

Land Surface Phenology Monitoring Protocol for Park Units in the Northern Colorado Plateau Network and Southern Colorado Plateau Network

Overview: These SOPs consist of downloading and preprocessing MODIS imagery, extracting pixel values for areas of interest, computing phenology and production metrics and trend over time. The last optional step includes computing water balance metrics for areas of interest and linking the water balance time-series to the NDVI time series for determining vegetation response relationships with climate. Phenology and vegetation production trends do not require water balance.

Note: there are two important user guides that have similar names. One is the official CRAN package documentation, and the other is an installation guide written by the package authors.

- 1) CRAN Document: “MODISrsp: A Tool for Automating Download and Preprocessing of MODIS Land Products Data” Available at: <https://cran.r-project.org/web/packages/MODISrsp/index.html>
- 2) Installation guide: “MODISrsp: A Tool for Automatic Preprocessing of MODIS Time Series - v1.3.3” Available at: <https://cran.r-project.org/web/packages/MODISrsp/vignettes/MODISrsp.pdf>

Associated file:

- O-NDVI_summary_BRCA_draft3

Land Surface Phenology Monitoring Protocol for Park Units in the Northern Colorado Plateau Network and Southern Colorado Plateau Network

Standard Operating Procedure (SOP) #1 Software Installation

Version 1.00 (September 2018)

Revision History Log

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Associated file:

- 1-MODISrsp_user_guide

1. Install software following the Installation guide <https://cran.r-project.org/web/packages/MODISrsp/vignettes/MODISrsp.pdf>
 - a. Download and install RStudio
 - b. Download and install R
 - c. Link R with RStudio
 - d. In RStudio install packages and package dependencies – reply “yes” if prompted
2. In addition these libraries should also be installed if not already installed

```
.libPaths( c( .libPaths(), "~/userLibrary" ) )  
.libPaths()  
install.packages("gWidgetsRGtk2")  
install.packages("devtools")  
install_github("lbusett/MODISrsp", lib="C:\\Users\\dthoma\\Documents\\R\\win-library\\3.3")  
library(gWidgetsRGtk2)  
library(devtools)  
library(curl)  
library(httr)
```

```
set_config(config(ssl_verifypeer = 0L))#prevents peer certificate authentication CA error
#httr::set_config( config( ssl_verifypeer = 0L ) )
install.packages("MODISrsp")
```

MODISrsp: A Tool for Automatic Preprocessing of MODIS Time Series - v1.3.3

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2017-08-17

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1 Introduction

MODISrsp is a novel "R" package allowing to automatize the creation of time series of rasters derived from MODIS Land Products data. It allows to perform several preprocessing steps on MODIS data available within a given time period.

Development of MODISrsp started from modifications of the ModisDownload "R" script by Thomas Hengl [-@Hengl2010], and successive adaptations by Babak Naimi [-@Naimi2014]. The basic functionalities for

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Standard Operating Procedure (SOP) #2 Download and Preprocess MODIS NDVI Imagery with MODISstsp in R

Version 1.00 (September 2018)

Revision History Log

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Associated file:

- 2-MODISstsp R documentation

The R module that automates most of the preprocessing is called MODISstsp.

Before running the code below, set up a user account for accessing and downloading MODIS Data from the NASA LPDAAC at <http://e4ftl01.cr.usgs.gov>. The MODISstsp GUI requires you to supply your LPDAAC password in order to download files.

Determine an area of interest as a bounding box that completely surrounds the maximum extent of any targets (eg. Vegetation polygons, habitats) that you plan to analyze.

Determine the date range, image type (NDVI, EVI etc.), image collection, projection, resampling, output format and pixel quality screening flags needed for analysis purposes. These may vary depending on objectives. All of these specifications are entered one time into a graphical user interface (Figure 1) and can be stored as a *.json file that can be reloaded for use again in the future.

```
#run from here after installing all dependencies above and any prompted for
library(httr)
set_config(config(ssl_verifypeer = 0L))#prevents peer certificate authentication CA error
#httr::set_config( config( ssl_verifypeer = 0L ) )
```

```
library(MODISrtp)  
MODISrtp()
```

After running this code you should see a pop up window (Figure 1). It may appear as a cube icon  in the windows bar at the bottom of your screen. Click it to open. Select options as appropriate and be sure to click “save options” in lower right hand corner of pop up window. Then click “start processing”. At this point MODISrtp will search your path to determine how many images you need to download to complete your request. It’s smart enough to skip files you downloaded earlier if you’re updating your image stack. Initially downloading the entire collection will take up to a week or more depending on geographic scope, period of interest and bandwidth. After that updates to your image stack will go much faster.

If you are appending images to an existing stack you can populate the GUI by using the “load options” button in the lower right corner of the pop up window. You would load options from an existing JSON file if you saved one earlier. If this is your first time through this process be sure to “Save Options” after filling in all the required information in Figure 1.

Output from this step is an image stack of geotiffs that have been projected, resampled and quality screened. These are the image files that will be used for analysis.

MODISp - v. 1.3.0

MODIS Product, Platform and Layers selection

Category: Ecosystem Variables - Vegetation Indices
Platform: Terra **Version:** 6
Product: Vegetation Indexes_16Days_250m (M*D13Q1)
Processing Layers: Click To Select

Download Method

Download Server: http **User Name:** dthoma **Password:** ***** ☒ Use 'aria2c' to accelerate download

Processing Period

Starting Date (yyyy-mm-dd): 2000-01-01 **Ending Date (yyyy-mm-dd):** 2017-01-11

Spatial Extent

Output Extent: Resized Retrieve Tiles from bounding box Load Extent from a spatial file

Required MODIS Tiles		Output Bounding Box (in output projection!)	
Horizontal: Start	8	End	10
Vertical: Start	4	End	5
Show Tiles Map		Left East. (xmin)	-115
		Right East. (xmax)	-105
		Lower North. (ymin)	36
		Upper North. (ymax)	42

Reprojection and Resize Options

Output Projection: Latlon WGS84 **PROJ4 String:** +init=epsg:4326 +proj=longlat +datum=WGS84 +no_defs +ellps=WGS84
Output Resolution: Native **Pixel Size:** native dec. degrees **Resampling Method:** near

Processing Options

Output Files Format: GTiff **GTiff Compression:** None
Create Virtual Rasters: None **Create RasterStacks:** ☒ Yes ☐ No **Change NODATA values:** ☐ Yes ☒ No

Output Folder for Original HDF files download

Z:\MODIS\Imagery\MOD13Q1.006\CO_Plateau\hdfs Browse **Delete original HDF files:** ☐ Yes ☒ No

Main Output Folder for Time Series storage

Z:\MODIS\Imagery\MOD13Q1.006\CO_Plateau\tifs Browse **ReProcess Existing Data:** ☐ Yes ☒ No

Start Processing Quit Program Load Options Save Options

Figure 1. MODISp graphical user interface for entering specifications for preprocessing. This example is for an area that includes the Northern Colorado Plateau network of parks.

