

# NASA RECOVER 2.0 LONG-TERM POST-FIRE MONITORING TOOL

## Introduction

The tools described in this tutorial allow you to automatically download current Landsat NDVI data for a specific wildfire area and compare that data to the long-term NDVI Baseline created for the NASA RECOVER project. **The first part of this tutorial describes a one-time setup** including cloning your current python environment (Part 1), swap to the new cloned environment (Part 2), and installing the geemap open source python package (Part 3).

Part 4 (Using the Long-Term Monitoring Tool) can be run many times once the one-time setup (parts 1-3) has been successfully completed.

The long-term monitoring tool is part of all new RECOVER Data Packages created after May 1<sup>st</sup> 2024. If you do not have access to the long-term monitoring tool, please download it from:

[https://giscenter.isu.edu/research/Techpg/nasa\\_RECOVER2/ZIP/RECOVER\\_LongTerm\\_Monitoring.zip](https://giscenter.isu.edu/research/Techpg/nasa_RECOVER2/ZIP/RECOVER_LongTerm_Monitoring.zip)


Once downloaded, extract the zip file to your PC (NOTE: Make note of the location of the \*.atbx file as we will use it in Part 4 of this tutorial).

## PART 1. Clone the Python Environment

Python virtual environments help to isolate your Python development projects from the system installed default Python environment. Many open-source Python packages such as geemap<sup>1</sup> (<https://geemap.org/>) are not included in the ArcGIS default Python environment. While it's usually not recommended for the ArcGIS end user to make changes to the default Python environment, Esri has provided the ability to clone the default python environment, and subsequently install additional Python packages that custom projects require. Using this approach, we will build a Python environment that works for both ArcGIS geoprocessing and open-source Python tools!

NOTE: if you already installed an ArcGIS Deep Learning package in the default Python environment, you will need to uninstall it before you clone it. This process is described in detail here:

[https://giscenter.isu.edu/pdf/PDF\\_NASA\\_RECOVER2/RemoveArcGISProDeepLearning.pdf](https://giscenter.isu.edu/pdf/PDF_NASA_RECOVER2/RemoveArcGISProDeepLearning.pdf).

1. With a clean/default ArcGIS Pro python environment, we will create a new Python environment clone. To do this, go to  Start – ArcGIS – Python Command Prompt (right click) – More – Run as administrator (you may need to enter an administrator password).

You will see the Python Command Prompt window open with the directory of the ArcGIS default Python environment (arcgispro-py3) displayed. The parenthesis encloses the name of the activate Python environment, which is also known as the default environment.

```
(arcgispro-py3) C:\Program Files\ArcGIS\Pro\bin\Python\envs\arcgispro-py3>
```

From the command prompt window, type **conda env list** and press ENTER

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<sup>1</sup> Geemap is an open-source Python package for interactive geospatial analysis/visualization with Google Earth Engine.

```
(arcgispro-py3) C:\Program Files\ArcGIS\Pro\bin\Python\envs\arcgispro-py3>conda env list
```

After a few seconds, you will see there are two Python environments listed. The arcgispro-py3 will be marked with a \*, which means this is the activated Python environment at this moment.

```
(arcgispro-py3) C:\Program Files\ArcGIS\Pro\bin\Python\envs\arcgispro-py3>conda env list
# conda environments:
#
base                  C:\Program Files\ArcGIS\Pro\bin\Python
arcgispro-py3        * C:\Program Files\ArcGIS\Pro\bin\Python\envs\arcgispro-py3
```

2. Type the following command to create a cloned environment based on the current ArcGIS Pro default/activated Python environment. Be sure to include **--pinned** as part of this command (HINT: feel free to copy and paste this command into the command prompt window).

```
conda create --clone arcgispro-py3 --name arcgispro-py3_clone --pinned
```

It may take several minutes for the clone process to finish. The following will appear when cloning successfully completes. Please wait until the python prompt appears before proceeding.

