlife Fund (WWF)
     http://www.worldwildlife.org/science/Ecoregions/item1267.html

2. NORTH AMERICAN AND EUROPEAN UNION SOIL DATA
   - Source: Harmonized World Soil Database (HWSD) – Published by International Institute for Applied Systems Analysis (IIASA)
     http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/

3. CLIMATE DATA:
   - Source: MARS FOODSEC Interim Meteodata – Published by European Commission, Joint Research Centre (EC JRC)
     http://marswiki.jrc.ec.europa.eu/datadownload/index.php

4. SLOPE DATA
   - HWSD Supplementary Data, Global Terrain Slope and Aspect Data
     http://webarchive.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/global-terrain-slope.html?sb=6

5. CANADIAN LAND USE DATA:

   - Source: Interpolated Census of Agriculture to Soil Landscapes of Canada (SLC) for years 1971 to 2006 – Published by National Land and Water Information Service (NLWIS) of Agriculture and Agri-Food Canada
     http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1227624499292&lang=eng

6. UNITED STATES LAND USE DATA:
   - Source: CENSTAT- Agricultural Census Data 2007 – Published by United States Department of Agriculture (USDA)
     http://www.agcensus.usda.gov/

7. EUROPEAN UNION LAND COVER DATA:
   - Source: CORINE (Coordination of information on the environment) Land Cover – Published by European Environment Agency (EEA) and Commission of European Communities (CEC)
     http://www.eea.europa.eu/data-and-maps/data#c5=all&c0=5&b_start=0&c11=landuse&c12=corine&c17=CLC2000

APPENDIX 2 - Feature Classes and Field Names

Climate

MeanAnnTemp - 32 Year Mean Annual Temperature (Celsius)
MeanJanTemp - 32 Year Mean January Temperature (Celsius)
MeanFebTemp - 32 Year Mean February Temperature (Celsius)
MeanMarTemp - 32 Year Mean March Temperature (Celsius)
MeanAprTemp - 32 Year Mean April Temperature (Celsius)
MeanMayTemp - 32 Year Mean May Temperature (Celsius)
MeanJunTemp - 32 Year Mean June Temperature (Celsius)
MeanJulTemp - 32 Year Mean July Temperature (Celsius)
MeanAugTemp - 32 Year Mean August Temperature (Celsius)
MeanSeptTemp - 32 Year Mean September Temperature (Celsius)
MeanOctTemp - 32 Year Mean October Temperature (Celsius)
MeanNovTemp - 32 Year Mean November Temperature (Celsius)
MeanDecTemp - 32 Year Mean December Temperature (Celsius)

MeanAnnPrec - 32 Year Mean Annual Precipitation (mm)
MeanJanPrec - 32 Year Mean January Precipitation (mm)
MeanFebPrec - 32 Year Mean February Precipitation (mm)
MeanMarPrec - 32 Year Mean March Precipitation (mm)
MeanAprPrec - 32 Year Mean April Precipitation (mm)
MeanMayPrec - 32 Year Mean May Precipitation (mm)
MeanJunPrec - 32 Year Mean June Precipitation (mm)
MeanJulPrec - 32 Year Mean July Precipitation (mm)
MeanAugPrec - 32 Year Mean August Precipitation (mm)
MeanSepPrec - 32 Year Mean September Precipitation (mm)
MeanOctPrec - 32 Year Mean October Precipitation (mm)
MeanNovPrec - 32 Year Mean November Precipitation (mm)
MeanDecPrec - 32 Year Mean Decmber Precipitation (mm)

Crops (Canada)

ALFALFA - Alfalfa (Hectares)
BUCWHT - Buckwheat (Hectares)
CANMUST - Canola and Mustard (Hectares)
CORNGR - Corn Grain (Hectares)
CORNSLG - Corn Silage (Hectares)
CRORG - (Hectares)
CRTORGNY - (Hectares)
FLAXSD - Flaxseed (Hectares)
FORAGE - Forage (Hectares)
GRNCRL – Grain Cereal (Hectares)
GRNTOT - Grain Total (Hectares)

