NASA RECOVER: NDVI Baseline Tutorial

Overview: The general health and aboveground biomass productivity of vegetation can be determined using the normalized difference vegetation index (NDVI) which is calculated by performing the following band math with the NIR and Red bands from a multispectral sensor like Landsat:

$$NDVI = (NIR - Red) / (NIR + Red)$$

Evaluating and understanding trends in NDVI can reveal important information about fire impact and recovery. You can use the NDVI Baseline to monitor post-fire recovery by comparing current NDVI data for a burned area against the NDVI Baseline statistics provided here.

NOTE: NDVI values typically range from -1 to 1, but are often scaled in order to more efficiently store the data. In the case of the NASA RECOVER NDVI Baseline dataset, NDVI values have been scaled by a factor of 10,000. To learn more about how the NDVI Baseline was created, click https://giscenter.isu.edu/pdf/PDF_NASA_RECOVER2/RECOVER_NDVI_Baseline.pdf

Steps:

Part 1: Access and Explore the Data

1. Open the ArcGIS Pro Project called `NDVI_Baseline` (NOTE: If you do not have a copy of this project, you can download it from https://giscenter.isu.edu/research/Techpg/nasa_RECOVER2/ZIP/NDVI_BaselineTutorial.zip).

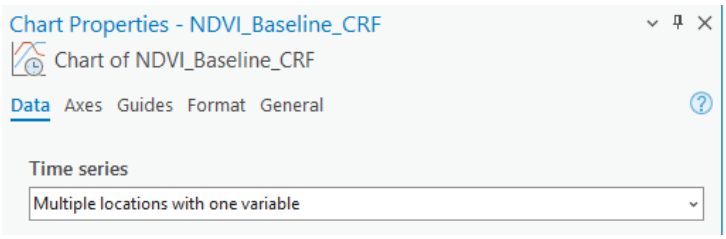
> The NDVI Baseline is a time-enabled multidimensional dataset stored as a cloud raster format (CRF) to improve the data's performance. The NDVI Baseline is made up of many different "slices" of NDVI data at different locations and times across the western United States. You can time-step through these slices using the Time tab and/or the Time slider bar across the top of the map area. In order to extract NDVI values over time for single point location we will create a Temporal Profile.

2. Once the ArcGIS Pro project opens, spend a few minutes exploring and familiarizing yourself with the data layers in this project.
    a. This project contains seven image service layers. One is the NDVI Baseline itself and the remaining six are summary statistics calculated from the NDVI Baseline.

Part 2: Extract a Temporal Profile

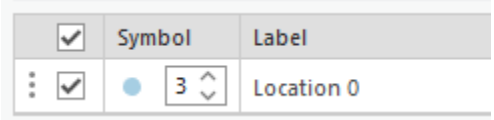
1. Zoom into an area on the map you would like to see NDVI trends for
2. Right-click the `NDVI Baseline` layer from the Contents pane and select CREATE CHART---TEMPORAL PROFILE.
3. Locate the Chart Properties pane that opens on the right side of the screen.

4. Set the `Time Series` drop-down to `Multiple locations with one variable` (NOTE: the NDVI Baseline dataset has one variable (NDVI), so this option allows you to collect temporal profiles of NDVI at multiple locations).