Citations:

Busetto, L., & Ranghetti, L. (2017) MODISp: A Tool for Automatic Preprocessing of MODIS Time Series - v1.3.3

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Standard Operating Procedure (SOP) #3 Water Balance

Version 1.00 (September 2018)

Revision History Log

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Associated files:

- 3-Geographic_Transformations_10.1
- 3-gSSURGO-UserGuide-FY2016
- 3-site_parameters
- 3-Soil Data Viewer guide
- 3-Soil_Data_Development-User-Guide_v3
- 3-Water balance graphic
- 3-Water_balance_ver_10

Water balance describes the fate of precipitation after it falls to the ground. The monthly model uses mean monthly temperature and monthly precipitation sums (Thornton, et al. 2012; Daymet: <http://daymet.ornl.gov/>, Accessed 29 Apr 2014) as inputs to a single bucket Thornthwaite-type monthly water balance model (Dingman 2002). The model partitions precipitation (P) into rain or snow; the latter of which accumulates until temperatures (T) are warm enough to melt. Soil moisture (SOIL) is the quantity of water stored in the top meter of soil at the end of each month (mm). Soil is treated as a single layer that has a maximum storage capacity defined by the water holding capacity. Potential evapotranspiration (PET) is the amount of water that could be evapotranspired with available energy if water availability was unlimited to a short grass. Actual evapotranspiration (AET) is the monthly loss of water from soil via transpiration and evaporation which is limited by soil moisture. Deficit (D) is the

amount of additional water vegetation would use if it was available, calculated as the difference between monthly PET and AET (Stephenson 1998). These variables were summed, or averaged in the case of SOIL, for the biologically relevant water year Oct 1 – Sep 30.

Modified from McCabe and Markstrom 2007

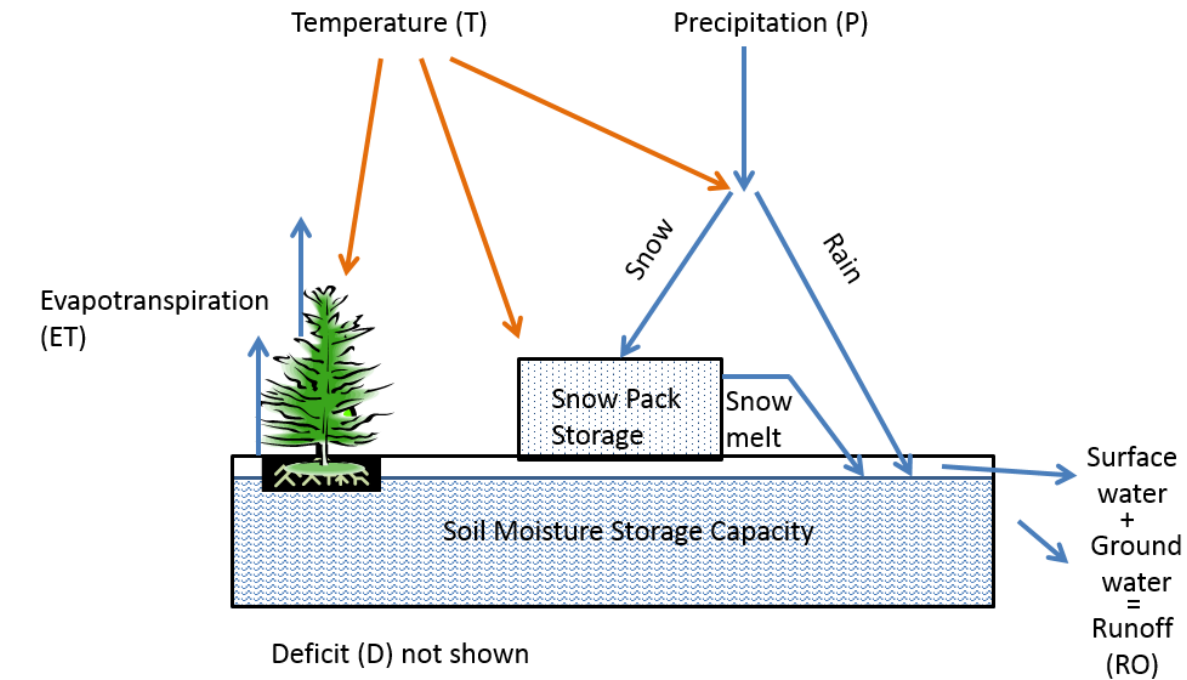


Figure 1. Conceptual diagram of water movement in the single-bucket Thornthwaite-type water balance model.

General steps include:

- a. Prepare a site attribute file
- b. Download Daymet data from Oak Ridge National Laboratory
- c. Run the monthly water balance model *Water_balance_ver_10.xlsm*
- d. Save data on the tab called "append_monthly" to a standalone *.csv file for import to R

Point-based Water Balance Instructions for *Water_balance_ver_10.xlsm* for Excel 2010

1. Prepare a standalone Excel site attribute file that describes your locations

1.1. See example below for one site.

1.2. Required fields are StationNam, LatDD, and LongDD.

1.3. Optional fields are slope in degrees, aspect or azimuth in degrees, water holding capacity in mm, and elevation in meters. If these are not supplied the model assumes a flat surface with 100mm water holding capacity. You can change the name of column headers, but the order of parameters which must be identical to this example. The code refers to column number so the name of the column can change, but their order must not change.

StationNam	LatDD	LongDD	slope	aspect	whc(mm)	elev (m)
Alta 1 NNW.csv	43.7727	-111.034	10	170	100	1250

1.4. StationNam must have a .csv extension.

1.4.1. You can add this easily to your existing station or site names using the concatenate function in Excel. =CONCATENATE(A1,".csv"), where A1 is cell location of site name

1.5. The tab name containing site attribute information must be named "sites". Do not rename the "sites" tab. Save the workbook as site_parameters.xlsx

2. We calculate water holding capacity according to NRCS guidelines or see guide .

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/tools/?cid=nrcs142p2_054223#06

3. If you don't have the water content at different pressures from the lab you can estimate water holding capacity based on horizon depth, texture and then subtract volume occupied by coarse fragments.

4. This will get you started but you'll have to convert to mm. It has an example you can follow.

<http://passel.unl.edu/pages/informationmodule.php?idinformationmodule=1130447039&topicorder=10&maxto=10>

Obtaining Soil Properties for Water Balance via ArcMap

3) Planning ahead

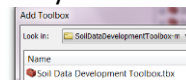
- a. All data layers must be geographic WGS 84 latitude, longitude decimal degrees!
 - i. Except the target shapefile when determining minimum areas
 - ii. MODIS pixel size is 6.25 ha, so eliminating polygons < 6.25 ha is advisable
- b. Reproject shape files, points, NDVI and any other analysis layers to decimal degrees before starting.
- c. Identify the attribute (ecological site, vegetation map) you're using as a target for extracting NDVI. You'll want an attribute that has a number linked to a map unit description. Numeric mapunit ID's are much easier to handle in R than map unit text names. Text names can always be linked back to numeric ID's if you maintain a key. Do this in the site attribute file that's used as input to the water balance model.
- d. Do you need soil property data for analysis?
 - i. Water holding capacity needed for the water balance model?
 - ii. Texture or soil depth or other soil property covariates?
 - iii. If so, then

