



DSET Application Case Study: Wildfires and Meadows

Please refer to the primary User Guide document for a general overview of the Navajo Nation Drought Severity Evaluation Tool (DSET) and a complete list of case study examples (including drought, agriculture, snowpack, and downloading data). If you are only interested in the wildfires and meadows case-study example, you can use this document.

Introduction

On the Navajo Nation, meadow ecosystems are important for carbon and nitrogen storage, mediation of surface water flow, recharge ground water, sediment filtration and can also serve as natural refugia for local plant and animal species. Meadows depend on the supply of water through the water table but also rely on surface water from springs and seeps as well as precipitation. Therefore, they are highly vulnerable to changes in hydrological regimes associated with wildfires and climate change.

DSET can contribute to a better understanding of the impacts and changes to meadows. This particular case study will look at the conditions and responses to meadows in the Chuska Mountains pre- and post-Asaayi Lake Fire. The Asaayi Lake Fire occurred during the summer of 2014 and burned over 14,000 acres. Managers interested in understanding wildfire impacts can use satellite-derived vegetation indices such as the Burned Area Index (BAI) and the Normalized Difference Vegetation Index (NDVI) from Landsat and MODIS. These indices identify vegetation stress, loss, and regrowth in meadow ecosystems, such as those associated with the Asaayi Lake Fire in 2014 in the Chuska Mountains.

The BAI uses the near-infrared and shortwave infrared wavelengths to identify burned areas after the fire. NDVI is calculated using reflectance of vegetation in the red and near-infrared wavelengths. Calculations of NDVI result in a value between -1 and 1 with larger values representing greater density of green leaves. Using the NDVI values we can identify areas of stressed vegetation that may require a closer look at for restoration post-fire. NDVI can also be used to identify regions that may also be affected by activities such as overgrazing.

Components of Analysis

- Datasets: MODIS Terra Daily and Landsat 4/5/7/8 Surface Reflectance
- Variables: Burned Area Index (BAI) and Normalized Difference Vegetation Index (NDVI)

Objectives

- Identify the burn scar area in the Chuska Mountains caused by the Asaayi Lake Fire using the MODIS BAI.

- Develop a custom polygon to create a time series of the Asaayi Lake Fire burn scar to compare BAI and NDVI values pre- and post-fire to monitor meadow restoration.
- Create Landsat NDVI Percent Difference from Average value maps for the same time period on three separate years (2013, 2014, and 2019) to see the vegetation health pre- and post-fire.

Helpful Tips

- DSET is optimized for Google Chrome, please use Chrome.
- Faster networks are preferred when using DSET.
- Zoom to area of interest before submitting map requests to help with re-computing data.
- Resubmission and reset of DSET can help with fail requests that produce a server error.
- The figures included in this case study will help you navigate the DSET to locate the features associated with each step. It is suggested that you use the figure to ensure your selections are correct prior to completing each major step within the exercise.
- In the case study exercise, a color-coding system is used to help with navigation of the DSET features. For example, the section heading **Visualization Layer**, matches the color of the wording you will find on the DSET webpage.

Estimated Time for Completion for the Drought Case Study: 28 Minutes

This exercise for Case Study 3: Climate Sensitivity of Meadows and Wildfire is broken up into three sections. The first section is Part 1: Asaayi Lake Fire Burned Area Index (BAI), the second is Part 2: BAI and NDVI Time Series, and the third section focuses on Part 3: NDVI Percent Difference from Average values for the Asaayi Lake Fire.

Part 1: Asaayi Lake Fire Burned Area Index (BAI)

- Objective: Identify the burn scar area in the Chuska Mountains caused by the Asaayi Lake Fire in the time period of May 10 to August 10, 2014 using the MODIS BAI variable.

Prior to the Asaayi Lake Fire this area in the Chuska Mountains had similar BAI values. Using the BAI, the burn scar created in 2014 will become apparent and stand out from the surrounding area.

*Drought Severity Evaluation Tool (DSET)
Case Study 3: Wildfires and Meadows
NASA Western Water Applications Office (WWAO)*