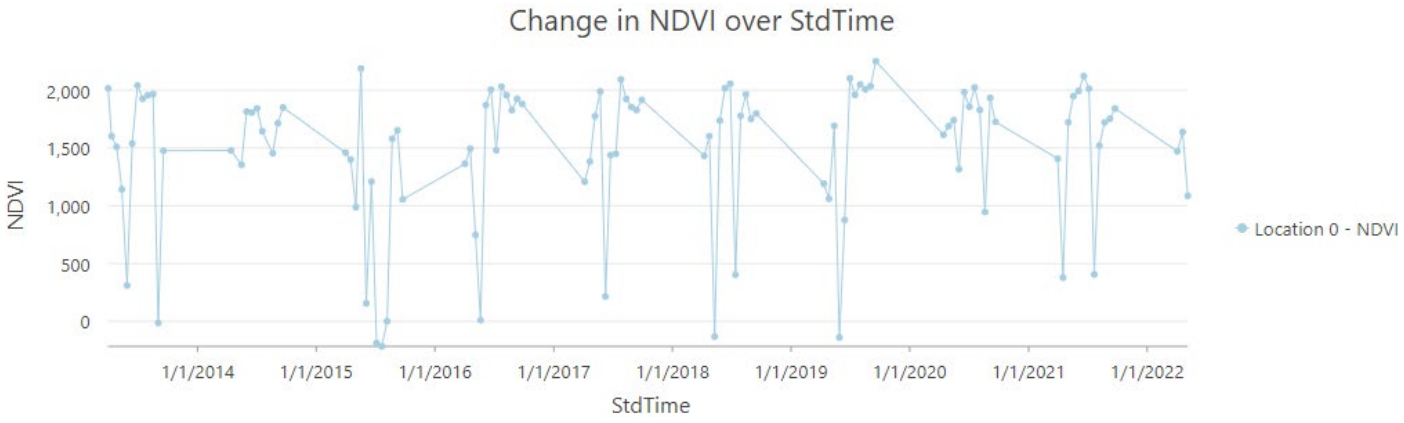


5. In this tutorial, we will extract a temporal profile of NDVI values at individual points (pixels). To do this, we will be using the "Point" tool.
    a. From the Chart Properties pane, select the point tool  under the `Define an area of interest.`
    b. Next, simply click a location in the map area.

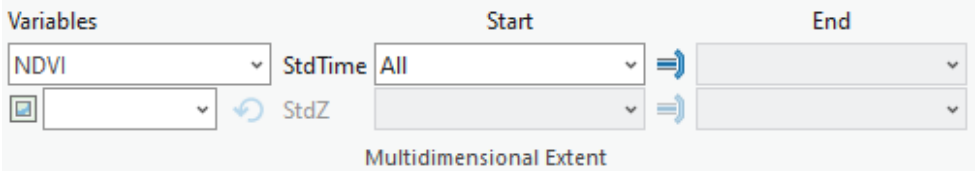
    A point will be placed and labeled as `Location 0 - NDVI` and your temporal profile will start loading on the bottom half of your screen.



    The process may take a couple minutes to generate. You will know it has completed when the chart loads with the most recently added data point.



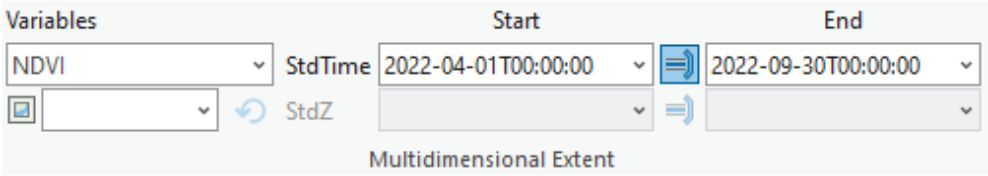
6. As you can see from the figure above, NDVI values for this pixel were extracted over `StdTime.` This is defined as the entire timespan of the NDVI Baseline dataset. If you would like to collect NDVI values over a more specific timespan, you can change the range of `StdTime.` To do this:
    a. Select the `NDVI Baseline` layer in the Contents pane.
    b. Click the `Multidimensional` menu
    c. Navigate to the `Multidimensional Extent` section within the Multidimensional ribbon.



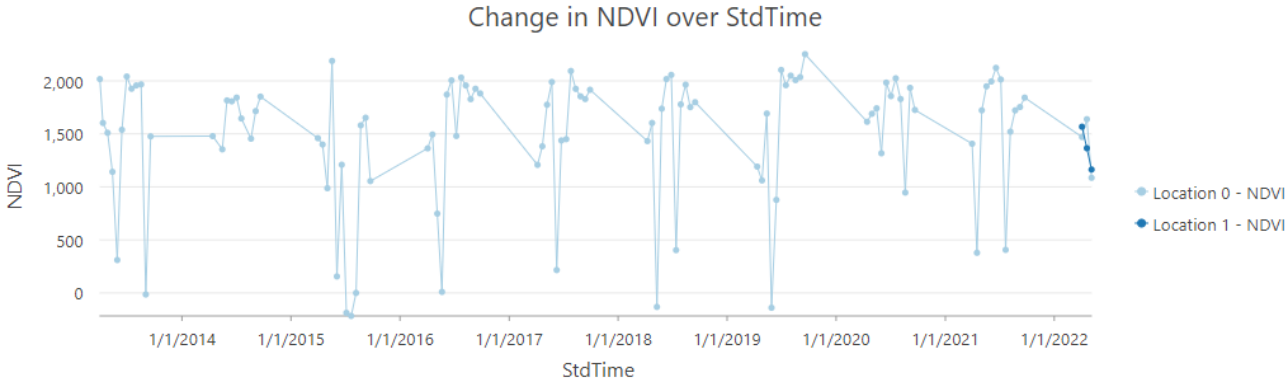
d. Currently, the `StdTime` Start time is set to `All`