4) Install the SoilDataDevelopmentToolbox

- e. Obtaining soil property values is challenging, but is accomplished via the SoilDataDevelopmentToolbox.
- f. Download the toolbox from GitHub.
 - i. <https://github.com/ncss-tech/SoilDataDevelopmentToolbox/tree/master>
 - ii. Then download by clicking the “clone or download” button. Save this bundle to your ArcMap toolbox.
 - iii. C:\Users\dthoma\AppData\Roaming\ESRI\Desktop10.4\ArcToolbox\My Toolboxes\SoilDataDevelopmentToolbox-master
 - iv. Install the toolbox by opening ArcToolbox in ArcMap 

- v. Right click on  then select add toolbox by navigating to the path where you stored the tools in your “mytoolboxes” path. Click on

SoilDataDevelopmentToolbox.tbx



5) Obtain soil survey data in the gSSURGO format

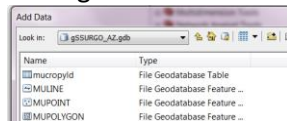
- g. <https://datagateway.nrcs.usda.gov/>
- h. Click “Get Data”
- i. Select data you want by state and county, or change to a map view to select an area of interest



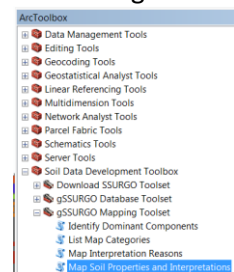
- j.
- k. Follow directions and a download link will be e-mailed to you. File sizes are Large!
- l. Download and unzip all the files. Dig into the subdirectories and unzip all the *.zip files

6) Build soil attribute layers in ArcMap with SoilDataDevelopmentToolbox

- m. NOTE: this will be a *polygon shape file*, unlike slope and aspect which are *rasters*
- n. Extracting data for these different formats requires different strategies
- o. Proceed as follows for extracting soil property data for points
- p. Attributes can be water holding capacity, %sand, % clay, depth, etc
- q. Add soil maps as polygon layers to cover your area of interest. These files are in the *.gdb folder named “MUPOLYGON”

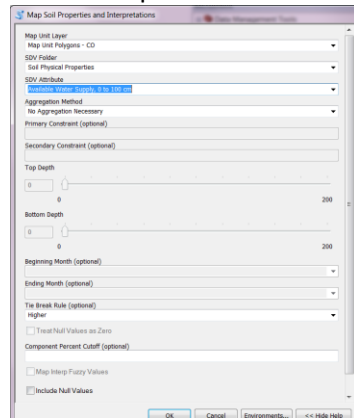


- r. Open the SoilDataDevelopmentToolbox from the ArcToolbox dropdown menu
- s. In the gSSURGO Mapping Toolset double click Map Soil Properties and Interps.

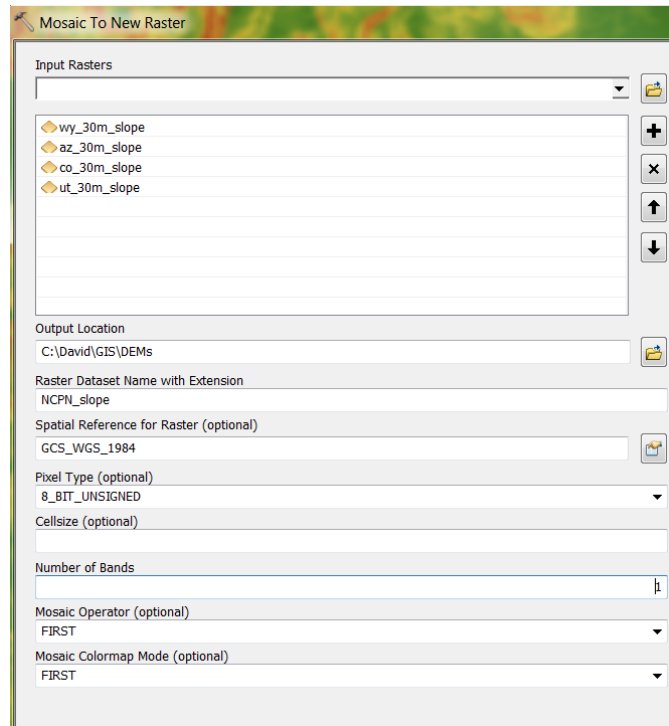


- t. Select the map unit layer for the state of interest.

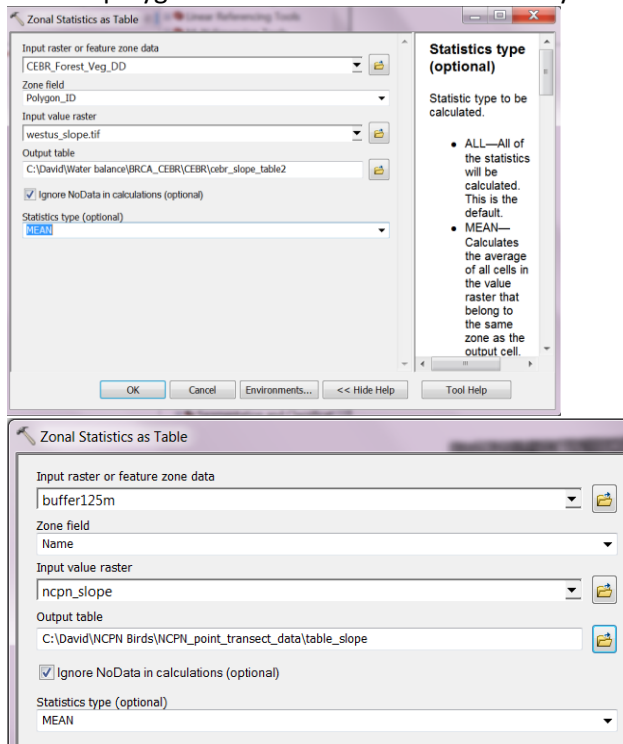
- u. Select the SDV Folder “Soil Physical Properties” for SDV attribute % sand, % clay, depth, or Available water supply 0-100cm
- v. Aggregation method choose weighted average if it’s an option
- w. Bottom Depth choose 100 cm to coincide with water balance model depth



- x.
- y. This will create an Albers Equal Area map of the soil property of interest.
- z. Reproject to Geographic > World>WGS_84 to match projection of extraction points (your NDVI target polygon centroids)
- aa. NOTE: I had trouble with reprojection because it lost the soil attribute information of interest (% clay, sand, depth) so I ended up using a join in Albers projection to obtain the soil attribute data.
- bb. Merge the water holding capacity layers into one file so that join can be done only once
 - i. ArcToolbox>DataManagement>General>Merge
- cc. Join: Right click the centroid points file > join > then follow instructions to make shapefile copy of points that have soil property attributes.
- dd. Merge the slope and aspect rasters. Reproject to geographic WGS 84 in same step
 - i. ArcToolbox -> Data Management Tools -> Raster -> Raster Dataset -> Mosaic To New Raster

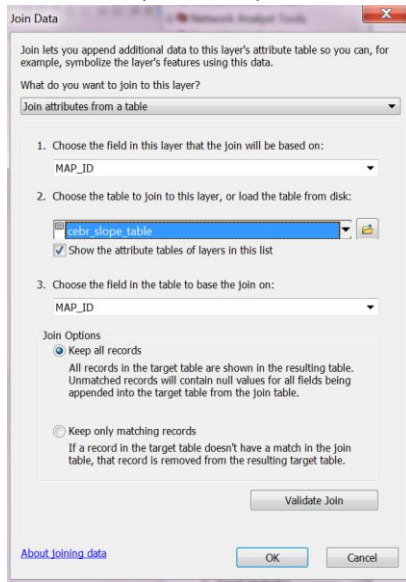


- 7) Extract the slope and aspect mean raster vales for each map unit as a table.
 ee. Spatial Analyst Tools > Zonal > Zonal Statistics and select the Mean statistic In the Zone field. Select object ID or polygon ID not the map unit name or it will average across all polygons of the same kind – not what you want!

