June 2021 Webinars

EMRRP

US Army Corps of Engineers

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

DISCOVER | DEVELOP | DELIVER

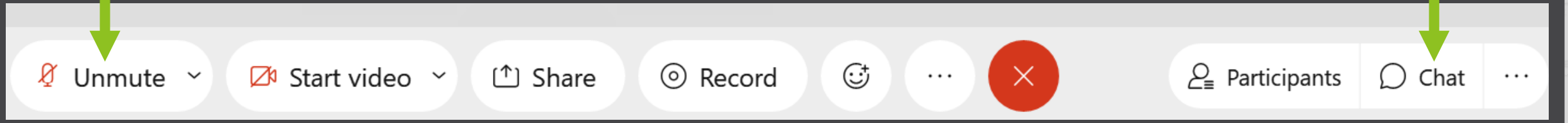
Monitoring Ecological Restoration with Imagery Tools (MERIT)

Webinar Logistics:

- The webinar will begin at 12:00 pm CDT.
- To access the audio select “Call Me” – this is the preferred option to reduce feedback.
- If you are unable to connect via the “Call Me” feature,
  - Dial: 1-844-800-2712
  - Access: 199 565 7227#

Webinar Instructions

- All lines are muted.
- Submit questions or comments in the Chat Box to "Everyone".
- The webinar is being recorded and will be shared following the meeting.



Monitoring Ecological Restoration with Imagery Tools (MERIT) : Python-based decision support tools integrated into ArcGIS for satellite and UAS image processing, analysis, and classification

Dr. Kristofer Lasko, Mr. Sean Griffin

Kristofer.D.Lasko@erdc.dren.mil

Sean.P.Griffin@erdc.dren.mil

Geospatial Research Laboratory

Engineer Research and Development Center

US Army Corps of Engineers

EMRRP

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

US Army Corps of Engineers®

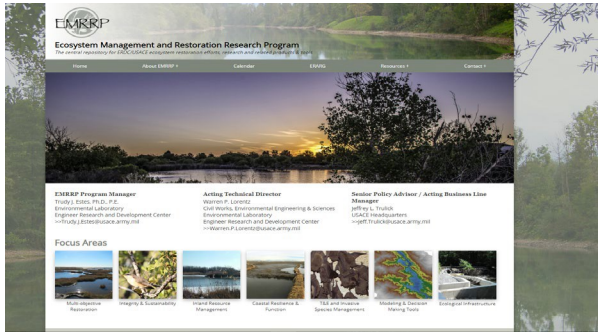
Kristofer Lasko is a Research Geographer with the Data Signature and Analysis Branch (DSAB) at ERDC GRL. His research efforts have included: agricultural fire characterization, synthetic aperture radar and remote sensing algorithm development, and machine learning for land cover mapping. He has previously served as an adjunct professor at the University of Maryland. Prior to joining ERDC, he was a DoD SMART program scholar and worked at the University of Maryland on interdisciplinary NASA funded research with field work in South/Southeast Asia.

Not Pictured

Sean Griffin is a Physical Scientist with the DSAB branch at ERDC GRL. His recent research efforts have included: UAS remote sensing, deep learning for land cover mapping, high resolution building and feature extraction, ecological applications in vectorborne diseases and much more. Prior to joining ERDC, his ~20 years of work and research experience included: the Peace Corps, and work with non-profits, academia, industry, and other government agencies such as NGA.

Schedule

- GRL's ArcGIS Tool suite
  - Description of capabilities
    - Python-based custom toolboxes in ArcGIS Pro
  - Example Walk-throughs
    - Tool installation
    - UAS Image Processing
    - Sentinel-2 Image acquisition
    - Image Pre-processing (cloud composite, image stacking)
    - Image automated classification
    - Region time series statistics (Burned Area application)
    - Mapping of a flood event
  - Discussion and questions



EMRRP

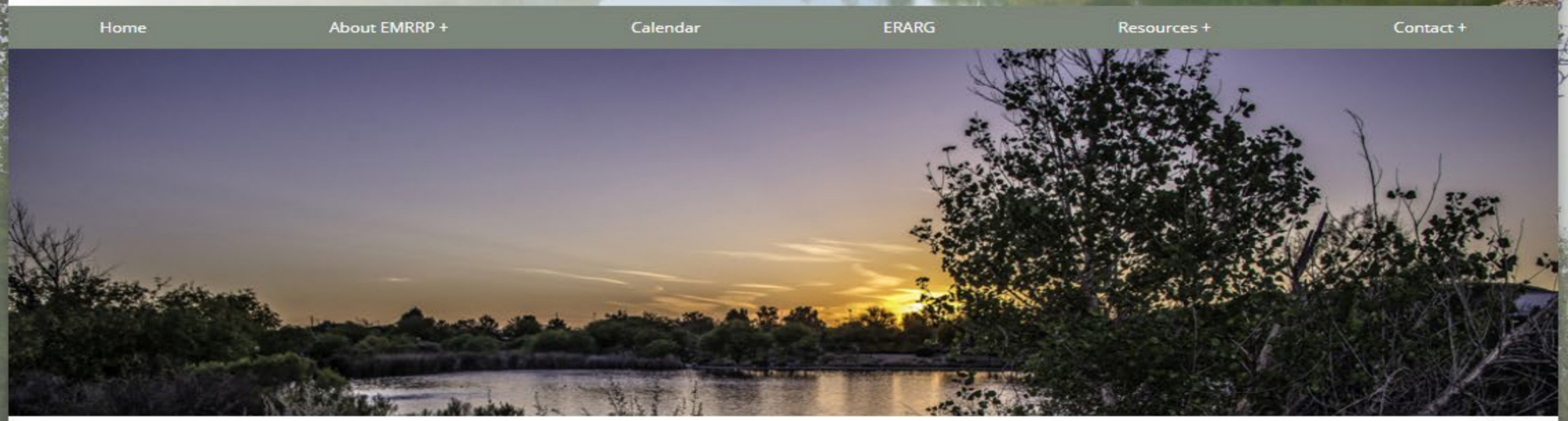
ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

US Army Corps of Engineers®

E RRP

Ecosystem Management and Restoration Research Program

The central repository for ERDC/USACE ecosystem rescoration efforts, research and related products&tools



EMRRP Program Manager
Trudy J. Estes, Ph.D., P.E.
Environmental Laboratory
Engineer Research and Development Center
>>Trudy.J.Estes@usace.army.mil

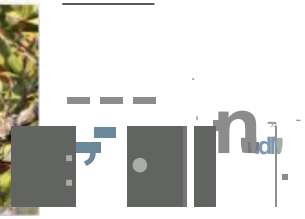
Acting Technical Director
Warren P. Lorentz
Civil Works, Environmental Engineering & Sciences
Environmental Laboratory
Engineer Research and Development Center
>>Warren.P.Lorentz@usace.army.mil

Senior Policy AdYisor / Acting Business Line Manager
Jeffrey L. Trulick
USACE Headquarters
>>Jeff.Trulick@usace.army.mil