e. To define more specific start and end times, select the blue symbol to the right of the start text box.

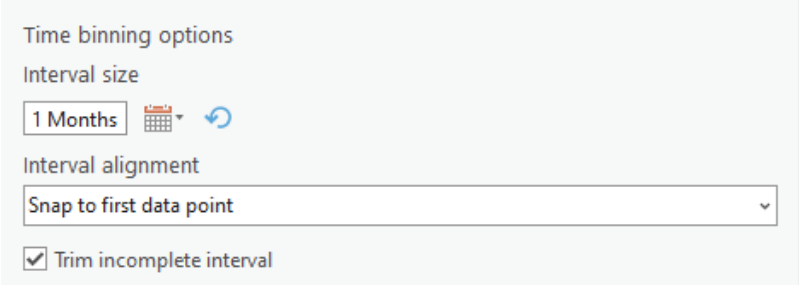
f. Then enter your desired temporal range in the corresponding drop-down boxes.



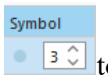
g. All subsequent data points will extract NDVI values for the specified time range.



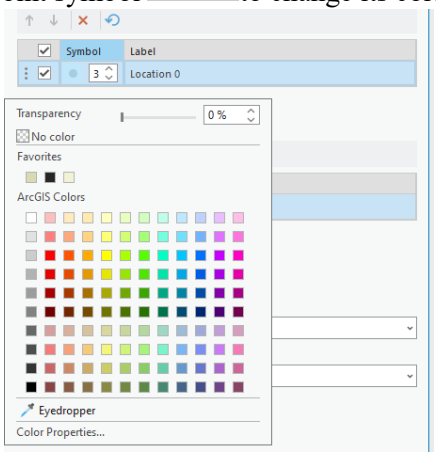
7. If you would like to change the temporal resolution of the NDVI temporal profile, you can do this by changing the `Interval size` under `Time binning options` in the Chart Properties pane.
   a. See the Chart Properties pane once again on the right side of the screen.
   b. In the figure below, the chart's Aggregation Options have been set to record monthly NDVI, rather than the default interval (cf. Time binning options within the Aggregations Options section of the Chart Properties pane)



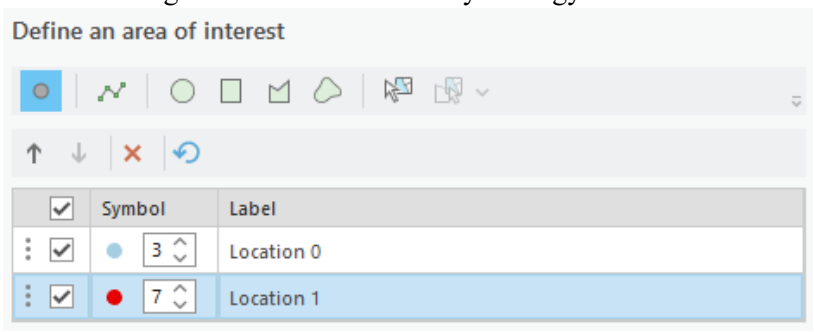
8. Within the same Chart Properties pane, you can also change the symbology of individual data points by changing the Symbol color and size. To do this:

a. Simply click the point symbol 

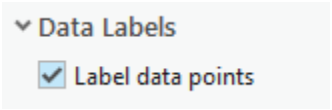
to change its color.