NOTE: If you see any error messages, typically shown in a red colored font, you will need to fix these errors before proceeding. The most common error is a conflict with the Esri Deep Learning Libraries. To fix these problems please refer to

[https://giscenter.isu.edu/pdf/PDF\\_NASA\\_RECOVER2/RemoveArcGISProDeepLearning.pdf](https://giscenter.isu.edu/pdf/PDF_NASA_RECOVER2/RemoveArcGISProDeepLearning.pdf)

```
Source: C:\Users\Di\AppData\Local\ESRI\conda\envs\arcgispro-py3
Destination: C:\Users\Di\AppData\Local\ESRI\conda\envs\arcgispro_py3_clone
Packages: 362
Files: 27371
Copying pinned file from C:\Users\Di\AppData\Local\ESRI\conda\envs\arcgispro-py3_clone\conda-meta\pinned to
Preparing transaction: done
Verifying transaction: done
Executing transaction: -
/ Uninstalling prior versions of arcgis widget
Installing C:\Users\Di\AppData\Local\ESRI\conda\envs\arcgispro_py3_dl\lib\site-packages\arcgis\widgets\js\di
Up to date: C:\Users\Di\AppData\Local\ESRI\conda\envs\arcgispro_py3_dl\share\jupyter\nbextensions\arcgis\arc
Up to date: C:\Users\Di\AppData\Local\ESRI\conda\envs\arcgispro_py3_dl\share\jupyter\nbextensions\arcgis\arc
Up to date: C:\Users\Di\AppData\Local\ESRI\conda\envs\arcgispro_py3_dl\share\jupyter\nbextensions\arcgis\ext
- Validating: ok

  To initialize this nbextension in the browser every time the notebook (or other app) loads:

    jupyter nbextension enable arcgis --py --sys-prefix

Enabling notebook extension arcgis/extension...
- Validating: ok

done
#
# To activate this environment, use
#
#   $ activate arcgispro_py3_dl
#
# To deactivate an active environment, use
#
#   $ deactivate

Retrieving notices: ...working... done
```

## PART 2. Swap to the New Cloned Environment

3. First, we need to activate the cloned Python environment. To do this, type the following command in the python command prompt and press ENTER.

```
proswap arcgispro-py3_clone
```

```
(arcgispro-py3) C:\Program Files\ArcGIS\Pro\bin\Python\envs\arcgispro-py3>proswap arcgispro-py3_clone
```

Notice the directory of the Python environment and the name of the Python environment within the parenthesis changed to our new cloned environment (arcgispro-py3\_clone). If you want to swap back to the default ArcGIS Python environment, or any other Python environment that you have created, simply type the command **proswap [name of the Python environment]** then press ENTER.

```
(arcgispro-py3) C:\Program Files\ArcGIS\Pro\bin\Python\envs\arcgispro-py3>proswap arcgispro-py3_clone  
proswap: Set active ArcGIS Pro environment to C:\Users\Di\AppData\Local\ESRI\conda\envs\arcgispro-py3_clone
```

```
(arcgispro-py3_clone) C:\Users\Di\AppData\Local\ESRI\conda\envs\arcgispro-py3_clone>
```

We can double-check the current environment using the same command we used earlier **conda env list**. Notice the new arcgispro-py3\_clone has been marked with a \* which means it is the activated environment.

```
(arcgispro-py3_clone) C:\Users\Di\AppData\Local\ESRI\conda\envs\arcgispro-py3_clone>conda env list  
# conda environments:  
#  
base C:\Program Files\ArcGIS\Pro\bin\Python  
arcgispro-py3 C:\Program Files\ArcGIS\Pro\bin\Python\envs\arcgispro-py3  
arcgispro-py3_clone * C:\Users\Di\AppData\Local\ESRI\conda\envs\arcgispro-py3_clone
```

## PART 3. Install the open-source geemap package

4. We will install the open-source geemap with the following command.

```
pip install geemap
```

Press ENTER.

The installation process may take a few minutes. Please be patient.