Focus Areas

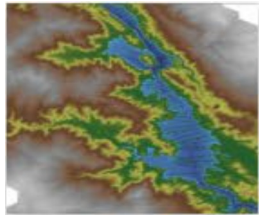

Multi-objec· ve Resto rai:io n


In egr ity & Sustainability


Inland Resource Management


Coastal Resilien ce & Function


T&E and Inv asive Species Management


Modeling & Decision Making Tools


Eco log ica l Infr ast ructur e

Tech Transfer and tool distribution

- Ecological Management and Restoration Research Program (EMRRP) that finished in September 2020

- Tools/software are available publicly on https://emrrp.el.erdc.dren.mil/ and then navigate to the "Resources+" section and the "Models"

- **An additional minor update will be soon made to the software hosted on the website**

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

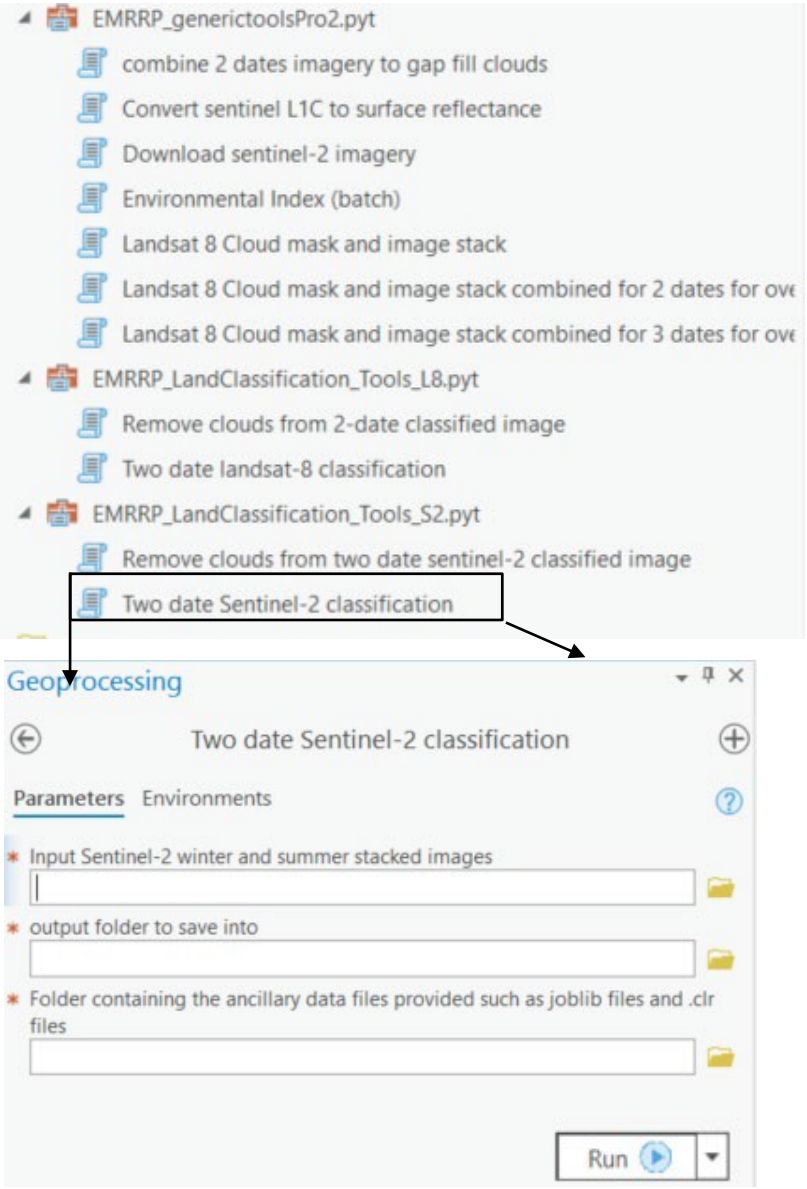
EMRRP

US Army Corps of Engineers®

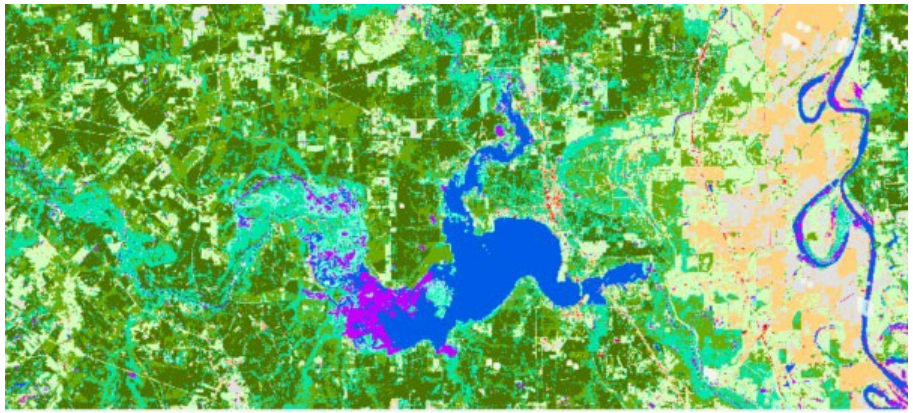
Capabilities

- Tools are integrated into ArcGIS Pro to enable processing of satellite or UAS imagery for use in ecosystem assessments
- Tools are fast, easy to install and user-friendly.
- Features include: Sentinel-2 image downloading, conversion to surface reflectance, cloud compositing, image stacking, area time series analysis, environmental indices, UAS block adjustment and orthomosaicking