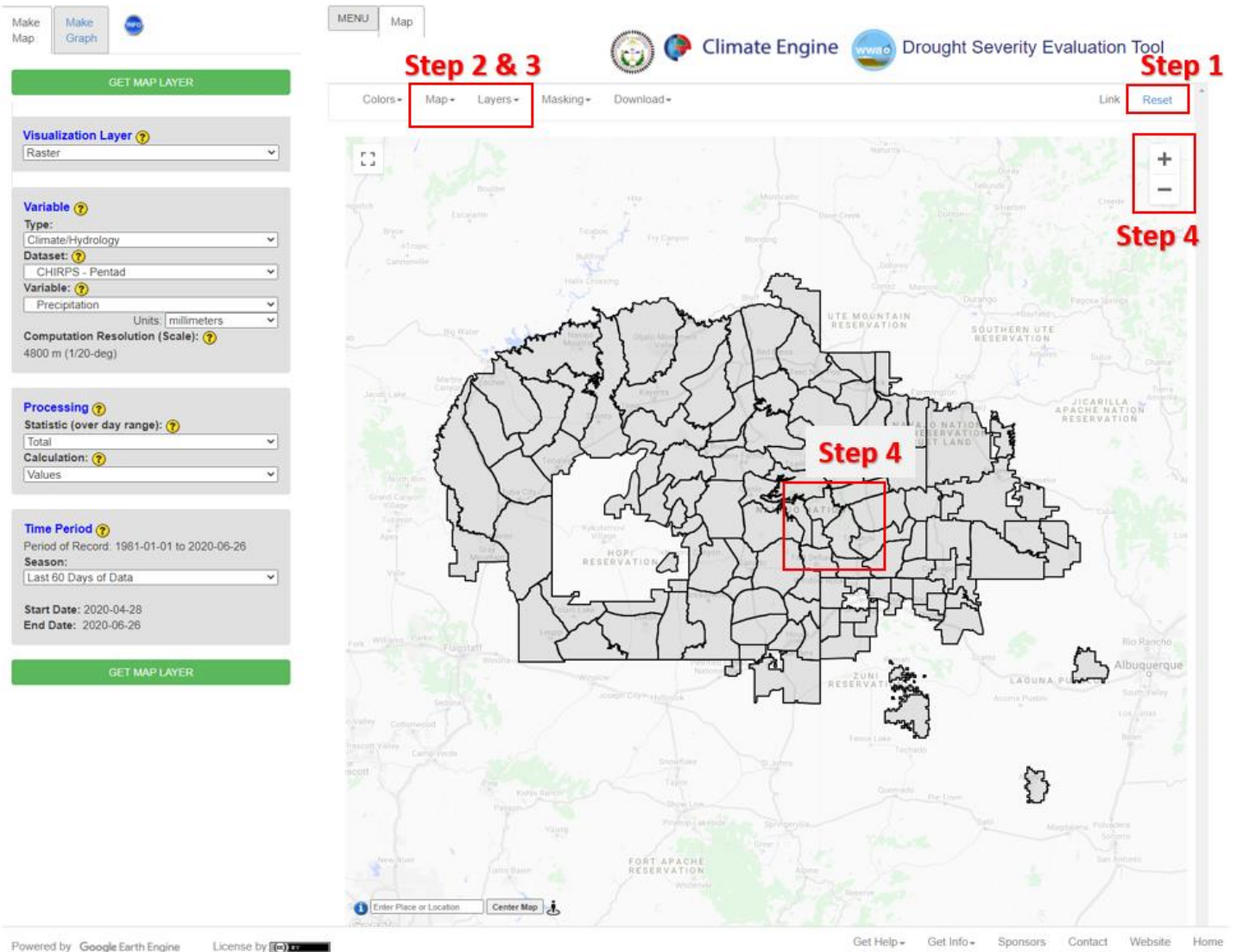


Figure 1. Steps 2 through 4 are displayed in the figure as a help to set DSET up to analyze the BAI values for the Asaayi Lake Fire burn scar in the Chuska Mountains.

1. Go to the DSET website using this link <https://app.climateengine.org/dset>.
 - a. If you are conducting this Case Study for Wildfires and Climate Sensitivity of Meadows after working on previous case studies, at the top right corner of the map, click **Reset**.
2. Under the **Layers** tab along the top, ensure that the **Navajo Nation Chapters**

boundary is selected and displayed on the map.

- a. Note: The Navajo Nation Chapter boundaries should appear as the default.
3. Click on the **Map** tab along the top, which hosts the map options, and select the **Light Political Style map**.
4. Zoom into the Navajo Nation Chapter boundaries of Crystal, Mexican Springs, and Red Lake using the “+” sign along the top right. Bring the chapter boundaries center map.
 - a. Reference the figure above to identify Crystal, Mexican Springs, and Red Lake Chapter boundaries.