As long as you see a message similar to the following, the install completed successfully:

```
Successfully installed bqplot-0.12.43 branca-0.7.1 earthengine-api-0.1.397  
eerepr-0.0.4 folium-0.16.0 geemap-0.32.0 geocoder-1.38.1 google-api-core-  
2.18.0 google-api-python-client-2.125.0 google-auth-2.29.0 google-auth-  
httplib2-0.2.0 google-cloud-core-2.4.1 google-cloud-storage-2.16.0 google-  
crc32c-1.5.0 google-resumable-media-2.7.0 googleapis-common-protos-1.63.0  
httplib2-0.22.0 ipyevents-2.0.2 ipyfilechooser-0.6.0 ipyleaflet-0.18.2  
ipytree-0.2.2 jupyterlab-widgets-1.1.7 proto-plus-1.23.0 python-box-7.1.1  
ratelim-0.1.6 scooby-0.9.2 traitletypes-0.2.1 tzdata-2024.1 uritemplate-4.1.1  
xyzservices-2024.4.0
```

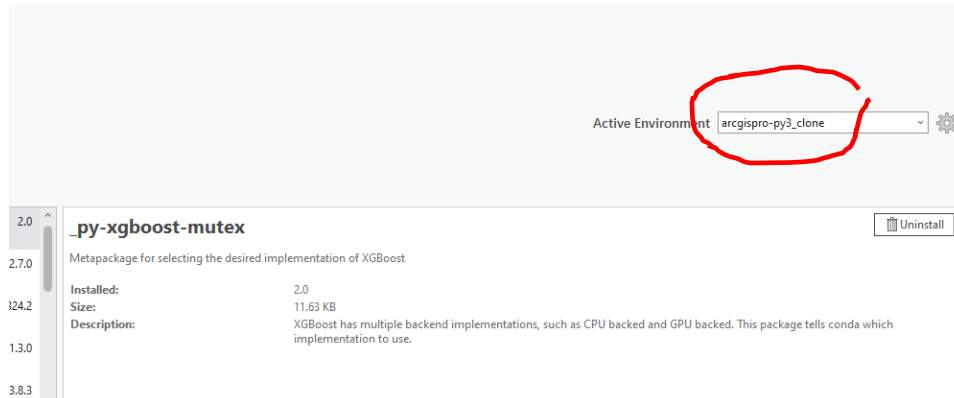
When completed, the command prompt will read: **C:\Users\[YOUR USERNAME]\AppData\Local\ESRI\conda\envs\arcgispro-py3\_clone>**. Once this

Python prompt appears, you can close the Python command prompt window as we have finished installation and setup for the Python environment.

**This completes the one-time installation and configuration. The next part of this tutorial can be run as many times as needed.**

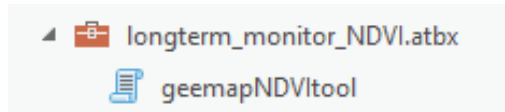
#### **PART 4. Use the Long-Term Monitoring tool**

5. Open ArcGIS Pro.
6. For simplicity, choose to create a new Project and give it a meaningful name (e.g., KellyFire\_Monitoring).
7. Click OK
8. If you do not already have a RECOVER Data Package containing the long-term monitoring tool you will need to copy the tool into your ArcGIS Project. Let's do that while ArcGIS Pro creates and opens the new project.
  - a. Open **Windows File Manager**
  - b. Navigate to the location where you extracted the RECOVER\_LongTerm\_Monitoring.zip file downloaded from [https://giscenter.isu.edu/research/Techpg/nasa\\_RECOVER2/ZIP/RECOVER\\_LongTerm\\_Monitoring.zip](https://giscenter.isu.edu/research/Techpg/nasa_RECOVER2/ZIP/RECOVER_LongTerm_Monitoring.zip) earlier in this tutorial.
  - c. Once you have extracted this zip file, copy the **longterm\_monitor\_NDVI.atbx** toolbox
  - d. Navigate to the folder where you created the new ArcGIS Pro project (e.g., KellyFire\_Monitoring)
  - e. Paste the **longterm\_monitor\_NDVI.atbx** toolbox into this folder.
  - f. This folder should now have two toolboxes. The default toolbox created by ArcGIS Pro and the customized toolbox created by for the NASA RECOVER project.
9. Return to ArcGIS Pro.
10. Click the Project menu
  - a. From the left-side of the screen click **Package Manager**
  - b. Check to ensure the Active Environment is `arcgispro-py3_clone`.



- c. Once you have confirmed the Active Python environment, return to the main map window.