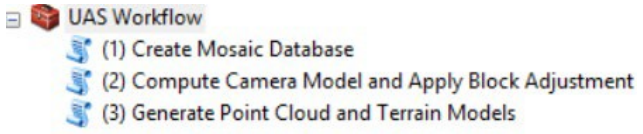
ArcGIS Pro Toolbox



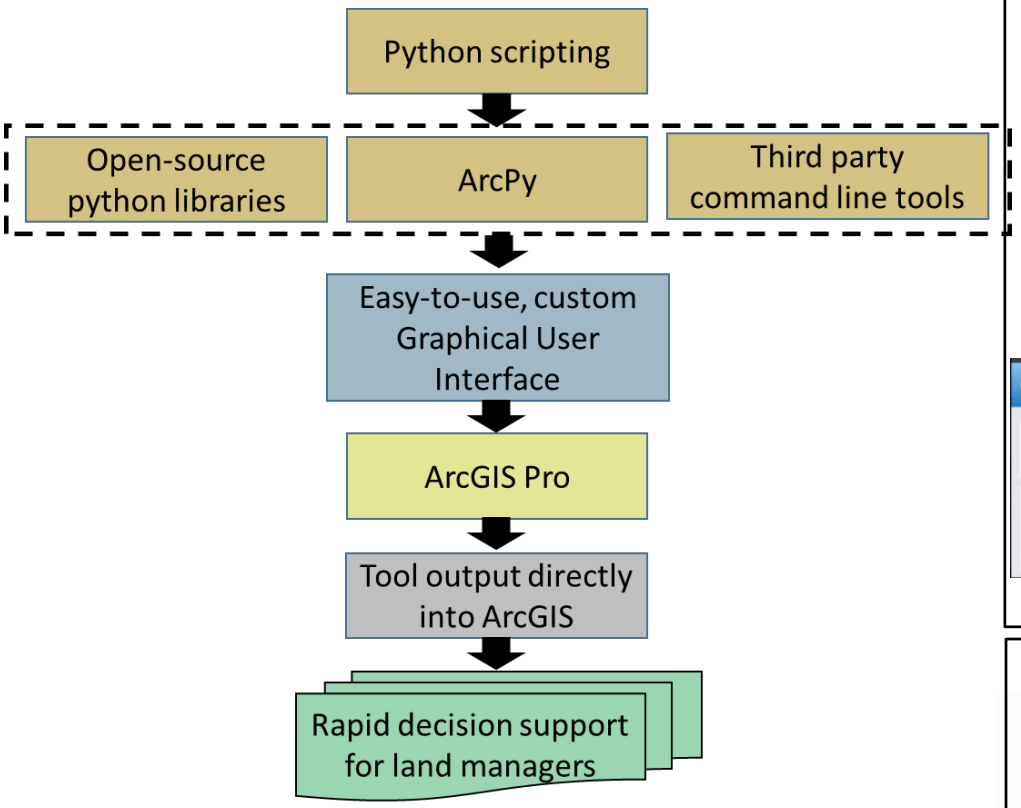
Wetland area land cover map



ArcMap Toolbox

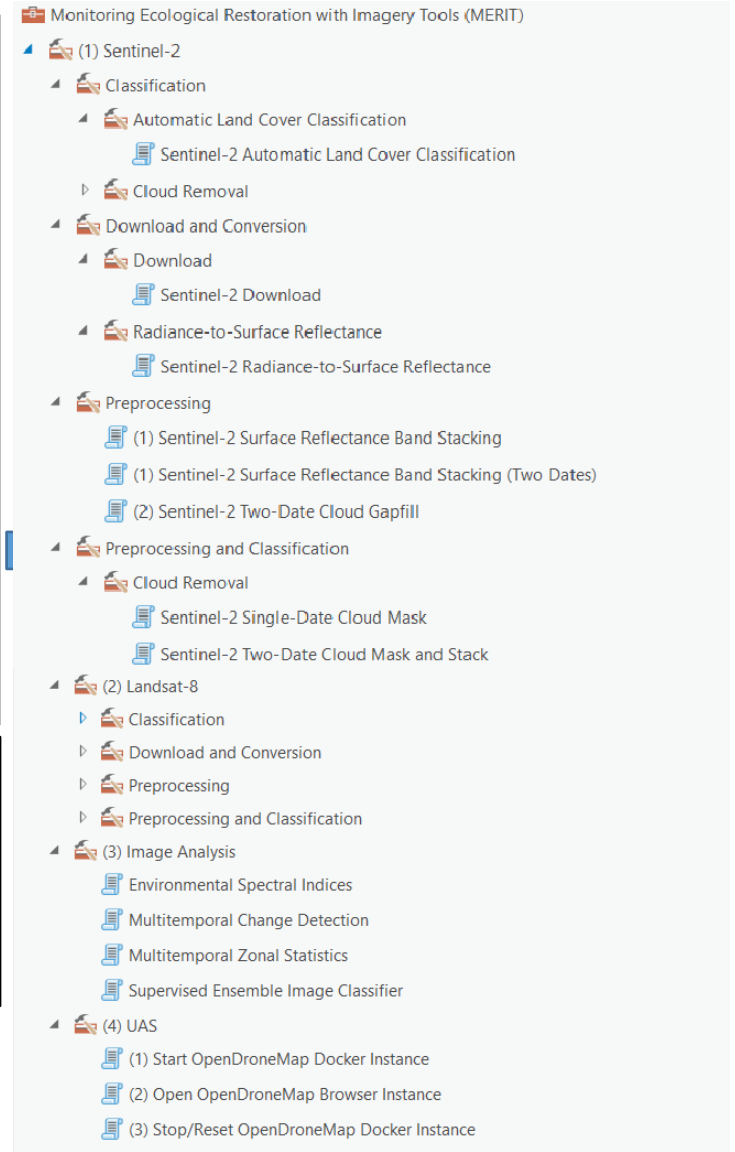


ArcGIS Pro and ArcMap Custom Python toolboxes

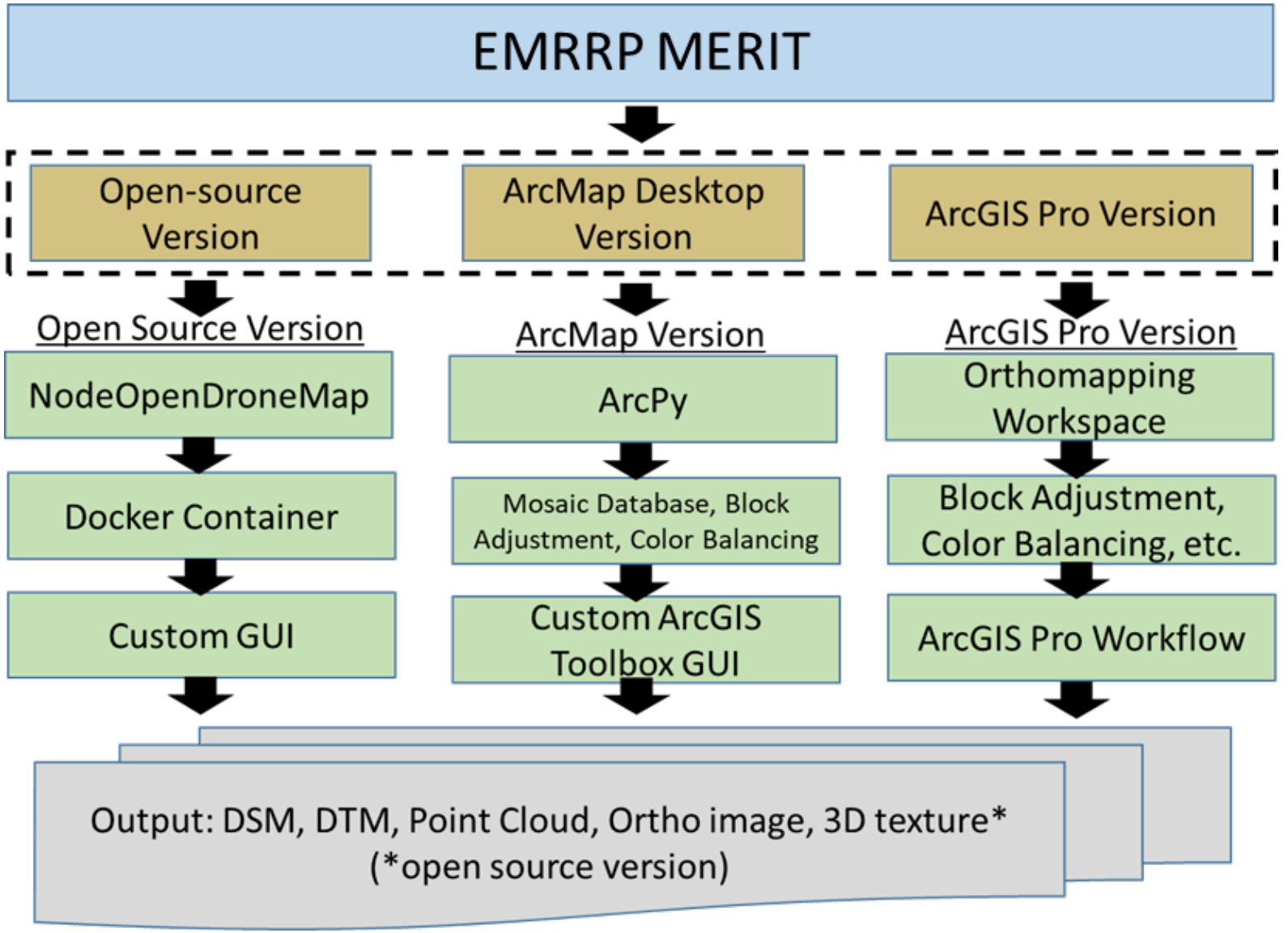


Third-party capabilities

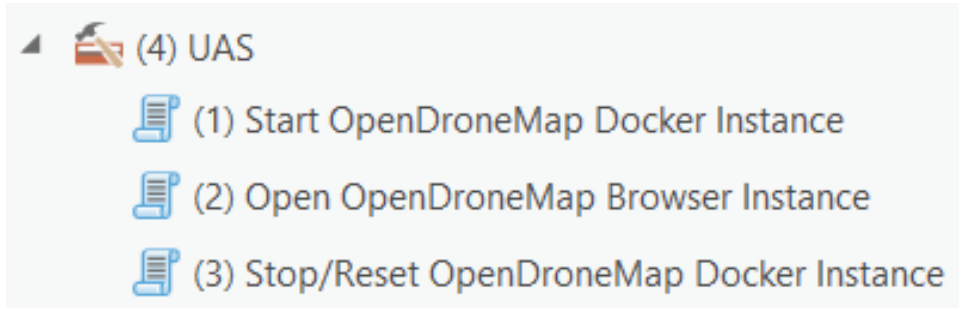
MERIT: ArcGIS Pro Python Toolbox

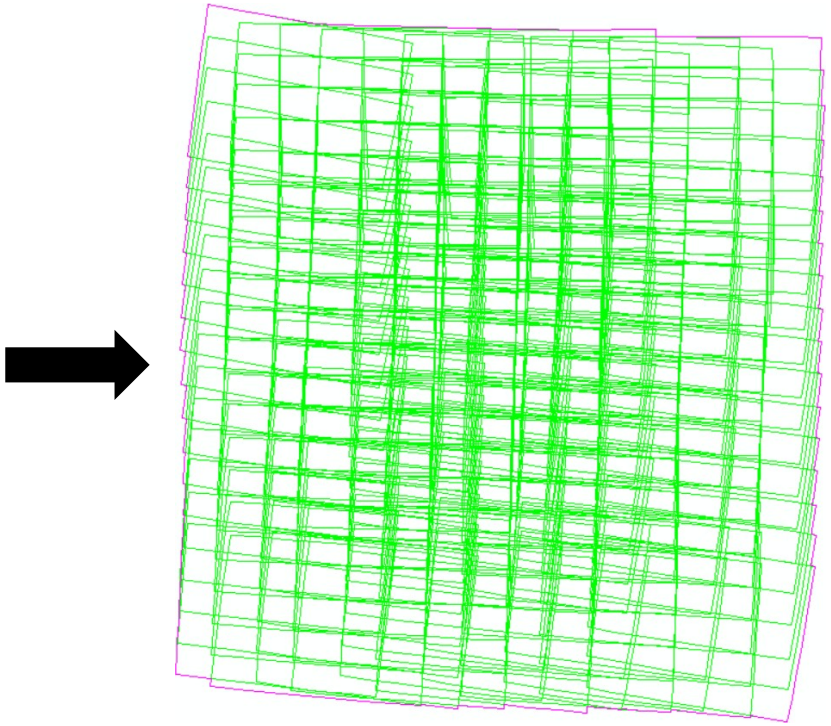


UAS Capabilities

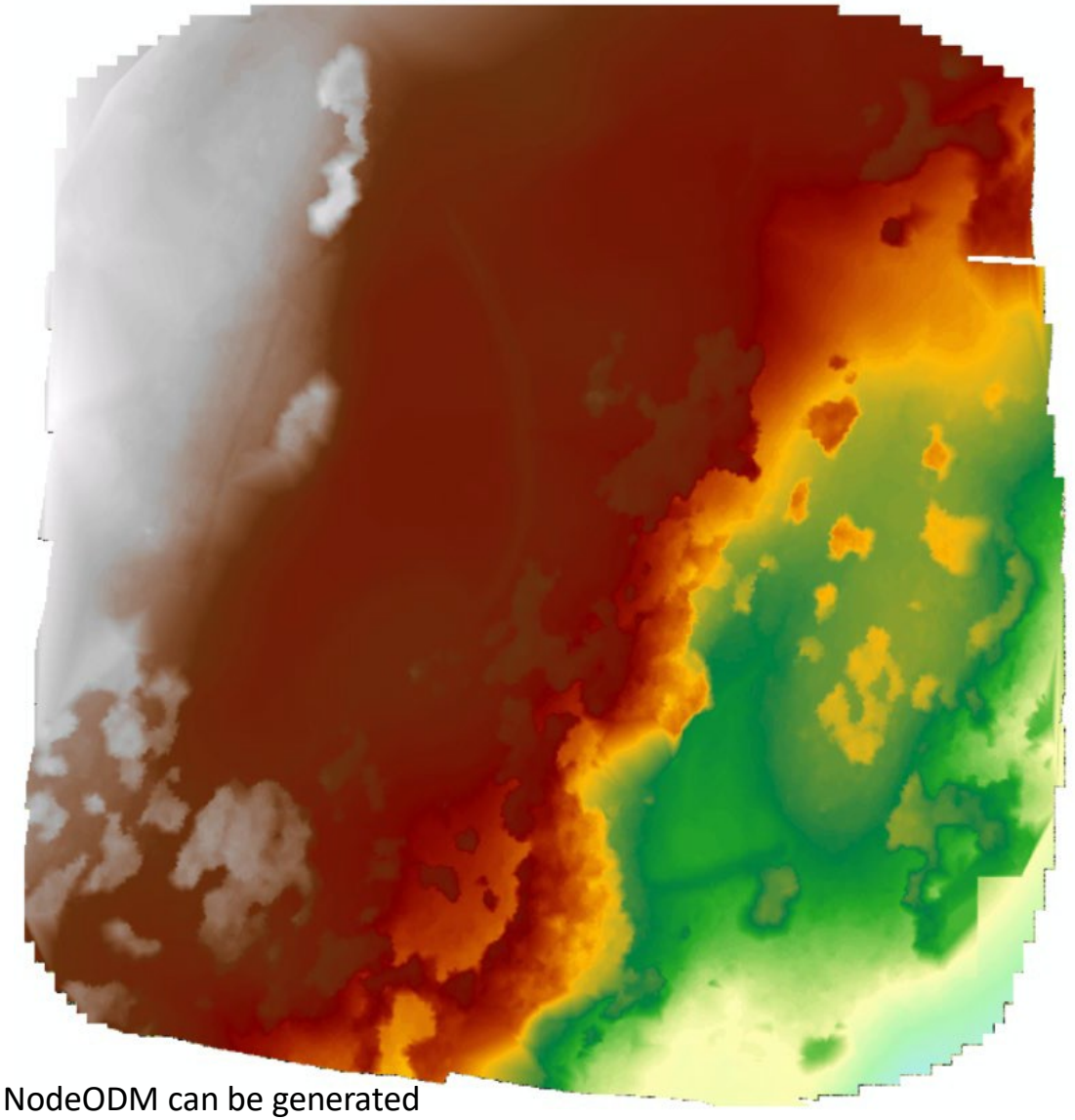


UAS Tool: NodeODM





Products: Colorbalanced Orthomosaic and DTM



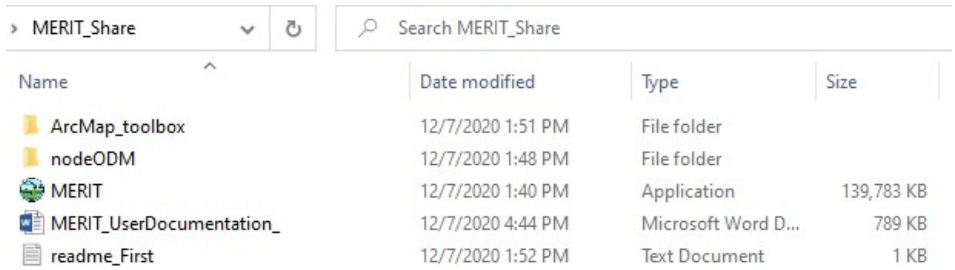
*Any output from NodeODM can be generated

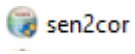
Demonstration #1: UAS/Drone imagery processing
and derivative product generation

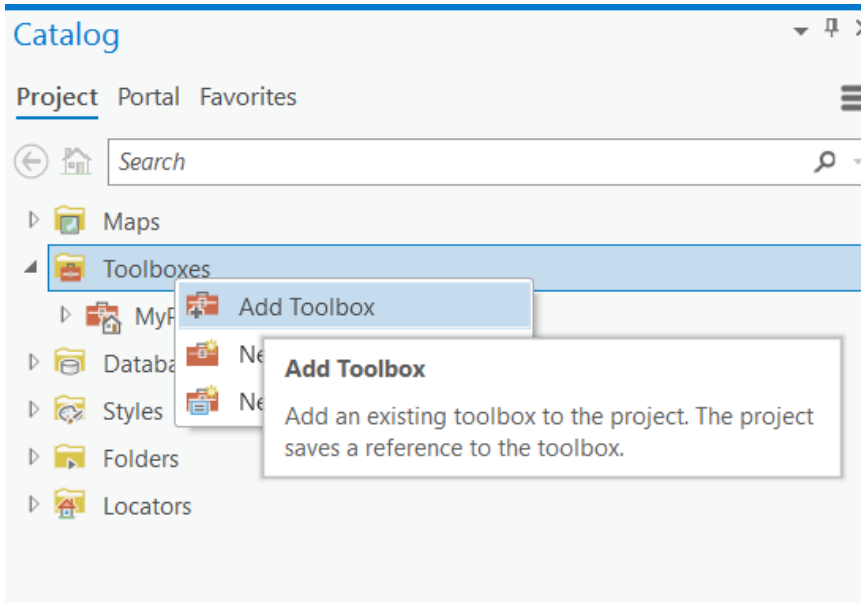
Installing GRL's EMRRP Image Processing and Analysis Tools