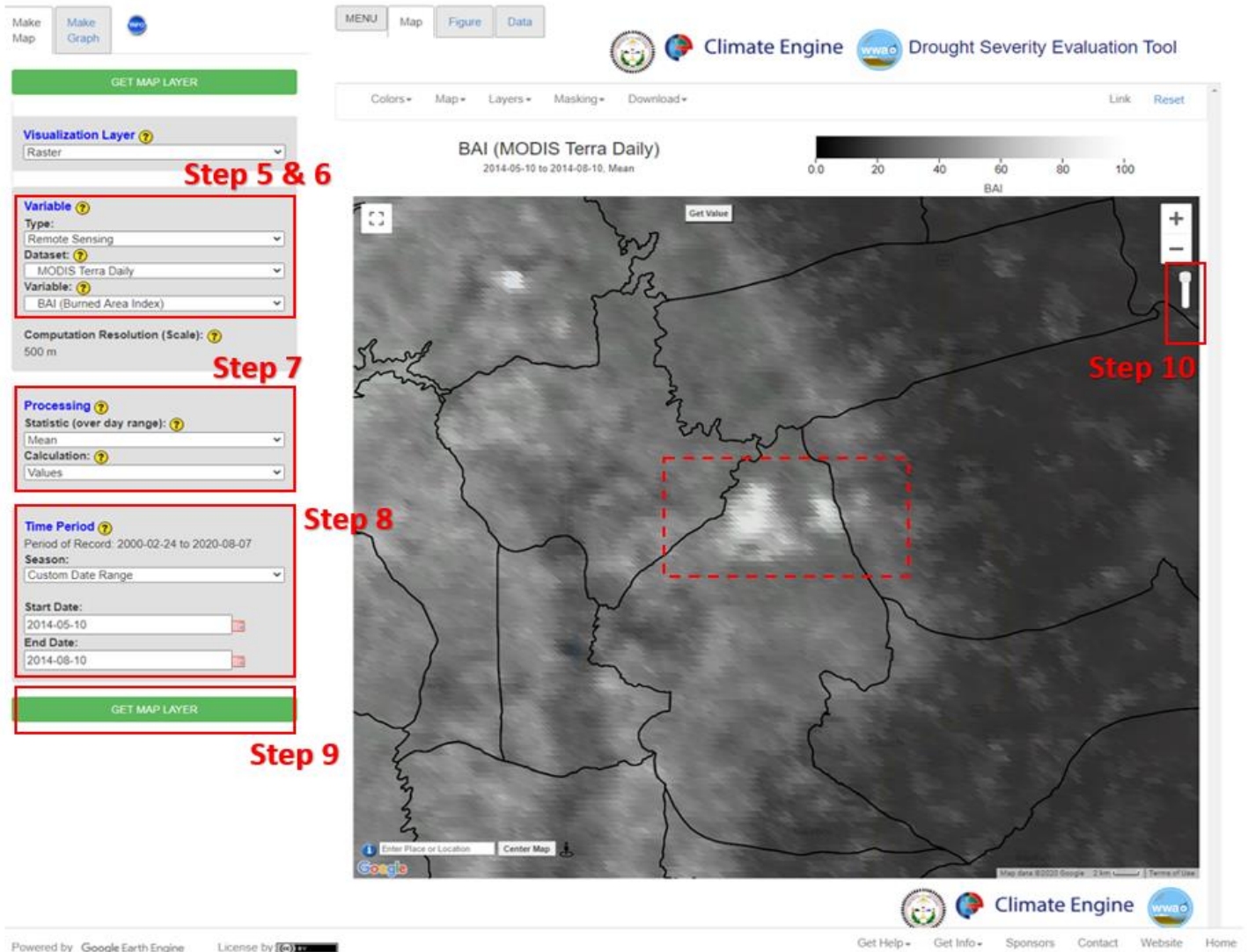


Figure 2. The dashed red box indicates the area of the Asaayi Lake Fire of 2014 primarily located in the Mexican Springs chapter boundary. Steps 5 through 10 are displayed in the figure as a help locate the DSET features needed to complete the case study exercise.

5. Located on the Make Map panel on the left side of the webpage, under the **Variable** section select the **Type** parameter to be **Remote Sensing**, and change the **Dataset** parameter to **MODIS Terra Daily**.
6. For the **Variable** select **BAI (Burned Area Index)** located under the **Fire Indices section**.
7. Under the **Processing** section select the **Statistic (over day range)** to be **Mean**, leave the **Calculation** to be set on **Values**.
8. Under the **Time Period** section located on the same panel, select the **Custom Date Range**.
 - a. Selecting **Custom Date Range** will change the **Start Date** and **End Date** options. For the **Start Date** enter **2014-05-10** and for the **End Date** enter **2014-08-10**.
9. Click on **Get Map Layer**, wait for the map to load. The loading of the map may take a few minutes for the request to process.
10. Once the processing is complete, the map will automatically display the data. The **transparency** may be decreased or enhanced to better see the results. On

the top right of the map, move the opacity slider  down to 70% Opaque.

11. The map will appear in greyscale, but you can change the colors to ensure that your burned area stands out.
12. Click on Colors, then under the Color options under Color Palette, use the drop-down to select Red-Blue Reversed under Divergent Maps. Click on **Update Map Layer**. Your map should now look like Figure 3 (below).