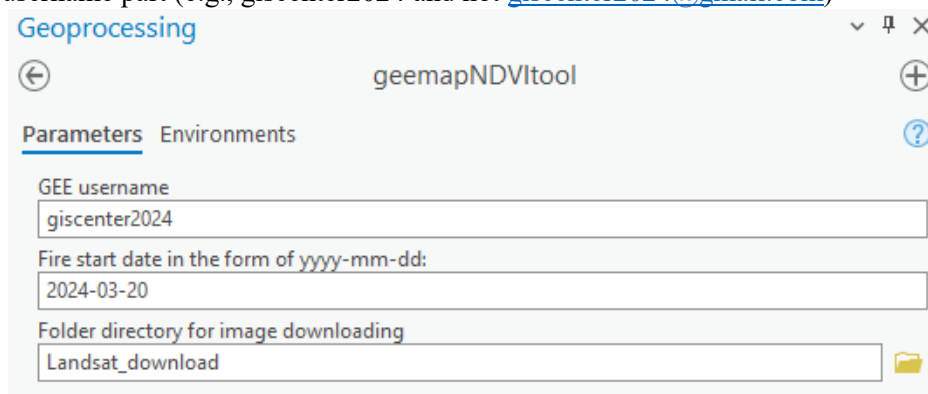
11. In this tutorial, we will assess post-fire recovery of the 2023 Kelly fire (NOTE: you can download the Data Package for this fire by visiting [https://giscenter-sl.isu.edu/aoc/aoc\\_research/recover2/Fire\\_2023\\_CASRF\\_000939.zip](https://giscenter-sl.isu.edu/aoc/aoc_research/recover2/Fire_2023_CASRF_000939.zip))
12. From the geodatabase in this fire's Data Package (Fire\_2023\_CASRF\_000939.gdb), add the fire polygon to the current map.
13. Zoom to the fire perimeter.
14. Save the ArcGIS Pro project (this will save the current spatial extent used later by the tool).
15. From the **Catalog pane**, navigate to the **Folders** section.
16. Navigate into the project folder and locate the LongTerm\_Monitor\_NDVI.atbx (NOTE: The RECOVERDataPackageTools toolbox may also contain the LongTerm\_Monitor\_NDVI tool).
  - a. Open the toolbox
  - b. Double-click the tool named **geemapNDVItool**.



17. You will be prompted for three input parameters. Your GEE username, the fire start date in the format of yyyy-mm-dd, and the folder where you want to save the new NDVI output layer. Some of the parameters have example values in place.

NOTE: The Fire Start Date parameter identifies the first date on which our geemap tool will search for imagery. You can use another date if you wish such as a date six months or one year following the date of the fire.

Make sure the GEE username matches *your* Gmail or Google account username as you will be required to authenticate this account shortly (NOTE: do not enter your entire email account but only the username part (e.g., giscenter2024 and not [giscenter2024@gmail.com](mailto:giscenter2024@gmail.com)))



18. Click Run and the tool will start running.

If this is your first time running the geemapNDVItool, you will need to authenticate your GEE cloud project/account. A web browser window will pop up but may be hidden behind other windows so be sure to watch for it. Select the account that you would like to work with. In this example I would select the [giscenter2024@gmail.com](mailto:giscenter2024@gmail.com) account shown in the figure below. You will need to select the account appropriate for you.



## Choose an account

to continue to [Google Earth Engine Authenticator](#)



Di Wu  
wudi@isu.edu



gis center  
giscenter2024@gmail.com



Use another account

Before using this app, you can review Google Earth Engine Authenticator's [privacy policy](#) and [terms of service](#).

In this tutorial, you can use the [giscenter2024@gmail.com](mailto:giscenter2024@gmail.com) account for GEE authentication as this account has been already registered for GEE cloud projects and has been setup as a user managed service account.

If this is the first time you log in with user giscenter2024, click 'Use another account', and then type user name as **giscenter2024**, password as **Monday@1**.

Next you will see the following screen:



## Google Earth Engine Authenticator wants to access your Google Account



giscenter2024@gmail.com

This will allow [Google Earth Engine Authenticator](#) to:

- See, edit, configure, and delete your Google Cloud data and see the email address for your Google Account. ⓘ
- View and manage your Google Earth Engine data ⓘ
- Manage your data and permissions in Cloud Storage and see the email address for your Google Account ⓘ

### Make sure you trust Google Earth Engine Authenticator

You may be sharing sensitive info with this site or app. Learn about how Google Earth Engine Authenticator will handle your data by reviewing its [terms of service](#) and [privacy policies](#). You can always see or remove access in your [Google Account](#).