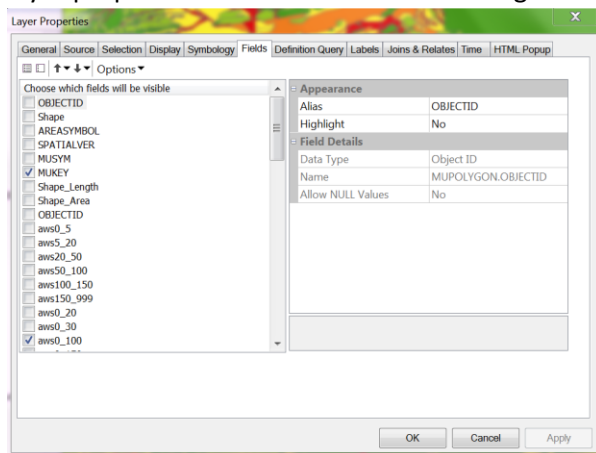


ff. Another example.

Join the slope and aspect tables to the polygon target map shape file attribute table.



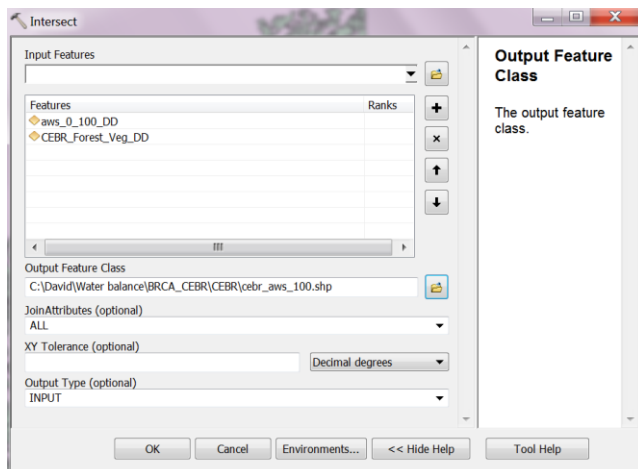
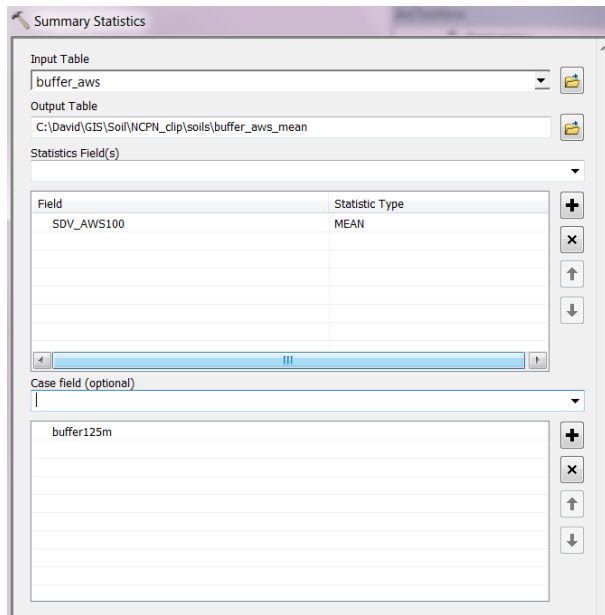
Create a soil water holding capacity data layer from the soil file geodatabases of state SSURGO data. Follow instructions in the file Water Balance Model Instructions.docx to isolate the water holding capacity depth of interest (0-100cm) WHC units are mm. In the file geodatabase for the state under layer properties select these fields. Then right click the geodatabase name, export, data to a shapefile.



Reproject this shape file to Geographic WGS 1984. This can be queried to pull water holding capacity values for the target vegetation polygons.

Obtain whc for target polygons via “Geoprocessing” tab along top row, select intersect and add the veg map layer and the water holding capacity layer to the drop down list.

Compute area averaged water holding capacity within target polygons using ToolBox>AnalysisTools>Statistics>SummaryStatistics. Then join this table with the shapefile containing slope and aspect that you joined earlier.



Obtain DAYMET data files from Oak Ridge National Lab

- 4.1. <http://daymet.org/singlepixel>
- 4.2. Create a username and password if downloading single pixel files
- 4.3. Download a single pixel time series one at a time by entering the lat and long coordinates in decimal degrees, or install the batch downloader to download many pixel time series each saved as a separate *.csv file.
- 4.4. Select all attributes and all years for download.

Enable macros

- 4.5. Ensure macros can run and developer tab opens on the toolbar ribbon (only need to do this once)

- 4.6. Open the Excel worksheet called Water_balance_ver_10.xlsm
- 4.7. Click “enable macros” if it asks.
- 4.8. Click File > Options> Trustcenter>Trustcenter settings>Macro Settings > click enable macros
- 4.9. Click File > Options>Customize Ribbon> check the Developer box to display a new tab
5. Click developer tab>Visual Basic> scroll to modules on left side pane and expand then double click Water_balance_DAYMET_batch to open the macro

Change settings for batch runs

- 5.1. Change path that points to location where DAYMET files are stored.
- 5.2. Or alternatively create a path c:\WaterBalance and drop files there
 - 5.2.1. Click the developer tab in Excel, then click Visual Basic
 - 5.2.2. Expand the Modules folder in the left hand panel of the Visual Basic screen
 - 5.2.3. Double click to open the Macro “Water_balance_DAYMET_batch” near line 54 search for these lines and change the path name as needed so it points to location of DAYMET files

```
' Specify the path\folder location of your DAYMET data files  
MyPath = "C:\Users\dtthoma\Desktop\daymet\Amphibians\AWS_constant_100mm"
```
- 5.3. Near line 82 and 144 change the site attribute file name as needed. This is the file you created in section 1 above. site_parameters.xlsx
- 5.4. Note: DO NOT rename the spreadsheet “Water_balance_ver_10.xlsm” This file name is hard coded in the macro. If you do change the name of your spreadsheet the macro scripts will not run.
- 5.5. Click the play button on the Excel VBA toolbar to run the macro.
6. Monthly and annual data will be created on a new tab for each site with tab name = site name
7. A tab called “append” will collate all the annual water balance values
8. A tab called “append_monthly” will collate all of the monthly values separately
9. Export the append pages to *.csv format for import to R or other statistical software.

Iterative runs

If you need to run the code iteratively for any reason you must delete the auto-generated site pages. Warning codes have been turned off and Excel may not overwrite existing spreadsheet pages without user consent.