Instructions

- From the EMRRP website, download the data files to your computer
- Read the "Readme_First" document. Then right click on "MERIT.exe" and select "Run as administrator". Follow the instructions presented. A black command line window will popup, allow this to complete (about 4-5minutes) before closing out and finishing the install.
- This setup will add the MERIT ArcGIS Pro toolbox directly into your ArcGIS Pro AND it will install the "MERIT" custom anaconda python libraries into ArcGIS Pro
- Read over the "MERIT_UserDocumentation" file as well as the technical report (online) for more information about the tools.







Demonstration #2: Installing MERIT onto your computer, and overview of tools in ArcGIS Pro

Sentinel-2 Multispectral Imagery

- While Sentinel-2 imagery may be coarser resolution than UAS, it provides advantages in some respects:
  - Repeat overpass of data collection (e.g. every 6-12 days) enables change detection, phenology curve mapping, etc. , global availability
  - Is free and scientifically validated
  - Multispectral imagery has higher spectral resolution than most UAS systems, which enables better differentiation of land surface phenomena.

Sentinel-2 bands	Central wavelength (µm)	Resolution (m)
Band 1 – Coastal aerosol	0.443	60
Band 2 – Blue	0.490	10
Band 3 – Green	0.560	10
Band 4 – Red	0.665	10
Band 5 – Vegetation red edge	0.705	20
Band 6 – Vegetation red edge	0.740	20
Band 7 – Vegetation red edge	0.783	20
Band 8 – NIR	0.842	10
Band 8A – Vegetation red edge	0.865	20
Band 9 – Water vapour	0.945	60
Band 10 – SWIR – Cirrius	1.375	60
Band 11 – SWIR	1.610	20
Band 12 – SWIR	2.190	20