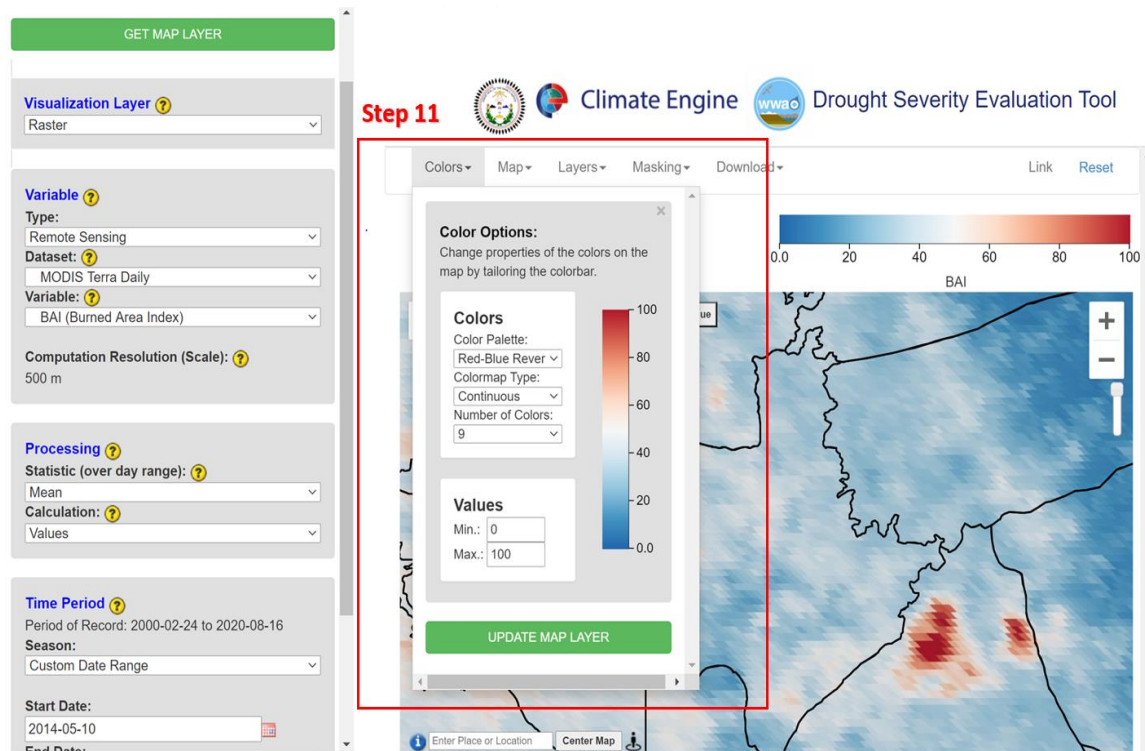


Figure 3. DSET color option feature to help in visualizing the data. Changing the color palette for the BAI values from black and white to red and blue shows the Asaayi Lake Fire clearly with the contrasting colors as described in Step 11.

13. When the process request is complete you will notice a cluster of high BAI values within the Mexican Springs Chapter boundaries that are highlighted with a dashed red box in Figure 2. These high values indicate the burned areas of the Asaayi Lake Fire.
14. **Do not Reset.** The same findings for the Asaayi Lake Fire BAI values will be used in Part 2 of this Case Study for Climate Sensitivity of Meadows and Wildfire.

Part 2: Time Series of Wildfire Indices

- Objective: Develop a custom polygon to create a time series of the Asaayi Lake Fire burn scar to compare BAI and NDVI values pre- and post-fire to monitor meadow restoration.

For this case study we are interested in the findings for the Asaayi Lake Fire. In Part 1 we identified the burn scar created in the 2014 fire. Now in Part 2 we will look further into

the data available for the Asaayi Lake Fire specifically using BAI and NDVI values to create a time series, which will include pre- and post-fire values.