Tab names cannot have certain characters like “/” which would be a common component of habitat names like psme/syal. Thus replace illegal characters using search and replace function in the site attribute file before running.

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Standard Operating Procedure (SOP) #4 Processing NDVI and Analysis

Version 1.00 (September 2018)

Revision History Log

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Associated file:

- 4-BRCA_ndvi_2.R

The annotated R script “BRCA_ndvi_2.R” (ver 1.0) is designed to use shapefile polygons from vegetation or ecological site maps as analysis targets. It can integrate water balance into the analysis if desired. Water balance data are generated in SOP 3 by running Excel visual basic water balance code on Daymet climate time series extracted for polygon centroids. Quality screening for NDVI was modified from Nathan Piekielek at Penn State University. The quality screening steps in this code may be redundant with MODIS_{stsp} screening procedures depending on settings in MODIS_{stsp}.json file.

General overview of procedures

1. Image subsetting process for smaller area analysis like NDVI for vegetation types in a single park starts with this script. See “Target Area Preparation” sequence below this overview
2. Ensure every polygon has unique identity for analysis in a column
 - a. Identify polygon groups that will simplify analysis ie. coarse veg types, burned etc.
 - b. Add this grouping column(s) to the water balance site description file in Excel site parameter file or as a new attribute in ArcMap. Either option is OK since water balance and NDVI analysis will be merged. If not implementing water balance the grouping column must be added in ArcMap.

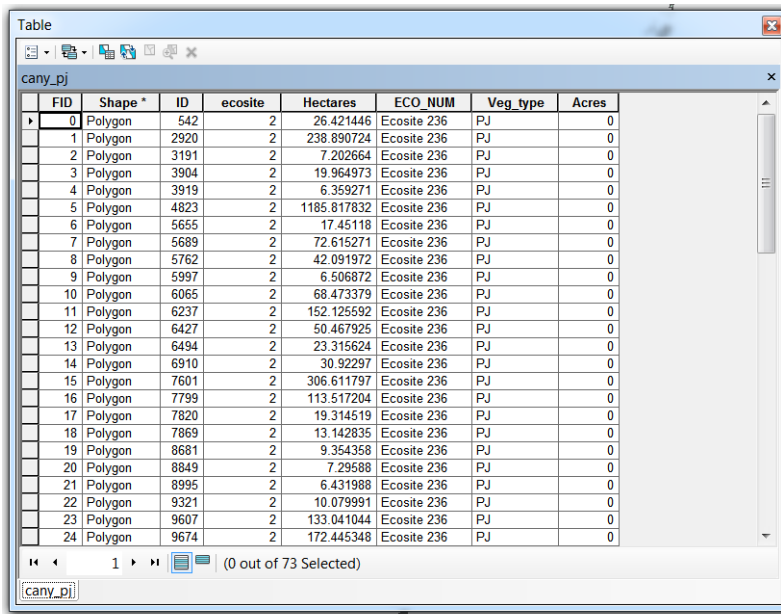
3. Note: this may be accomplished in SOP 2.
 - a. Identify bounding box, download and process imagery to remove cloud, atmosphere and snow effects project to geographic coordinates if not already projected
4. Extract ndvi by polygon
5. Smooth and gap fill ndvi time series
 - a. this process may take a few hours to a day or two depending on polygon count and area
6. Import target polygon layer (vegetation or ecological site map) to R
 - a. Project to geographic coordinates
7. If integrating water balance with NDVI analysis
 - a. Extract polygon centroids that will be used to obtain single-pixel Daymet climate data time series if you haven't already determined polygon centroids for Daymet download in SOP 3
 - b. In ArcMap obtain slope, aspect and water holding capacity used to populate the site parameter file in water balance model, add to site parameter file
 - c. Run water balance model "Water_balance_ver_10.xlsm"
 - d. this process takes about 1 minute per site/polygon in Excel
8. Extract NDVI for each polygon and compute mean NDVI for each polygon at each time step
9. Import monthly water balance values to R
10. Merge ndvi and water balance time series data in R
11. Compile seasonal NDVI and water balance values by degrading monthly to seasonal, annual or other period of interest.
12. Determine trends in NDVI by polygon
13. Determine phenology by polygon
14. Summarize results by group, for example vegetation type or ecological site type (usually necessary to make sense of the enormous quantity of information)
15. Compute pivot points and responses NDVI~water balance
16. Evaluate trends in climate drivers that have most influence on NDVI response
17. An example of the integrated analyses can be found in the Bryce Canyon draft Natural Resources Condition Assessment report "NDVI_summary_BRCA_draft3.docx"

Target Area Preparation

- 1) Steps to obtain shape files in format readable by R.
 - a. Load shape files containing polygons of interest into an ArcMap project.
 - b. Select unique polygon ID of interest from sampling frame.
 - c. Click Data export selected features and save into a new path.
- 2) Determine area of each polygon.
 - a. Note: area calculations in ArcGis won't work if shape file is geographic coordinates (eg. Degrees)
 - b. Will need to calculate area, then as above select and "Data export" then transform the projection in a separate step.
 - c. Open newly extracted polygons from above step in a new Arcmap mxd.
- 3) Make sure all polygons are identifiable as discrete units that have independent area calculations.

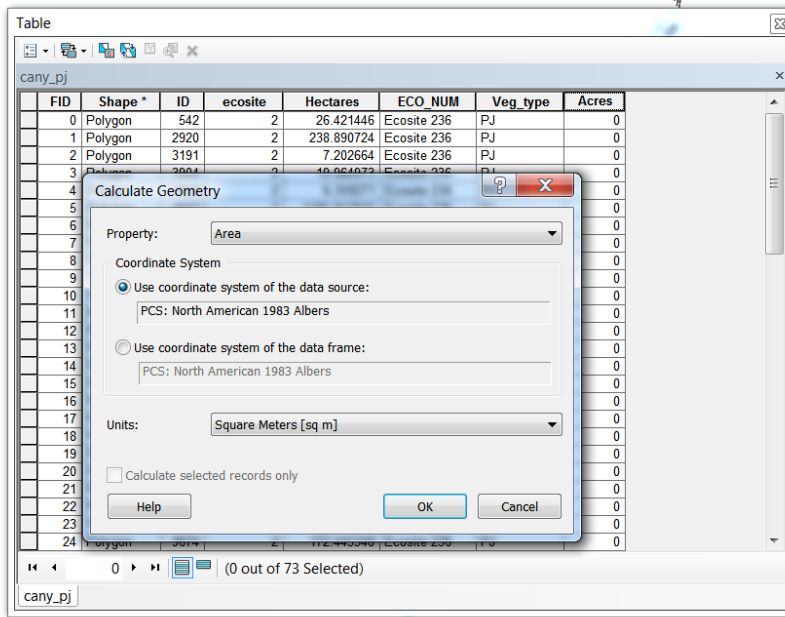
- 4) Right click shapefile in Table of Contents, click Edit Features, Start Editing and editor toolbar will open.
- 5) Click the editor dropdown arrow in the editor toolbar then click More Editing then Advanced Editing
- 6) Right click shapefile in Table of Contents and open the attribute table. Highlight every row, to select every polygon Then hit the "explode" icon on the Adv. Ed. toolbar and you should have a bunch of discrete polygons with identical attributes (minus polyIDs and such) 