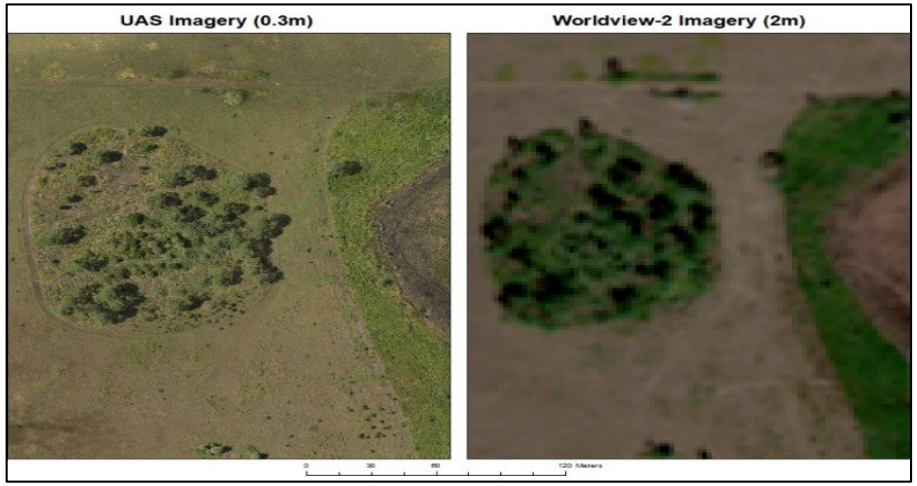
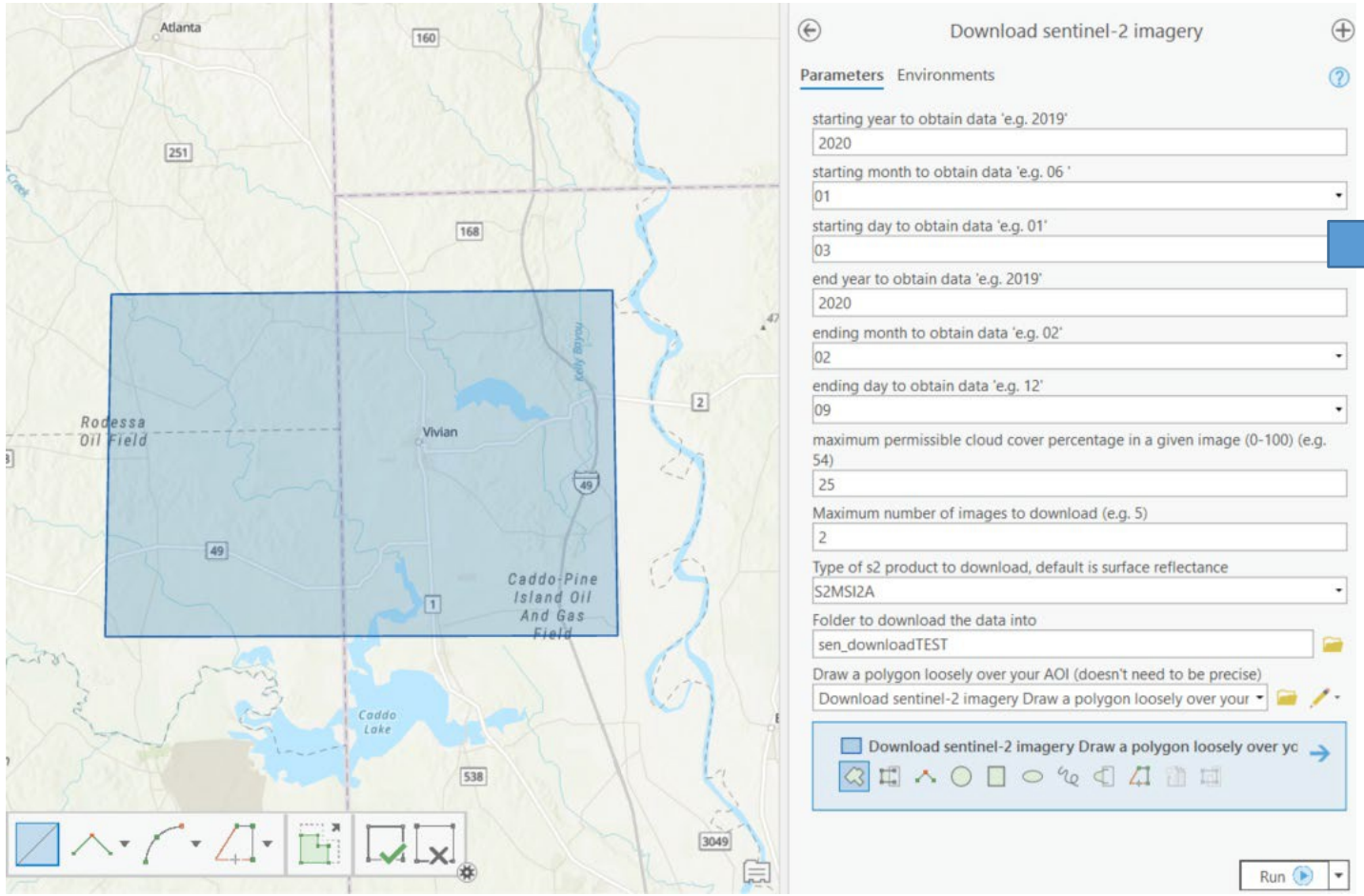


Figure 5: Comparison of spatial resolution between VHR airborne and HR spaceborne imagery at Hog Island site.

Automated Sentinel-2 Image Acquisition

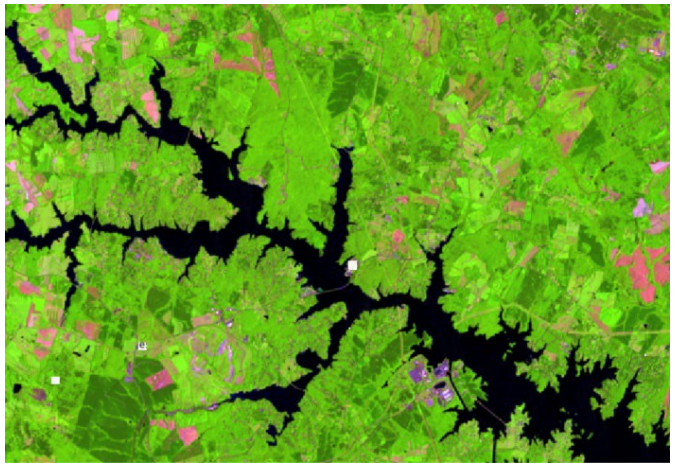
Integration with ArcGIS Pro



Custom Tool output

```
Messages
Running script s2_download...
Found 15 images matching your criteria
The following Sentinel-2 files with associated cloud cover are available to be downloaded
{'S2A_MSIL2A_20191123T170631_N0213_R069_T15SVS_20191123T212553': 11.781116,
'S2A_MSIL2A_20191123T170631_N0213_R069_T15SUS_20191123T212553': 1.927882,
'S2B_MSIL2A_20191118T170609_N0213_R069_T15SUS_20191118T204410': 3.7465460000000004,
'S2B_MSIL2A_20191118T170609_N0213_R069_T15SVS_20191118T204410': 12.031494,
'S2B_MSIL2A_20191115T165549_N0213_R026_T15SUS_20191115T210352': 0.070747,
'S2B_MSIL2A_20191115T165549_N0213_R026_T15SVS_20191115T210352': 0.05981100000000001,
'S2A_MSIL2A_20191110T165531_N0213_R026_T15SVS_20191110T210852': 9.812815,
'S2A_MSIL2A_20191110T165531_N0213_R026_T15SUS_20191110T210852': 2.050653,
'S2A_MSIL2A_20191031T165431_N0213_R026_T15SVS_20191031T212244': 0.9255810000000001,
'S2A_MSIL2A_20191031T165431_N0213_R026_T15SUS_20191031T212244': 0.683054,
'S2A_MSIL2A_20191024T170401_N0213_R069_T15SUS_20191024T213007': 8.025175,
'S2A_MSIL2A_20191024T170401_N0213_R069_T15SVS_20191024T213007': 14.649070999999998,
'S2A_MSIL2A_20191021T165351_N0213_R026_T15SUS_20191021T220413': 9.432958,
'S2B_MSIL2A_20191006T165149_N0213_R026_T15SVS_20191006T212121': 3.707118,
'S2B_MSIL2A_20191006T165149_N0213_R026_T15SUS_20191006T212121': 1.008097}
Preparing to download the images with the lowest cloud cover within your selected date range.
Downloading image 1 of 3....
Downloading image 2 of 3....
Downloading image 3 of 3....
```

Sentinel-2 Multispectral Imagery (10m, 20m)