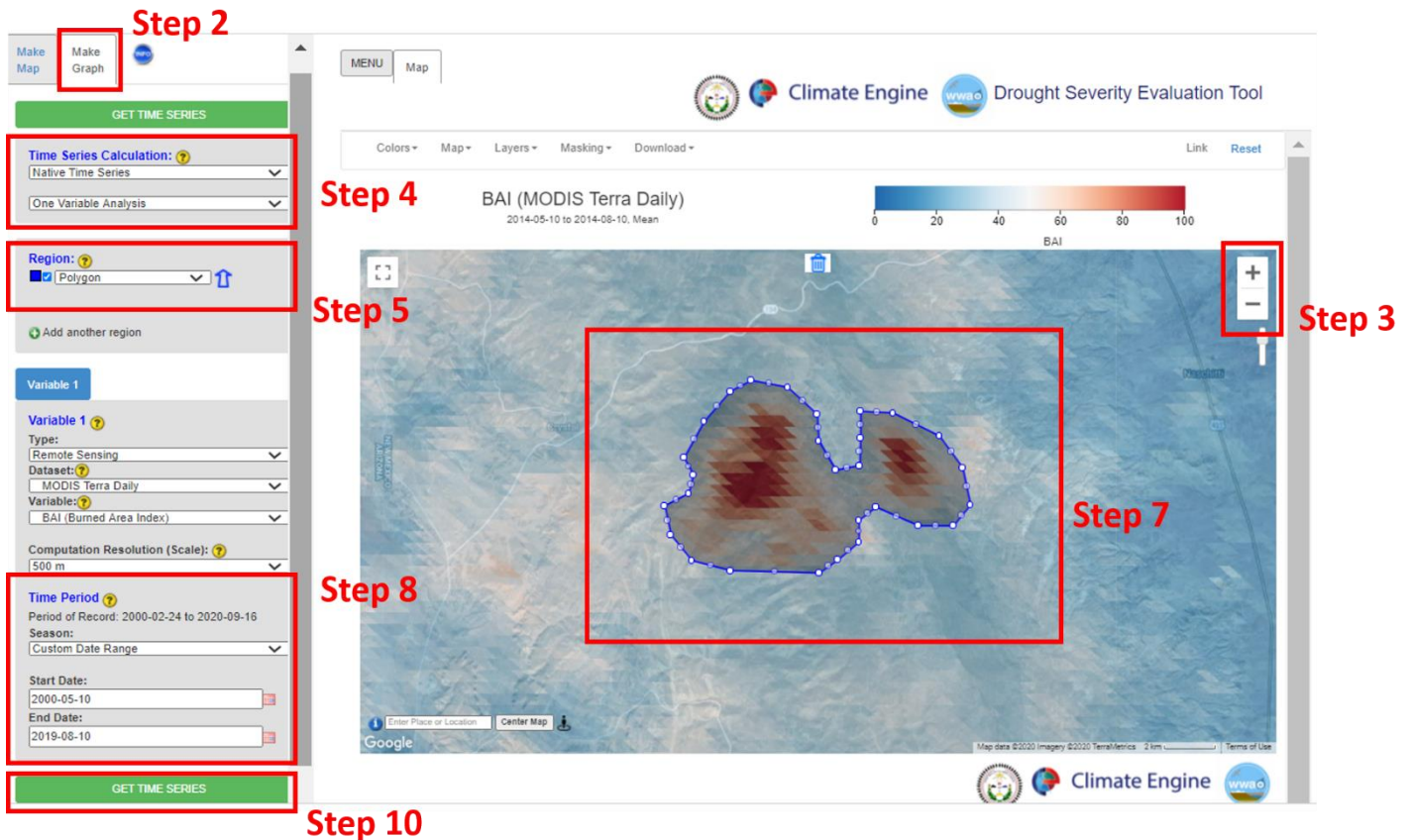

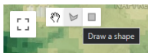



Figure 4. The custom polygon region developed and outlined for the Asaayi Lake Fire in the Mexican Springs chapter boundaries. Steps 2-10 are shown in this figure to provide support of locating DSET features to help complete this case study exercise.

1. Leave the **Make Map** panel as is from Part 1 of this Case Study.
2. Click on **Map Graph** tab beside the **Make Map** tab along the top left section of the DSET home screen.
3. Zoom into the Asaayi Lake Fire burn site located (Figure 2) in the Mexican Springs chapter boundary using the “+” sign along the top right.
4. Under **Time Series Calculation** change the first drop-down to **Summary Time Series**. Leave the second drop-down as **One Variable Analysis**.
5. Under **Region** select **Polygon** under the **Custom Polygon Regions**.
 - a. Note that when you do this a pop-up will appear that describes **How to create a polygon how**. Reading through this pop-up will help in making a polygon.
6. Close the pop-up and click on the **Draw a Shape** icon  in the top left of the map .
 - a. Note that when you do this, a crosshair symbol will appear as your cursor.

7. Click on the outer edge of the Asaayi Lake Fire burn site to start to draw your polygon. Multiple clicks will be needed to enclose the burn site. Keep clicking all the way around the burn site. To close the polygon, click the first dot in the polygon.
 - a. Once you have closed the custom burn site polygon the polygon will flicker and then will appear as a darker shade on the map.
 - b. If you are unhappy with, the way the circle came out around the field you have the option to re-draw the crop circle. Use the delete button next to the Get Value button at the top of the map .
8. Once you are happy with the polygon, change the **Time Period** section to have the **Season** select the **Custom Day Range**
 - a. Selecting **Custom Day Range** will change the **Start Day** and **End Day** options. For the **Start Day** select **May 10** and for the **End Day** select **August 10**. Select the **Year Range** to be from **2000** to **2019**.
9. The **Variable 1** section can be left as is with the selected **Type, Dataset, and Variable**.
10. Click on **Get Time Series** and wait for your figure to load.
 - a. If your time series does not appear after a few minutes you may have to **Reset** DSET again and run the analysis. Due to the large time frame loading including many years of data this might create some issues.