[Learn about the risks](#)

Cancel

Allow

Click Allow.

Lastly, you will see the following message in the browser.

Google Earth Engine authorization successful!

Credentials have been retrieved. Please close this window.



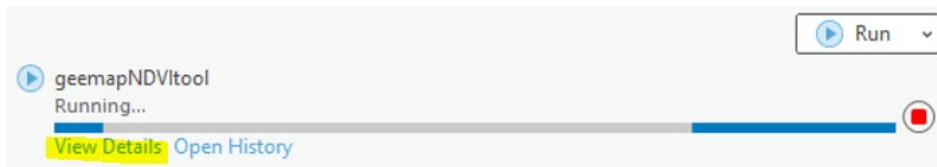
BTW, if you go to C:\Users\[YOUR USERNAME]\.config\earthengine\ on your computer, you will see a credentials file was generated in this folder.

Name	Date modified	Type	Size
credentials	3/25/2024 1:13 PM	File	1 KB

The credentials file is generated after you complete GEE authentication. If you plan to continue using the same account on the same computer for this tool, you won't be prompted for authentication again. But if you switch computers, or if you would like to use a different GEE account, you will need to make sure that the directory C:\Users\[YOUR USERNAME]\.config\earthengine\ is empty and does not contain any previous credential files. If this is not the case, you will likely receive an error and the tool will fail to run. FYI, the error message will be similar to the following:

```
ee.ee_exception.EEException: Caller does not have required permission to use project ee-wudi. Grant the caller the roles/serviceusage.serviceUsageConsumer role, or a custom role with the serviceusage.services.use permission, by visiting https://console.developers.google.com/iam-admin/iam/project?project=ee-wudi and then retry. Propagation of the new permission may take a few minutes.
```

19. Following successful authentication, the tool will continue to run.
  - a. It's recommended to click View Details to review progress under the Message tab of the tool while it is executing.



Here is a sample message and an explanation of the output to help you understand the workflow. Note that the NDVI value is scaled to match the RECOVER NDVI baseline data used to compare current conditions. To return to unscaled data you will need to multiply the NDVI layer by 0.0001 (i.e., use the TIMES tool and the value 0.0001).

✓ **geemapNDVItool (longtermmonitorNDVI)**

Started: Today at 11:18:32 AM  
Completed: Today at 11:19:02 AM  
Elapsed Time: 30 Seconds

Parameters Environments Messages (18)



Start Time: Thursday, April 4, 2024 11:18:32 AM

```
the earth engine project is  
ee-giscenter2024  
the cloud project has been successfully authenticated  
  
the current map extent is  
-119.14470258031145  
34.26225163679034  
-119.01776854020875  
34.33822018740002  
  
the image will be retrieved between:  
2024-03-20  
2024-04-04  
The retrived image date is:  
20240401  
  
NDVI has been calculated  
current image NDVI has been downloaded to the designated folder  
  
calculating the current image NDVI statistics  
current image NDVI mean is  
5360
```

Authentication

the map extent for retrieving image

The time period and the date that image is retrieved

Download process

Calculate the mean NDVI of the image

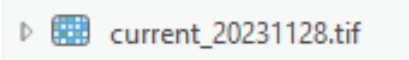
Succeeded at Thursday, April 4, 2024 11:19:02 AM (Elapsed Time: 30.34 seconds)

There could be an issue if the Fire Start Date and current date are too close together and no imagery can be found within the time period. If so, you will see a warning in the Message window. Similarly, you will see the same error if the Fire Start Date and current date are the same. An example of this type of warning message is shown below:

```
the image will be retrieved between:  
2024-03-20  
2024-03-21  
WARNING!!!No image in the study area was found during the specific time period. Please include a longer search period!  
Succeeded at Thursday, March 21, 2024 1:13:46 PM (Elapsed Time: 1.41 seconds)
```

**PART 5. Using the new NDVI Data**

- 20. From the Catalog pane in ArcGIS Pro, navigate to the output folder used when you ran the tool.
- 21. You will see an NDVI image layer as in the example below.



Here `current_20231128.tif` indicates that the NDVI was calculated from a Landsat image collected at 20231128.