- a. Click the shape file of interest and open the attribute table
- b. If necessary click the upper left icon drop down menu to add a new Field and give it a name like hectares or acres



FID	Shape *	ID	ecosite	Hectares	ECO_NUM	Veg_type	Acres
0	Polygon	542	2	26.421446	Ecosite 236	PJ	0
1	Polygon	2920	2	238.890724	Ecosite 236	PJ	0
2	Polygon	3191	2	7.202664	Ecosite 236	PJ	0
3	Polygon	3904	2	19.964973	Ecosite 236	PJ	0
4	Polygon	3919	2	6.359271	Ecosite 236	PJ	0
5	Polygon	4823	2	1185.817832	Ecosite 236	PJ	0
6	Polygon	5655	2	17.45118	Ecosite 236	PJ	0
7	Polygon	5689	2	72.615271	Ecosite 236	PJ	0
8	Polygon	5762	2	42.091972	Ecosite 236	PJ	0
9	Polygon	5997	2	6.506872	Ecosite 236	PJ	0
10	Polygon	6065	2	68.473379	Ecosite 236	PJ	0
11	Polygon	6237	2	152.125592	Ecosite 236	PJ	0
12	Polygon	6427	2	50.467925	Ecosite 236	PJ	0
13	Polygon	6494	2	23.315624	Ecosite 236	PJ	0
14	Polygon	6910	2	30.92297	Ecosite 236	PJ	0
15	Polygon	7601	2	306.611797	Ecosite 236	PJ	0
16	Polygon	7799	2	113.517204	Ecosite 236	PJ	0
17	Polygon	7820	2	19.314519	Ecosite 236	PJ	0
18	Polygon	7869	2	13.142835	Ecosite 236	PJ	0
19	Polygon	8681	2	9.354358	Ecosite 236	PJ	0
20	Polygon	8849	2	7.29588	Ecosite 236	PJ	0
21	Polygon	8995	2	6.431988	Ecosite 236	PJ	0
22	Polygon	9321	2	10.079991	Ecosite 236	PJ	0
23	Polygon	9607	2	133.041044	Ecosite 236	PJ	0
24	Polygon	9674	2	172.445348	Ecosite 236	PJ	0

- c. Right click the new field name then click "Calculate geometry" and specify units



Table

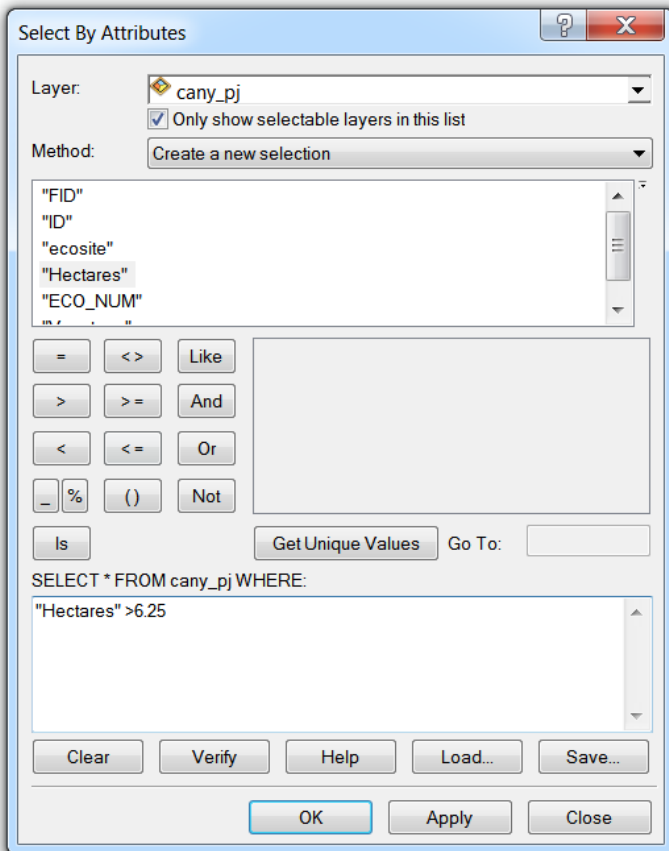
cany_pj

FID	Shape *	ID	ecosite	Hectares	ECO_NUM	Veg_type
0	Polygon	542	2	26.421446	Ecosite 236	PJ
1	Polygon	2920	2	238.890724	Ecosite 236	PJ
2	Polygon	3191	2	7.202664	Ecosite 236	PJ
3	Polygon	3904	2	19.964973	Ecosite 236	PJ
4	Polygon	3919	2	6.359271	Ecosite 236	PJ
5	Polygon	4823	2	1185.817832	Ecosite 236	PJ
6	Polygon	5655	2	17.45118	Ecosite 236	PJ
7	Polygon	5689	2	72.615271	Ecosite 236	PJ
8	Polygon	5762	2	42.091972	Ecosite 236	PJ
9	Polygon	5997	2	6.506872	Ecosite 236	PJ
10	Polygon	6065	2	68.473379	Ecosite 236	PJ
11	Polygon	6237	2	152.125592	Ecosite 236	PJ
12	Polygon	6427	2	50.467925	Ecosite 236	PJ
13	Polygon	6494	2	23.315624	Ecosite 236	PJ
14	Polygon	6910	2	30.92297	Ecosite 236	PJ
15	Polygon	7601	2	306.611797	Ecosite 236	PJ
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21	Polygon	8995	2	6.431988	Ecosite 236	PJ
22	Polygon	9321	2	10.079991	Ecosite 236	PJ
23	Polygon	9607	2	133.041044	Ecosite 236	PJ
24	Polygon	9674	2	172.445348	Ecosite 236	PJ

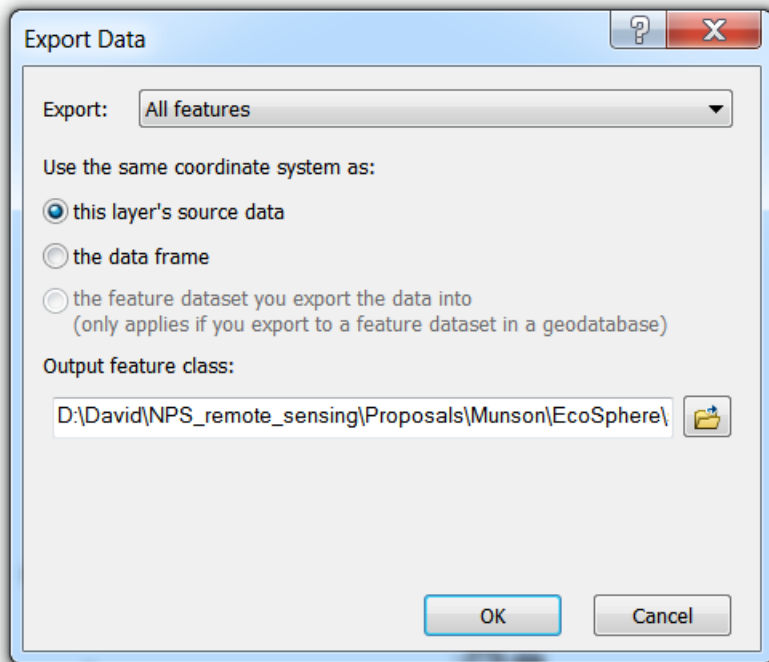
1 (0 out of 73 Selected)