MAPLET - Mapletrees (Hectares)
MUSHRM - Mushrooms (Hectares)
OHAYFD - Hay (Hectares)
OILSD - Oilseeds (Hectares)
OTHFLD - Other Field Crops (Hectares)
POTATS - Potatoes (Hectares)
PULSES - Pulses (Hectares)
SOYBNS - Soybeans (Hectares)
SUGARB - Sugarbeets (Hectares)
TNURSRY - Tree Nursery (Hectares)
TOBACO - Tobacco (Hectares)
TOFDCP - HayFieldCrops (Hectares)
TOTVEG - Total Vegetables (Hectares)
UNGLAS - Greenhouse (Hectares)
WHTRYE – Winter Cereals (fall rye and winter wheat) (Hectares)
WHTSPG - Spring Wheat (Hectares)
XMSTREE – Christmas Trees (Hectares)
FRTBRY - Fruits Berry (Hectares)
FRTGRP - Fruits Grape (Hectares)
FRTTREE – Tree Fruit (Hectares)
dALFALFA - Alfalfa Density (Percentage land covered by crop)
dBUCWHT - Buckwheat Density (Percentage land covered by crop)
dCANMUST - Canola Mustard Density (Percentage land covered by crop)
dCORNGR - Corn Grain Density (Percentage land covered by crop)
dCORNSLG - Corn Silage Density (Percentage land covered by crop)
dFLAXSD - Flaxseed Density (Percentage land covered by crop)
dGRNCRL - Grain Cereal Density (Percentage land covered by crop)
dGRNTOT - Grain Total Density (Percentage land covered by crop)
dMAPLET - Maple Trees Density (Percentage land covered by crop)
dMUSHRM - Mushrooms Density (Percentage land covered by crop)
dOHAYFD - Hay Density (Percentage land covered by crop)
dOILSD - Oilseeds Density (Percentage land covered by crop)
dOTHFLD - Other Field Crops Density (Percentage land covered by crop)
dPOTATS - Potatoes Density (Percentage land covered by crop)
dPULSES - Pulses Density (Percentage land covered by crop)
dSOYBNS - Soybeans Density (Percentage land covered by crop)
dSUGARB - Sugarbeets Density (Percentage land covered by crop)
dTNURSRY - Tree Nursery Density (Percentage land covered by crop)
dTOBACO - Tobacco Density (Percentage land covered by crop)
dTOFDCP - HayFieldCrops (Percentage land covered by crop)
dTOTVEG - Total Vegetables Density (Percentage land covered by crop)
dUNGLAS - Greenhouse Density (Percentage land covered by crop)
dWHTRYE - Winter Cereals (fall rye and winter wheat) Density (Percentage land covered by crop)
dWHTSPG - Spring Wheat Density (Percentage land covered by crop)
dFRTBRY - Fruits Berry Density (Percentage land covered by crop)
dFRTGRP - Fruits Grape Density (Percentage land covered by crop)
dFRTTREE – Tree Fruit Density (Percentage land covered by crop)

Crops (USA)

ALFALFA_HA – Alfalfa (Hectares)
APPLES - Apples (Hectares)
BARLEY_GRA - Barley (Hectares)
BEANS_SNAP – Beans, Snap (Hectares)
BLUEBERRIE - Blueberries (Hectares)
CORN_SILAG - Corn Silage (Hectares)
GRAPES - Grapes (Hectares)
HAY - Hay (Hectares)
NECTARINES - Nectarines (Hectares)
PEACHES - Peaches (Hectares)
PEANUTS - Peanuts (Hectares)
PEARS - Pears (Hectares)
SOD - Sod (Hectares)
SORGHUM_GR – Sorghum, Grain (Hectares)
SOYBEANS - Soybeans (Hectares)
STRAWBERRI - Strawberries (Hectares)
VEGETABLES - Vegetables (Hectares)
WHEAT_GRAI - Wheat, Grain (Hectares)
CITRUS - Citrus (Hectares)
FIGS - Figs (Hectares)
POTATOES - Potatoes (Hectares)
RASPBERRIE - Raspberries (Hectares)
SORGHUM_SI - Sorghum, Silage(Hectares)
LIMA_DRY - Lima Beans, Dry (Hectares)
CHERRIES_S - Cherries, sweet (Hectares)
SUNFLOWER - Sunflower (Hectares)
TOBACCO - Tobacco (Hectares)
KIWI - Kiwi (Hectares)
BEANS_DRY – Beans, Dry (Hectares)
APRICOTS - Apricots (Hectares)
CHERRIES_T - Cherries, tart (Hectares)
CANOLA - Canola (Hectares)
PLUMS – Plums (Hectares)
POMEGRANAT - Pomegranates (Hectares)
DATES - Dates (Hectares)
OLIVES - Olives (Hectares)
AVOCADOS - Avocados (Hectares)
SUGARBEETS - Sugarbeets (Hectares)
SUGARBEE_1 - Sugarbeats, sugar (Hectares)
dALFALFA - Alfalfa Density (Percentage land covered by crop)
dAPPLES - Apples Density (Percentage land covered by crop)
dAVACADOS - Avocadoes Density (Percentage land covered by crop)
dAPRICOTS - Apricots Density (Percentage land covered by crop)
dBARLEY_GRA - Barley Grain Density (Percentage land covered by crop)
dBEANS_DRY - Beans, Dry Density (Percentage land covered by crop)
dBEANS_SNAP - Beans, Snap Density (Percentage land covered by crop)
dBLUEBERRIES - Blueberries Density (Percentage land covered by crop)