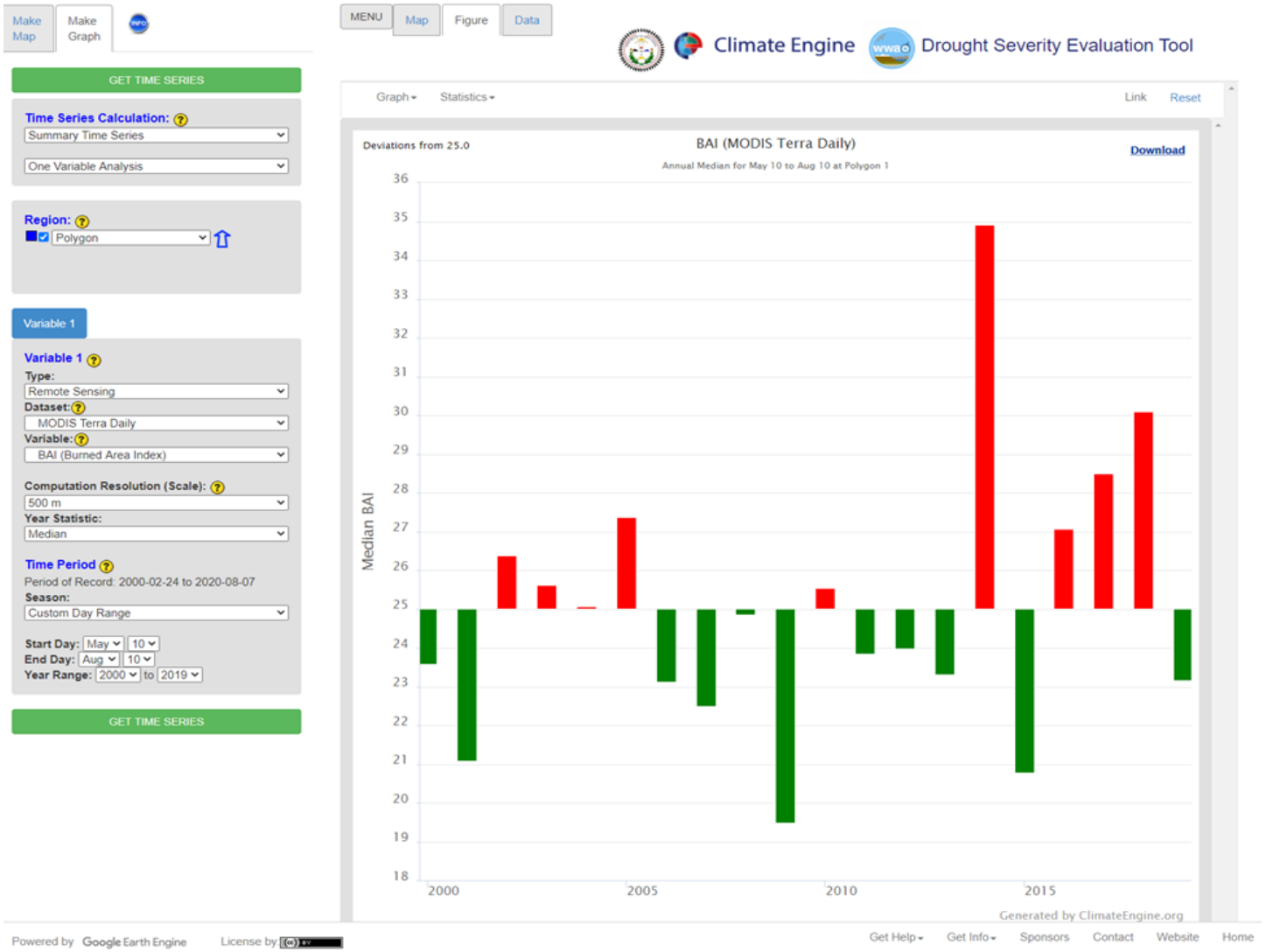


Figure 5. Time series created for the Asaayi Lake Fire BAI values pre- and post-fire for the time period of 2000 to 2019.

Looking at the time series created for BAI variable pre- and post-fire it is evident that in 2014 a land cover change occurred, that resulted in the largest increase in BAI values within the nineteen-year period of record (2000 - 2019). When a fire occurs, the BAI value increases due to a decrease in vegetation, therefore the burned area is emphasized by the post-fire images captured by MODIS. This time series (Figure 5) shows the BAI values created by the fire however, the inclusion of NDVI in this case study analysis will support the understanding of meadow restoration after a wildfire.