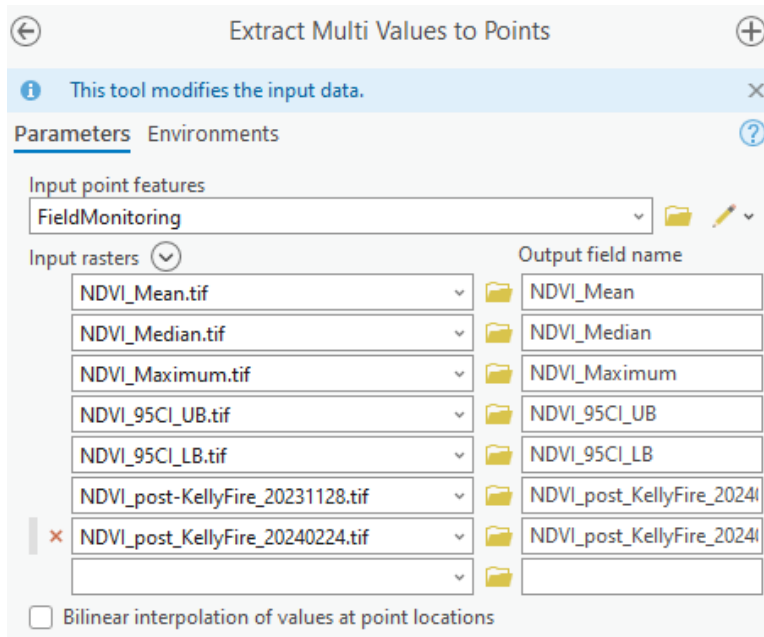
NOTE: You may wish to rename this layer. To do so, simply right-click the layer from the Catalog pane and choose rename.

- 22. Right-click this image and choose Add to Current Map.
  - a. If you have already downloaded the entire Data Package for this wildfire, you can add the NDVI Baseline data layers to the map also (NOTE: Within current Data Packages



processed in after September 2023 you should find NDVI Baseline Mean, Median, Maximum, and both the upper and lower bounds data at 95% CI around the mean.

- b. Using these data, you can compare current conditions to the long-term NDVI Baseline on a pixel-by-pixel basis using the minus tool (e.g., [NDVI Baseline Median] minus [CurrentNDVI]).
- c. Alternatively, you can use point sampling to make a comparison. In this instance you may already have point locations from previous visits to the field or you may wish to create a new point feature class in the project geodatabase to contain specific points of interest in the fire area.
- d. Sampling NDVI values at point locations can be accomplished very easily using the Extract Multi Values to Points geoprocessing tool. Using this tool, you can extract NDVI values from each of the NDVI Baseline layers as well as one or more “current” NDVI layers. An example is shown below.



- e. Running this tool will provide tabular information to help you understand how the fire area is recovering based on post-fire conditions. An example of the output and the attributes added to the point sampling feature class is shown below.

CID	NDVI_Mean	NDVI_Median	NDVI_Maximum	NDVI_95CI_UB	NDVI_95CI_LB	NDVI_post_KellyFire_20240224	NDVI_post_KellyFire_20240224_10399
1	3691	4281	4853	6450.206	931.7939	7132	6710
1	3364	4058	4445	6144.612	583.3879	7069	6729
1	3407	3957	4305	5976.574	837.4258	7166	6711
1	3053	3779	4200	5559.106	546.8938	6542	6366
1	3045	3696	4218	5757.783	332.2166	2937	2818
1	3057	3634	4554	5486.929	627.071	6220	6289
1	3053	3586	4060	5477.933	628.0671	478	665
1	2841	3508	3938	5492.144	189.8564	3653	2957
1	2772	3454	4002	5156.642	387.3586	2766	2132

- f. You can easily export this table to an Excel spreadsheet using the Table to Excel geoprocessing tool.
23. Additional spatial analysis of these data can and should be completed as you monitor the recovery of each wildfire. These data, along with field verification and other monitoring techniques and post-fire treatments will help ensure the ecosystem returns to a health condition as soon as possible.

We hope you have learned how to access Landsat satellite imagery to support your post-wildfire efforts. If you have any suggestions to improve the NASA RECOVER system, please let us know by emailing [webekeit@isu.edu](mailto:webekeit@isu.edu).