dCANOLA - Canola Density (Percentage land covered by crop)
dCHERRIES_S - Cherries, Sweet Density (Percentage land covered by crop)
dCHERRIES_T - Cherries, TartDensity (Percentage land covered by crop)
dCITRUS - Citrus Density (Percentage land covered by crop)
dCORN_SILAG – Corn Silage Density (Percentage land covered by crop)
dDATES - Dates Density (Percentage land covered by crop)
dFIGS - Figs Density (Percentage land covered by crop)
dGRAPES - Grapes Density (Percentage land covered by crop)
dHAY - Hay Density (Percentage land covered by crop)
dKIWI - Kiwi Density (Percentage land covered by crop)
dLIMA_DRY – Lima Beans, Dry Density (Percentage land covered by crop)
dNECTARINES - Nectarines Density (Percentage land covered by crop)
dOLIVES - Olives Density (Percentage land covered by crop)
dPEACHES - Peaches Density (Percentage land covered by crop)
dPEANUTS - Peanuts Density (Percentage land covered by crop)
dPEARS - Pears Density (Percentage land covered by crop)
dPLUMS - Plums Density (Percentage land covered by crop)
dPOMEGRANATE - Pomegranates Density (Percentage land covered by crop)
dPOTATOES - Potatoes Density (Percentage land covered by crop)
dRASPBERRIES - Raspberries Density (Percentage land covered by crop)
dSORGHUM_SI - Sorghum Silage Density (Percentage land covered by crop)
dSOD - Sod Density (Percentage land covered by crop)
dSORGHAM_GR – Sorghum Grain Density (Percentage land covered by crop)
dSOYBEANS - Soybeans Density (Percentage land covered by crop)
dSTRAWBERRIES - Strawberries Density (Percentage land covered by crop)
dSUGARBEETS - Sugarbeats Density (Percentage land covered by crop)
dSUNFLOWER - Sunflower Density (Percentage land covered by crop)
dTOBACCO - Tobacco Density (Percentage land covered by crop)
dVEGETABLES - Vegetables Density (Percentage land covered by crop)

Crops (EU)

TOMA - Tomatoes (Hectares)
OVEG - Other Vegetables (Hectares)
FLOW - Flowers (Hectares)
SWHE – Common Wheat (Hectares)
DWHE - Durham Wheat (Hectares)
BARL - Barley (Hectares)
RYEM - Rye (Hectares)
OATS - Oats (Hectares)
LMAIZ - Maize (Hectares)
PARI - Rice (Hectares)
OCER - Other cereals (Hectares)
POTA - Potatoes (Hectares)

SUGB - Sugarbeats (Hectares)
ROOF - Grennhouse (Hectares)
SUNF - Sunflower (Hectares)
LRAPE – Rape and Turnip Rape (Hectares)
SOYA - Soybean (Hectares)
LTEXT - Fibre and oleaginous (Hectares)
TOBA - Tobabco (Hectares)
OIND - Other non permanent industrial crops(Hectares)
PULS - Pulses, dry (Hectares)
LFRUI - Fruit tree and berry plantations (Hectares)
OFAR - Fodder other on arable land (Hectares)
LFALL - Fallow land (Hectares)
CITR - Citrus (Hectares)
LOLIV - Olives (Hectares)
NURS - Nursery (Hectares)
OCRO – Other Crops (Hectares)
GRAS - Permanent gras and grazing (Hectares)