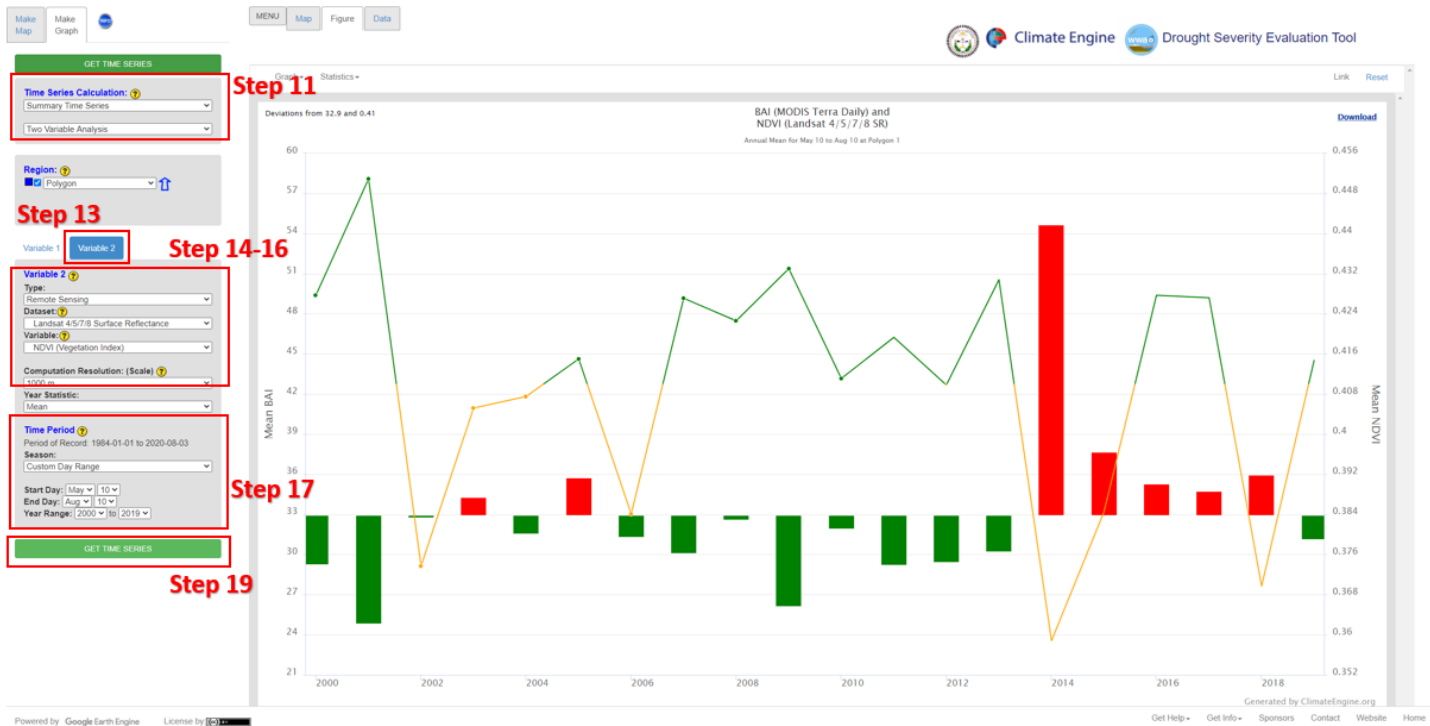


Figure 6. Time series created for the Asaayi Lake Fire mean BAI values compared to the mean NDIV values pre- and post-fire for the time period of 2000 to 2019. Steps 11-19 are also shown in this figure to provide support of locating DSET features to help complete this case study exercise.

11. Under **Time Series Calculation** change the second drop-down to **Two Variable Analysis**.
12. For **Variable 1** change the **Computation Resolution: (Scale)** to **1000 m**.
 - a. Don't make any other changes to **Variable 1**. Note: you may need to change the Year Range to 2000 - 2019 if that does not remain the default from Part 1.
13. Click on **Variable 2**, we are adding NDVI data to understand the meadow restoration after a wildfire on the Asaayi Lake Fire burn site used in this example.
14. Under **Variable 2** for the **Type** select **Remote Sensing**. For the **Dataset** section, select **Landsat 4/5/7/8 Surface Reflectance**.
15. For the **Variable** select **NDVI (Vegetation Index)** located under the **Vegetation Indices** section.
16. Also, under **Variable 2** change the **Computation Resolution: (Scale)** to **1000 m**.
17. Under **Time Period**, select the **Custom Day Range**.
 - a. Selecting **Custom Day Range** will change the **Start Day** and **End Day** options. For the **Start Day** select **May 10** and for the **End Day** select **August 10**. Select the **Year Range** to be from **2000 to 2019**.
18. **Check** to make sure the **Time Period** is the same for **Variable 1** and **Variable 2**.
19. Click on **Get Time Series** and wait for the map to graph.

Figure 6 shows us that before the Asaayi Lake Fire the NDVI values were fairly consistent in the years prior to the wildfire. After the 2014 wildfire, the BAI drastically increases and

NDVI value decreases, thus indicating vegetation loss during the wildfire. In the years following 2014, the BAI values decline and the NDVI values slowly increase, indicating some vegetation regrowth in the previously burned region. The NDVI values can also be visualized to examine these changes in the map interface. Part 3 aims to visualize the NDVI data pre- and post-fire.

Part 3: Percent Difference from Average values for the Asaayi Lake Fire

- Objective: Create Landsat NDVI Percent Difference from Average value maps for the same time period in three separate years (2013, 2014, and 2019) to see vegetation changes pre- and post-fire. This objective has the primary focus of visualizing the Landsat imagery.

The BAI values in Part 1 of this case study helped us identify the Asaayi Lake Fire burn scar. The primary goal of this section is to see the pre- and post-fire changes to vegetation density as identified by NDVI values for the years 2013, 2014, and 2019.