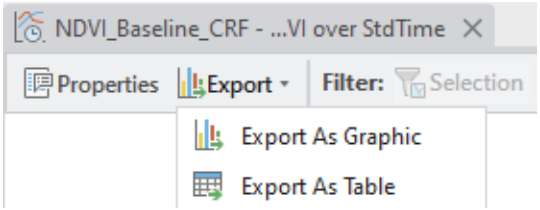
b. Adjust the symbol's size using the up/down (increment/decrement) buttons. The figure below shows a change has been made to the symbology for Location 1.



c. Additionally, you can choose to label points on the chart with actual NDVI values by turning on the `Label data points` option under Data Labels:



9. When you are satisfied with the temporal resolution and chart display of the NDVI profile, you can export it as either a graphic and/or a table (.csv). This is done using the Export tool found near the top of the Chart window.



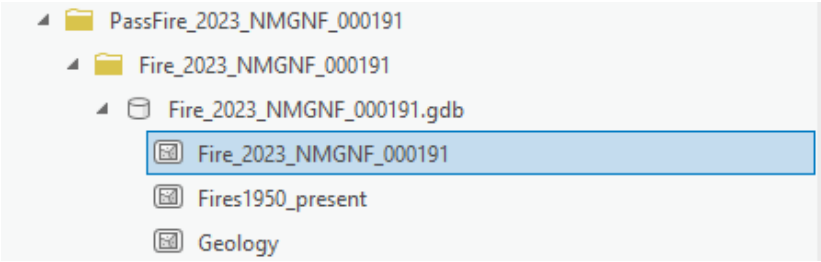
Part 3: Calculating NDVI Summary Statistics within a Fire Area

1. If necessary, begin by downloading a RECOVER Data package from the RECOVER Dashboard: https://www.arcgis.com/apps/dashboards/19af90a8bc5d41188ed855d249bc1c72. Alternatively, you can access RECOVER's bulk download page at https://giscenter-sl.isu.edu/AOC/AOC_Research/recover2/

2. Once a RECOVER Data Package has been downloaded, unzip the file and note the path/folder where these new data exist on your computer.

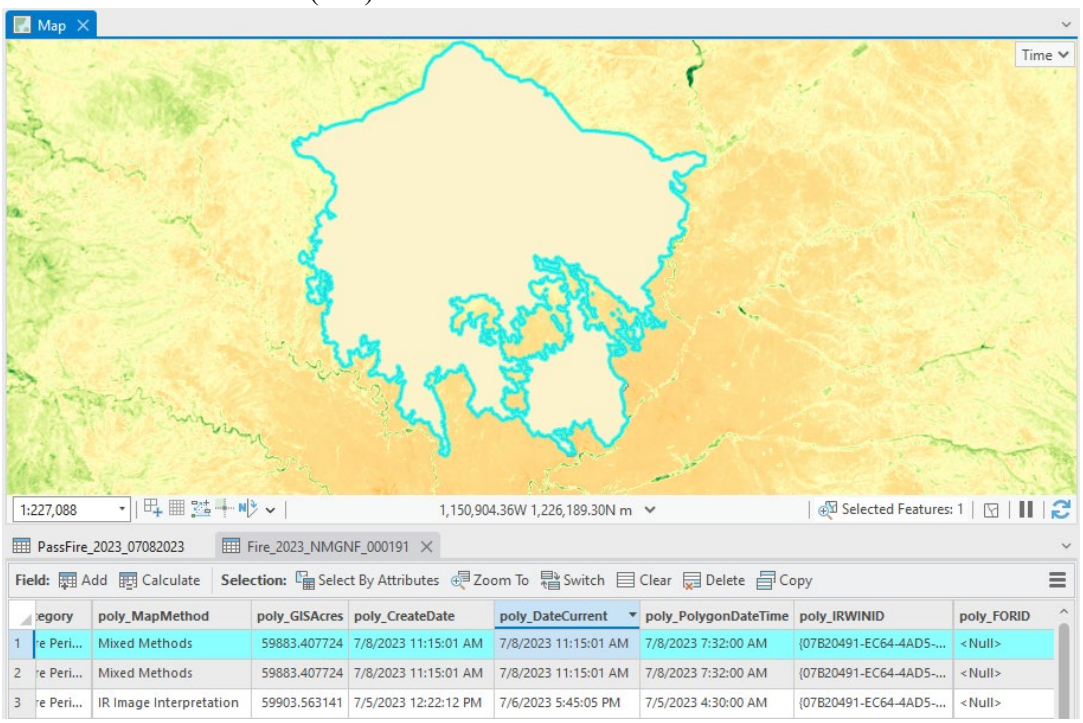
   Example: Data path to wildfire data: (e.g., `C:\GIS\Fire_2023_NMGNMF_000191`)

3. From ArcGIS Pro, add the unzipped fire folder to the project. To do this, right-click `Folders` from the catalog pane and choose `Add Folder Connection`).
   a. In this example, I've acquired and added the data package folder for the 2023 Pass Fire in New Mexico.
   b. Expand the fire geodatabase (.gdb)
   c. Locate the fire boundary layer file. It is a polygon feature class with the same name as the fire itself.



   d. Right-click the feature class and add it to the current map.