cany_pj

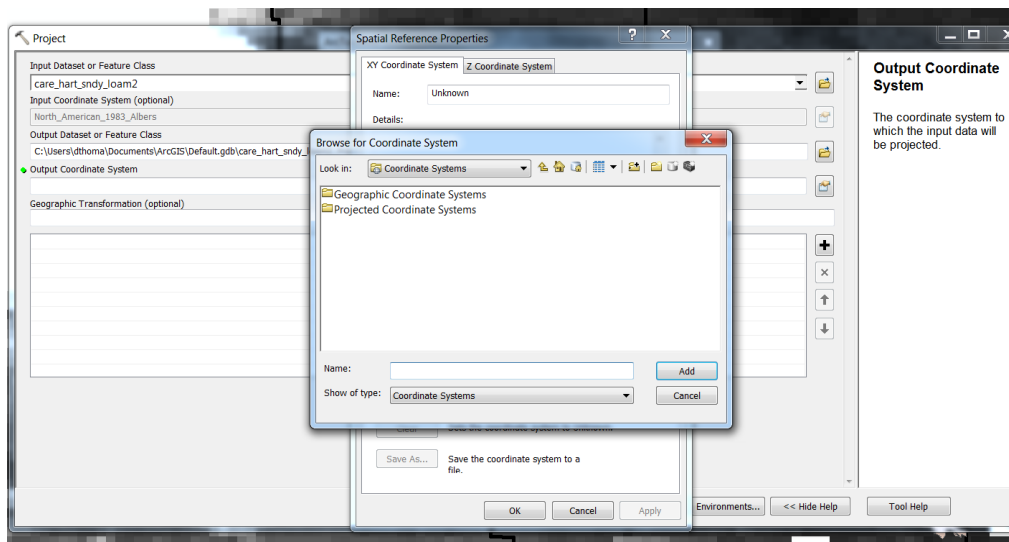
7) Extract only polygons of user defined area.

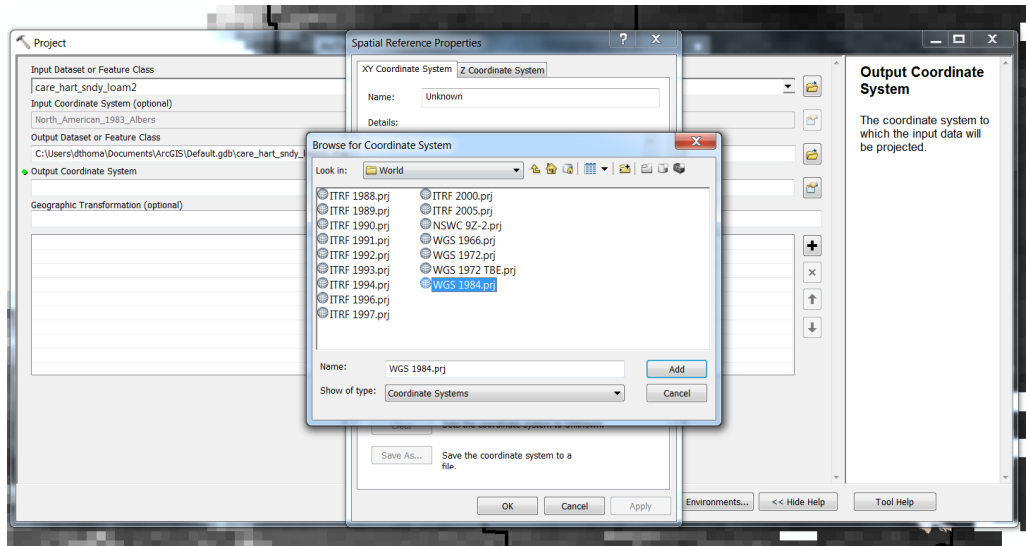


- 8) Then save selected polygons as a new data file.
 - a. Right click polygon layer in Layers, then Data, export data and save in a new location.

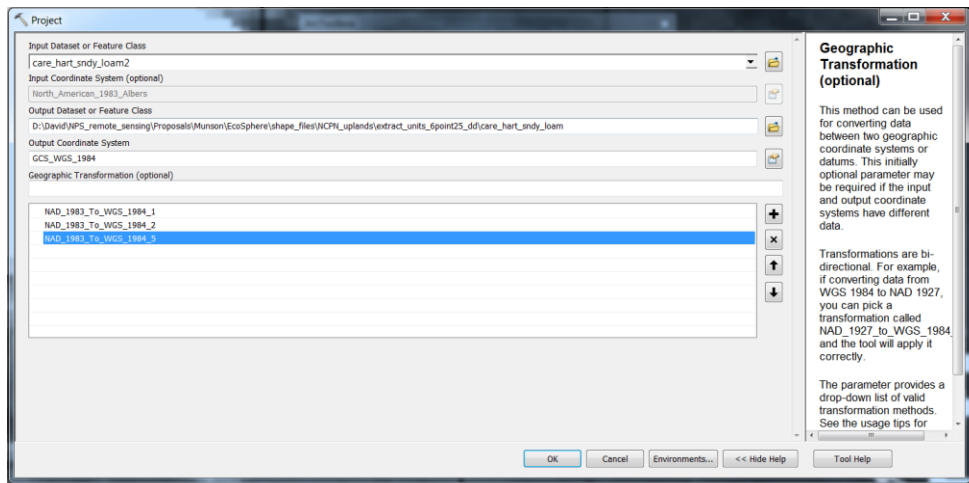


- 9) Batch reproject shape files from projected to geographic coordinates using a pre defined transformation.
 - a. In ArcToolbox click Data Management Tools
 - b. Click Projections and Transformations, then Feature and Batch Project or Project
 - c. Drag and drop shape file you want to project, edit the output file name to write to intended path
 - d. Specify output coordinate system as Geographic Coordinate Systems, World, WGS 1984