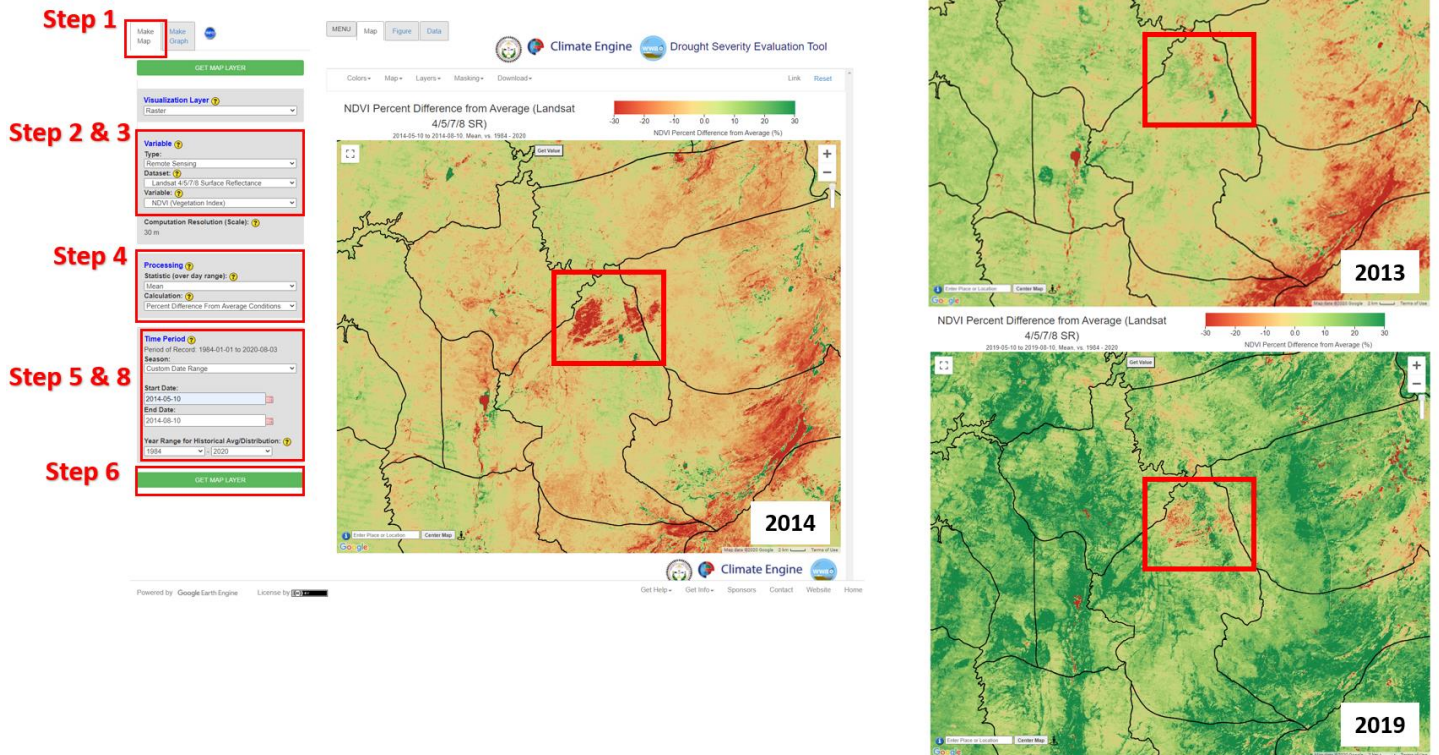


Figure 7. NDVI Percent Difference from Average values pre- and post-fire are presented for 2013 (before fire), 2014 (year fire occurred), and 2019 (five years after fire). From 2014 to 2019 based on the Landsat NDVI values it is evident that

restoration of the meadows in the burn site are recovering. Steps 1 through 8 are listed here to help complete Part 3 of this case study.

1. Leave the **Make Graph** panel and click on the **Make Map** tab along the top left section of the DSET home screen.
2. Located on the Make Map panel on the left side of the webpage, under the **Variable** section select the **Type** parameter to be **Remote Sensing**, and change the **Dataset** parameter to **Landsat 4/5/7/8 Surface Reflectance**.
3. For the **Variable** select **NDVI (Vegetation Index)** located under the **Vegetation Indices** section.
4. Under the **Processing** section select the **Statistic (over day range)** to be **Mean**, change the **Calculation** to **Percent Difference From Average Conditions**.
5. Under the **Time Period** section located on the same panel, leave the **Custom Date Range** as was entered for the **Make Graph** variables.
 - a. Double check to make sure the **Custom Date Range** has the **Start Date** entered as **2014-05-10** and for the **End Date** entered as **2014-08-10**. The **Year Range for Historical Avg/Distribution** should be 1984 to 2020.
6. Click on **Get Map Layer**, wait for the map to load. The loading of the map may take a few minutes for the request to process.
7. The bright red NDVI values are within the area of the Asaayi Lake Fire burn site.
8. **Repeat Step 6** for years **2013** and **2019**. The map for 2013 will show the pre-wildfire NDVI values and the 2019 map will show the post-wildfire NDVI values.
 - a. **Pre-wildfire Dates: Start Date** entered as **2013-05-10** and for the **End Date** entered as **2013-08-10**.
 - b. **Post-wildfire Dates: Start Date** entered as **2019-05-10** and for the **End Date** entered as **2019-08-10**.

In this case study, the BAI and NDVI values indicate the impacts on landcover as a result of the Asaayi Lake Fire. The post- fire NDVI values reflect the restoration of the meadow and surrounding forest after the fire. The red values observed with the NDVI indicates less dense vegetation and the dark green values indicate denser vegetation cover. The red boxes on the maps are used to highlight the burn scar created in 2014. Then in 2019, the darker green regions indicate vegetation regrowth and restoration of the meadow to conditions similar to those prior to the wildfire.

Additional Resources

- The Applied Remote Sensing Training (ARSET) is a program that is designed to build the capacity of decision-makers to use NASA data. ARSET offers online and in-person trainings for beginners and advanced practitioners alike. Trainings cover a range of datasets, web portals, and analysis tools and their application to air quality, agriculture, disaster, land, and water resources management. <http://appliedsciences.nasa.gov/arset>
- The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information provides public access to climate and weather

data. This particular link provides a deeper look at drought as well as provide projections: <https://www.drought.gov/drought/data-maps-tools/tools>

- DSET is a spin-off of Climate Engine, a web-based platform for conducting on-the-fly climate analysis: <http://climateengine.org/data>