dTOMA - Tomatoes Density (percentage land covered by crop)
dOVEG - Other Vegetables Density (percentage land covered by crop)
dFLOW - Flowers Density (percentage land covered by crop)
dSWHE – Common Wheat Density (percentage land covered by crop)
dDWHE - Durham Wheat Density (percentage land covered by crop)
dBARL - Barley Density (percentage land covered by crop)
dRYEM - Rye Density (percentage land covered by crop)
dOATS - Oats Density (percentage land covered by crop)
dLMAIZ - Maize Density (percentage land covered by crop)
dPARI - Rice Density (percentage land covered by crop)
dOCER - Other cereals Density (percentage land covered by crop)
dPOTA - Potatoes Density (percentage land covered by crop)
dSUGB – Sugar beats Density (percentage land covered by crop)
dROOF - Greenhouse Density (percentage land covered by crop)
dSUNF - Sunflower Density (percentage land covered by crop)
dLRAPE – Rape and Turnip Rape Density (percentage land covered by crop)
dSOYA - Soybean Density (percentage land covered by crop)
dLTEXT - Fibre and oleaginous Density (percentage land covered by crop)
dTOBA - Tobacco Density (percentage land covered by crop)
dOIND - Other non permanent industrial cropsDensity (percentage land covered by crop)
dPULS - Pulses, dry Density (percentage land covered by crop)
dLFRUI - Fruit tree and berry plantations Density (percentage land covered by crop)
dOFAR - Fodder other on arable land Density (percentage land covered by crop)
dLFALL - Fallow land Density (percentage land covered by crop)
dCITR - Citrus Density (percentage land covered by crop)
dLOLIV - Olives Density (percentage land covered by crop)
dNURS - Nursery Density (percentage land covered by crop)
dOCRO – Other Crops Density (percentage land covered by crop)

dGRAS - Permanent grass and grazing Density (percentage land covered by crop)

StudyAreaEcoregions

ECO_NAME - Ecoregion name
eco_code - Ecoregion Number
MEAN_T_OC - Mean Topsoil Organic Carbon
STD_T_OC - Standard Deviation Topsoil Organic Carbon
MEAN_T_PH_H2O - Mean Topsoil pH
STD_T_PH_H2O - Standard Deviation Topsoil pH
MEAN_T_CEC_SOIL - Mean Topsoil cation-exchange capacity meq/100 g
STD_T_CEC_SOIL - Standard Deviation Topsoil cation-exchange capacity
MEAN_T_USDA_TEX_CLASS - Mean USDA Texture Class
STD_T_USDA_TEX_CLASS - Standard Deviation USDA Texture Class
MEAN_TextureRank - Mean USDA Texture Class Ranking
STD_TextureRank - Standard Deviation USDA Texture Class Ranking
MEAN_MeanAnnTemp - Mean Annual Temperature (Celsius)
STD_MeanAnnTemp - Standard Deviation Annual Temperature (Celsius)
MEAN_MeanAnnPrec - Mean Annual Precipitation (mm)
STD_MeanAnnPrec - Standard Deviation Annual Precipitation (mm)
MEAN_MeanJanTemp - Mean January Temperature (Celsius)
MEAN_MeanFebTemp - Mean February Temperature (Celsius)
MEAN_MeanMarTemp - Mean March Temperature (Celsius)
MEAN_MeanAprTemp - Mean April Temperature (Celsius)
MEAN_MeanMayTemp - Mean May Temperature (Celsius)
MEAN_MeanJunTemp - Mean June Temperature (Celsius)
MEAN_MeanJulTemp - Mean July Temperature (Celsius)
MEAN_MeanAugTemp - Mean August Temperature (Celsius)
MEAN_MeanSeptTemp - Mean September Temperature (Celsius)
MEAN_MeanOctTemp - Mean October Temperature (Celsius)
MEAN_MeanNovTemp - Mean November Temperature (Celsius)
MEAN_MeanDecTemp - Mean December Temperature (Celsius)
MEAN_MeanJanPrec - Mean January Precipitation (mm)
MEAN_MeanFebPrec - Mean February Precipitation (mm)
MEAN_MeanMarPrec - Mean March Precipitation (mm)
MEAN_MeanAprPrec - Mean April Precipitation (mm)
MEAN_MeanMayPrec - Mean May Precipitation (mm)
MEAN_MeanJunPrec - Mean June Precipitation (mm)
MEAN_MeanJulPrec - Mean July Precipitation (mm)
MEAN_MeanAugPrec - Mean August Precipitation (mm)
MEAN_MeanSepPrec - Mean September Precipitation (mm)
MEAN_MeanOctPrec - Mean October Precipitation (mm)
MEAN_MeanNovPrec - Mean November Precipitation (mm)
MEAN_MeanDecPrec - Mean December Precipitation (mm)