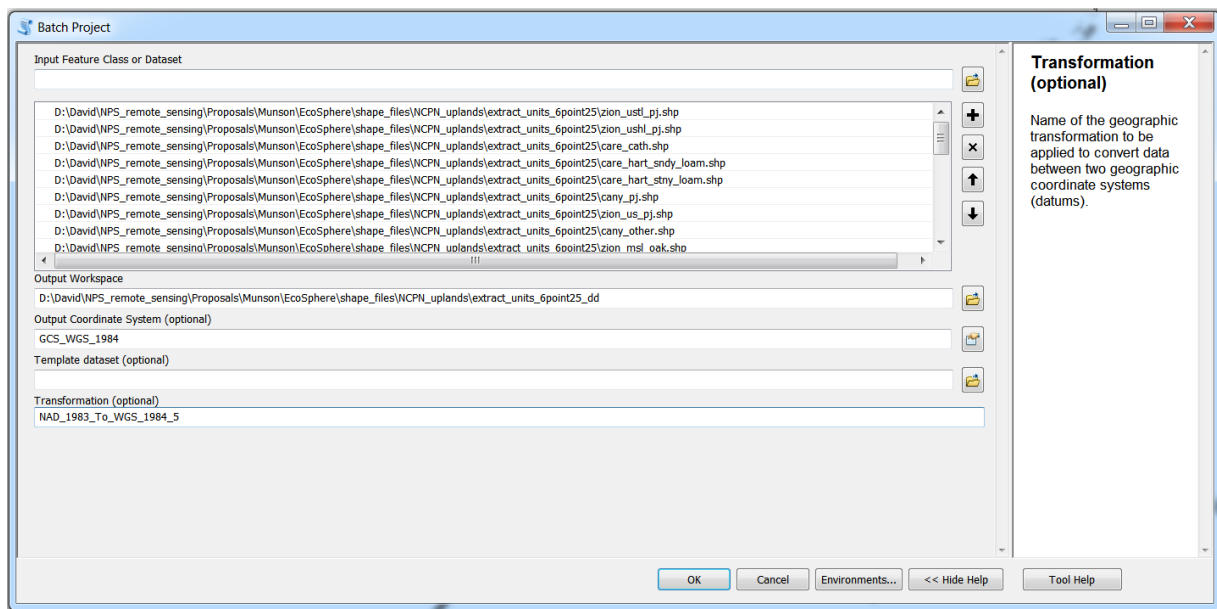




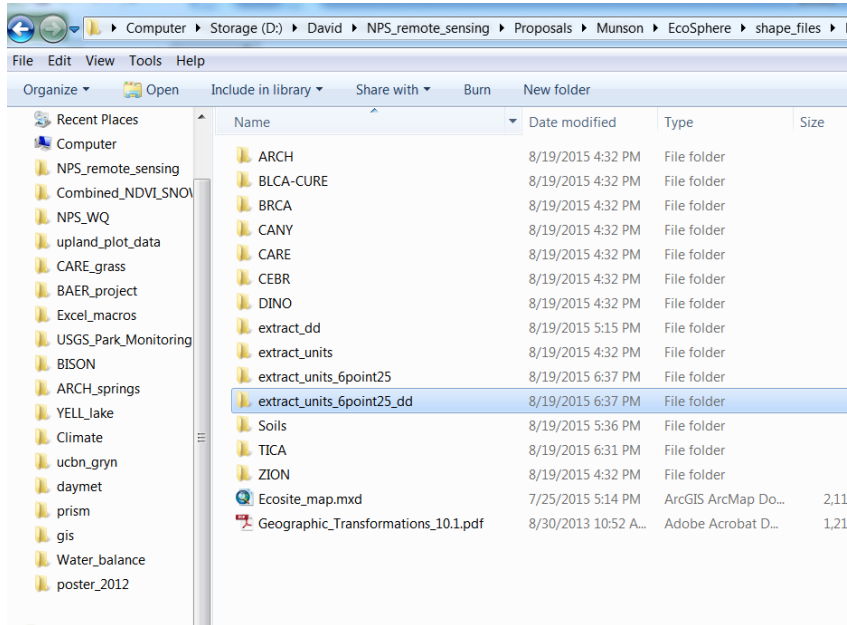
e. Full specifications for projecting into WGS 1984 should look something like this.



- f. The transformation definitions can be found here.
- g. <http://support.esri.com/en/knowledgebase/techarticles/detail/21327>
- h. Download the pdf for ArcGis 10.1.
- i. In this example the transformation definition is
 - i. NAD_1983_To_WGS_1984_5
 - ii. More info here.
 - iii. <http://gis.stackexchange.com/questions/4489/how-can-i-transform-gcs-north-american-1983-to-gcs-wgs-1984>



- 11) Create R code to access shape files by name
- 12) Copy file names from DOS
- 13) Open DOS window in path by highlighting the path name of interest then Shift+right mouse click.



- 14) Then To copy text from a command prompt window
 - Open Command Prompt type `dir /b`
 - Right-click the title bar of the command prompt window, point to **Edit**, and then click **Mark**.
 - Click the beginning of the text you want to copy.
 - Press and hold down the SHIFT key, and then click the end of the text you want to copy (or you can click and drag the cursor to select the text).
 - Right-click the title bar, point to **Edit**, and then click **Copy**.
 - Position the cursor where you want the text to be inserted:
 - In an MS-DOS-based program, or in a command prompt window, right-click the title bar, point to **Edit**, and then click **Paste**.
 - In a Windows-based program, click the **Edit** menu, and then click **Paste**.

15) Note

- To open command prompt, click **Start**, point to **All Programs**, point to **Accessories**, and then click **Command Prompt**.
- You cannot paste text into a command prompt window or MS-DOS-based program when it is running in a full screen. For more information, click **Related Topics**.

Land Surface Phenology Monitoring Protocol for Park Units in the Northern Colorado Plateau Network and Southern Colorado Plateau Network

Standard Operating Procedure (SOP) #5 Revising the Protocol Narrative and SOPs

Version 1.00 (October 2018)

Revision History Log

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains how to make and track changes to the narrative and standard operating procedures for the Northern Colorado Plateau Network (NCPN) and Southern Colorado Plateau Network (SCPN) Land Surface Phenology Monitoring Protocol. Individuals editing the protocol narrative or any SOP need to follow these procedures in order to eliminate confusion on how data are collected and analyzed.

Procedures

1. Modifications must be reviewed for clarity and technical soundness. Small changes or additions to existing methods will be reviewed in-house by NCPN staff. An outside review is required for substantive changes in methods. Regional and national staff of the National Park Service (NPS) and experts outside the NPS with familiarity in land surface phenology will be used to review major changes.
2. Record all changes to a protocol document (protocol narrative or SOP) in the document's revision history log, even minor edits like fixing typos or formatting changes. It is not necessary to record the specific edits made—rather, just the fact that typos were fixed or formatting changes were made. For minor edits, record the same document version number in the revision history log. For actual protocol changes (e.g., changes in methods), assign a new version number in the revision history log. Depending on the significance of the changes, it may be okay to combine multiple changes in the same entry in the revision history log. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major

revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, and the reason for the changes, along with the new version number.

3. Narrative and SOP updates may occur independently. That is, a change in one SOP will not necessarily invoke changes in other SOPs; a narrative update may not require SOP modifications. The NCPN tracks the narrative and SOP version numbers in a Master Version Table (MVT), which is maintained in this SOP. Any time the narrative or an SOP version change occurs, the MVT is updated to reflect the date of the change and the versions of the narrative and SOPs in effect.
4. New versions of the protocol narrative and SOPs must be posted on the NCPN website. Older versions of the protocol narrative and SOPs must be archived in the NCPN Land Surface Phenology Protocol Library: (R:\Monitoring_Archive\Land_Surface_Phenology\Protocol).

Land Surface Phenology Monitoring Protocol Master Version Table

Effective Date	Narrative	1-Software Installation	2-Download & Preprocess Imagery	3-Water Balance	4-Processing NDVI & Analysis	5-Revising the Protocol
10/21/2017	1.00	1.00	1.00	1.00	1.00	1.00