4. From the Contents pane, right-click the fire perimeter layer and choose `Attribute Table`.
   a. Find the `poly_DateCurrent` field and sort it to locate the most recent fire perimeter.
   b. Select this record (row).



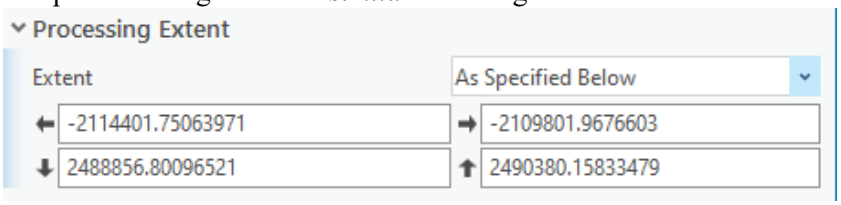
   c. With the most current perimeter selected (or other polygon of interest selected), right-click the layer from the Contents pane and select `Zoom to Layer`

5. Next, open the `Zonal Statistics as Table` geoprocessing tool (NOTE: To open the Geoprocessing pane, first may need to click the View menu and then click Geoprocessing).
    a. Be sure you are using the `Zonal Statistics as Table` tool and not another type of Zonal Statistics tool.
    b. For `Input Raster or Feature Zone Data`, select the fire perimeter layer you added to the map.
    c. Choose `poly_SourceOID` as the Zone Field (alternatively, you could select `ObjectID` or other unique ID field).
    d. For the `Input Value Raster`, select `NDVI Baseline` (NOTE: An error indicator will appear, but ignore this for now, it will be resolved shortly).
    e. For the `Output Table`, provide a name for the new table that will be created (HINT: I usually follow a naming convention similar to `Zonal_PassFire2023_NDVI_Baseline`)
    f. Select the `Statistics Type` you would like calculated for the fire area. In this example, we will choose the `All` statistics type and get the most comprehensive statistical summary within the fire polygon.
    g. **Be sure to place a check in the Process as Multidimensional box.**

    h. Next, click the Environments tab (located to the right of the Parameters tab at the top of the Zonal Statistics as Table pane).

    Ensure you are zoomed into the fire perimeter (i.e., Zoom to layer).

    i. Change the processing extent setting to `Current Display Extent`. The completed setting will look *similar* to the figure below.



    j. Return to the Parameters tab.
    k. Click Run. This process may take upwards of 10 to 30 minutes to complete depending on the types of statistics you chose to calculate and the size of the fire polygon.

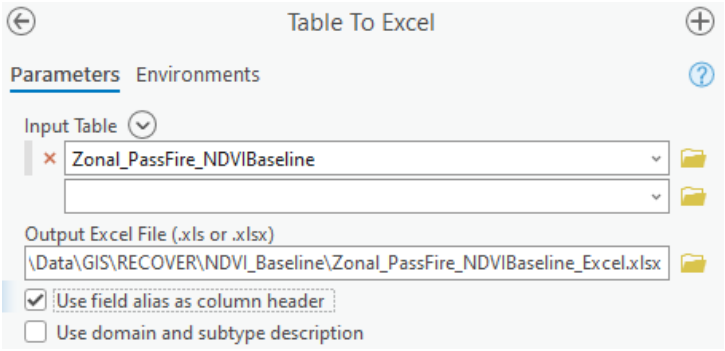
6. When processing completes, open the resulting table (it will be automatically added the Contents pane).
    a. The output table will look very *similar* to the figure shown below.