Demonstration 3 & 4: ESA's data repository for Sentinel-2 imagery; Acquiring Sentinel-2 Imagery from ESA directly within ArcGIS Pro

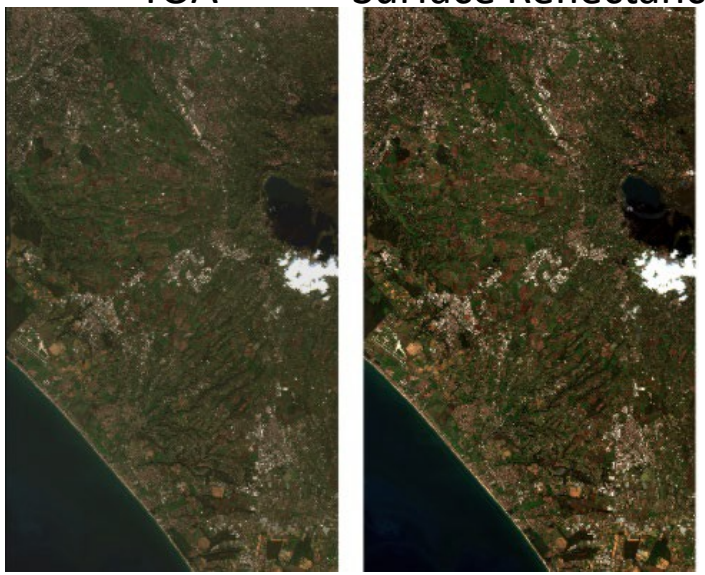
Image Pre-processing

After downloading imagery, continue to Use EMRRP Image Processing tools to:

1. Convert imagery to surface reflectance (optional)
2. “stack” or combine imagery from 2 dates into a single file.

Once imagery is in surface reflectance format and combined into a single file, it’s ready for automatic image classification tool…

TOA Surface Reflectance



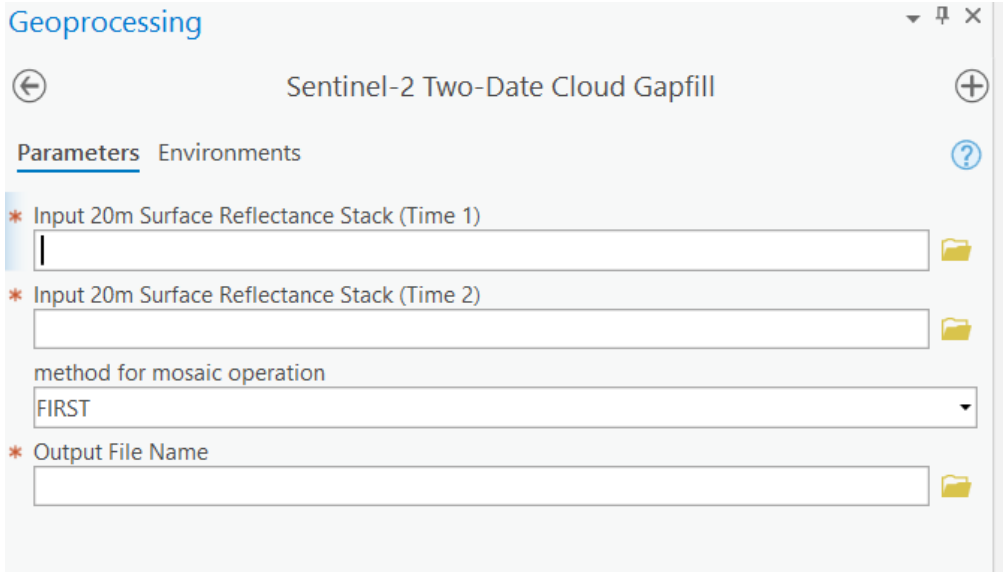
Sentinel Band	Date	Type
B1 Blue	Winter	Surface Reflectance
B2 Green	Winter	Surface Reflectance
B3 Red	Winter	Surface Reflectance
B4 Red Edge	Winter	Surface Reflectance
B5 Veg Red Edge	Winter	Surface Reflectance
B6 Red edge	Winter	Surface Reflectance
B7 Near-IR	Winter	Surface Reflectance
B8 SWIR-1	Winter	Surface Reflectance
B9 SWIR-2	Winter	Surface Reflectance
B10 Blue	Summer	Surface Reflectance
B11 Green	Summer	Surface Reflectance
B12 Red	Summer	Surface Reflectance
B13 Red Edge	Summer	Surface Reflectance
B14 Veg Red Edge	Summer	Surface Reflectance
B15 Red edge	Summer	Surface Reflectance
B16 Near-IR	Summer	Surface Reflectance
B17 SWIR-1	Summer	Surface Reflectance
B18 SWIR-2	Summer	Surface Reflectance

Demonstration 5: Conversion of Sentinel-2 Radiance (L1C) to Surface Reflectance (L2A)

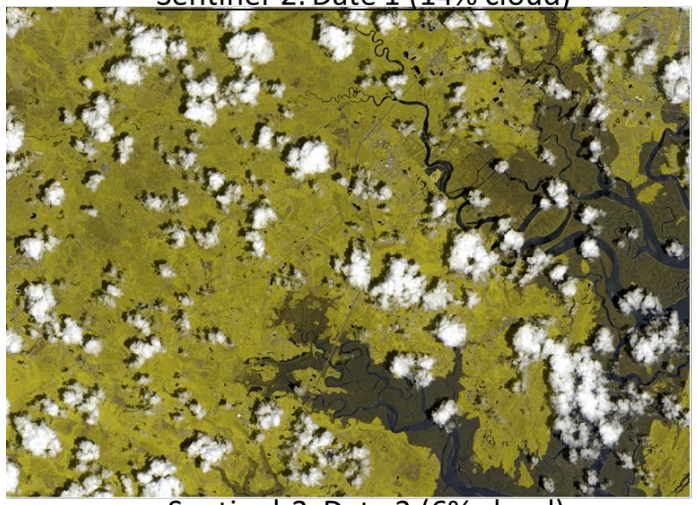
Demonstration 6 & 7: Sentinel-2 single date image composite/stack; Sentinel-2 two date image composite/stack

Cloud free composite generation

- With any satellite imagery, clouds are an issue. By using several dates of imagery, cloudy areas can be removed or reduced.