PassFire_ZonalStats_tutorial

Field: Add Calculate | Selection: Select By Attributes Zoom To Switch Clear Delete Copy | Rows: Insert

	OBJECTID *	poly_SourceOID	COUNT	AREA	Variable	Dimensions	Standard Time	MIN	MAX	RANGE	MEAN	STD	SUM	VARIETY	MAJORITY	MINORITY	MEDIAN	PCT90
1	1	22379	269258	242332200	NDVI	StdTime	05-Apr-13	-110	3281	3391	1098.074382	379.151029	295665312	2313	1088	-110	1090	1596
2	2	22379	269258	242332200	NDVI	StdTime	10-Apr-13	-212	2156	2368	-1.810903	121.909768	-487600	1221	-86	-212	-43	153
3	3	22379	269258	242332200	NDVI	StdTime	12-May-13	-334	6582	6916	1020.353137	604.457858	274738245	3163	1430	-334	1102	1754
4	4	22379	269258	242332200	NDVI	StdTime	28-May-13	399	3054	2655	1380.124624	295.56594	371609596	1727	1347	399	1385	1762
5	5	22379	269258	242332200	NDVI	StdTime	13-Jun-13	-618	4240	4858	1241.731235	520.205029	334346069	2959	1435	-618	1326	1801
6	6	22379	269258	242332200	NDVI	StdTime	29-Jun-13	350	2906	2556	1391.834207	271.270665	374762495	1802	1455	350	1399	1744
7	7	22379	269258	242332200	NDVI	StdTime	15-Jul-13	-79	3956	4035	730.557978	546.098226	196708580	2581	104	-79	597	1537
8	8	22379	269258	242332200	NDVI	StdTime	31-Jul-13	-206	4821	5027	1762.690754	363.369719	474618587	3057	1868	-206	1822	2116
9	9	22379	269258	242332200	NDVI	StdTime	16-Aug-13	-87	8338	8425	1894.867101	323.366004	510208126	3267	1870	-87	1912	2209
10	10	22379	269258	242332200	NDVI	StdTime	01-Sep-13	-451	7686	8137	1776.673243	567.364879	478383484	3717	1907	-451	1908	2268
11	11	22379	269254	242328600	NDVI	StdTime	17-Sep-13	-703	9875	10578	1733.187392	605.441624	466667638	4313	2025	-703	1827	2333

   b. Each record (row) describes NDVI values within the fire polygon for the date indicted by the `Standard Time` field (column).
   c. I like to view these data by first sorting the table ascending based on the `Standard Time` field (HINT: You can do this by right-clicking the `Standard Time` field label and choose `Sort Ascending`).
   d. Next, take a look at MEAN. By scrolling through these records, you will be able to begin visualizing how NDVI typically has changed throughout the year within the burned area. Of course, if a previous fire, other disturbance, or data anomaly occurred in this same area, the NDVI Baseline will record that also. Be aware of this as you interpret these data.
   e. I also like to look at the MEDIAN. Recall, the median is a resilient statistic. In other words, it is not affected by individual high or low values which does impact the mean (or average). The absence of occasional extreme values is indicated by general agreement between the mean and median.
   f. I do not recommend putting too much emphasis on MIN as records with very low NDVI values are most often the result of data anomalies (e.g., clouds) and not actually representative of vegetation conditions.
   g. The MAX value on the other hand can be informative. It can tell you what the potential productivity for this area is even though it too may be an anomalously high value recorded under ideal conditions.
7. You may wish to run the same `Zonal Statistics as Table` tool again using the six summary layers found in this project (NOTE: All RECOVER Data Packages created after October 1st 2023 contain these raster layers by default, greatly simplifying geoprocessing).
8. Last, you may find it helpful to export the resulting Zonal Statistics table to Excel. To do this:
   a. Return to the Geoprocessing pane.
   b. Using the Find Tools search box, enter `Table to Excel.`
   c. Open the `Table to Excel` tool.
   d. Complete the tool dialog like that shown below.



e. Click Run

9. Once completed, you can open this file in MS Excel to perform additional analysis or data visualization/graphing.

We hope you find the **NDVI Baseline** dataset and this tutorial helpful. This dataset provides you with a decade of Landsat observational data and can assist you in monitoring post-fire recovery by comparing new or current NDVI data[1] to the NDVI Baseline for the burned area.

END

[1] Remember to scale any new NDVI data (by multiplying NDVI by 10,000) to match the scaling applied to the NDVI Baseline.