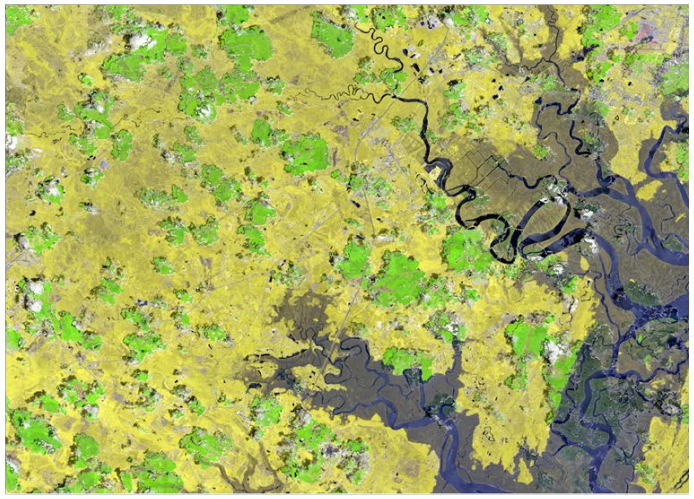


Sentinel-2: Date 1 (14% cloud)



Sentinel-2: Date 2 (6% cloud)

Combined (2% cloud)



Automated wetland area mapping with satellite imagery

EMRRP ArcGIS Pro toolsuite

↓

Tool: Download Sentinel-2 imagery

↓

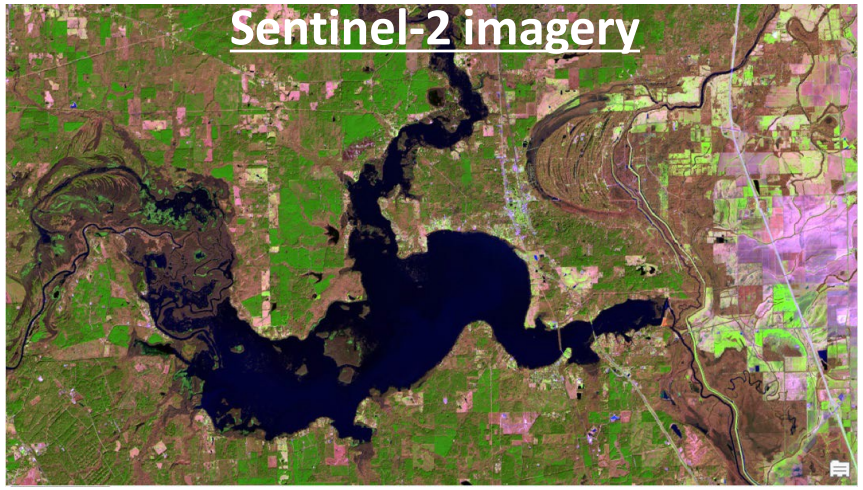
Tool (optional): pre-process image to surface reflectance

↓

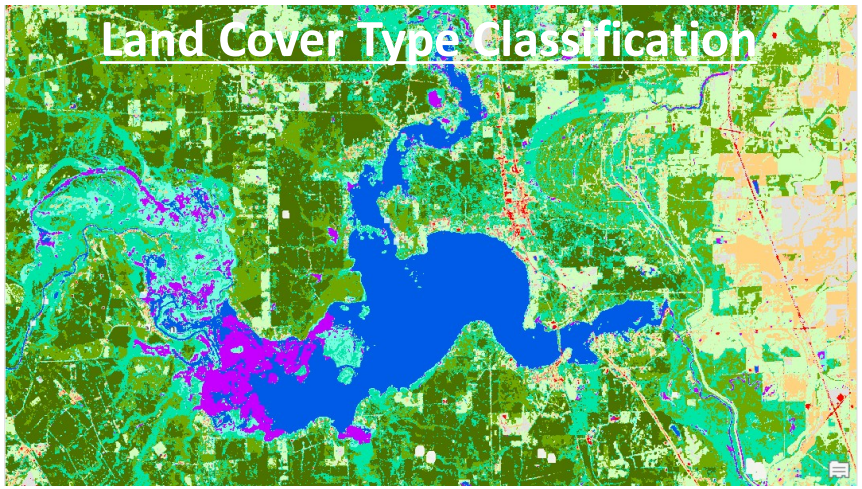
Tool: Cloud free composite and image stacking for 2 dates

↓

Tool: Wetland area land cover type classification



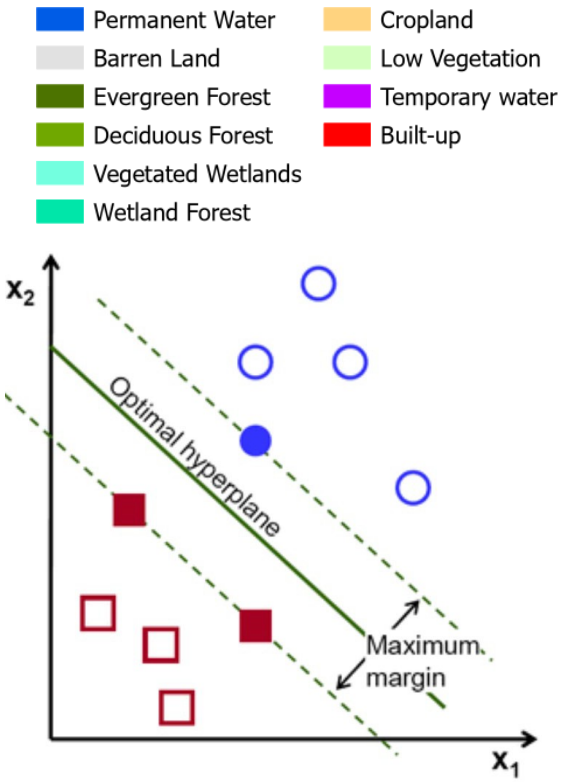
↓



- Wetland area land cover type mapping. Model will currently work in Southern and Eastern US, and non-arid, non-snow environments.
- Input: Winter and summer Sentinel-2 imagery
- Leverages: Machine learning, open-source python libraries integrated into ArcGIS interface

classification

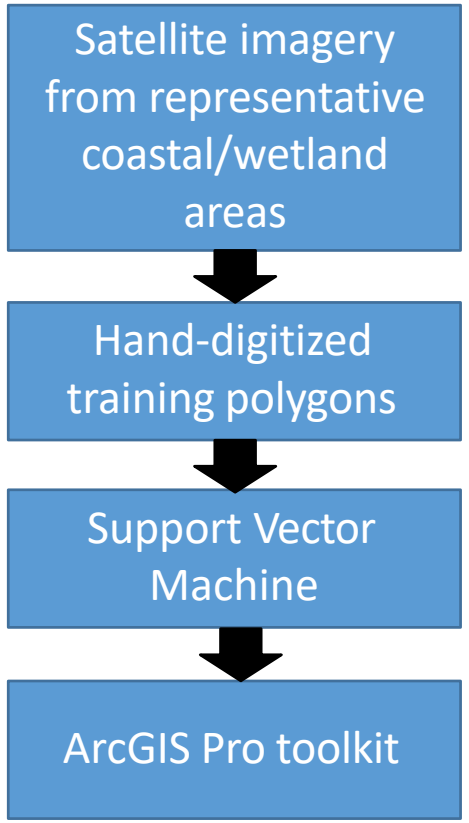
- Different land covers exhibit unique spectral signatures captured by the multiple wavelengths in the imagery
- These unique signatures can be very similar to one another and difficult to differentiate. Machine learning algorithms enable us to distinguish a unique signal with high accuracy for each land cover type



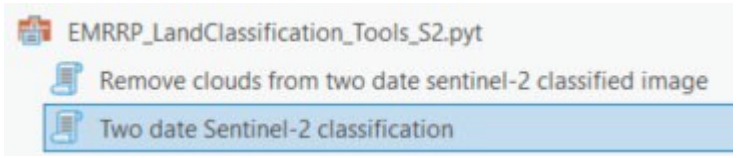
Support Vector Machine (SVM)

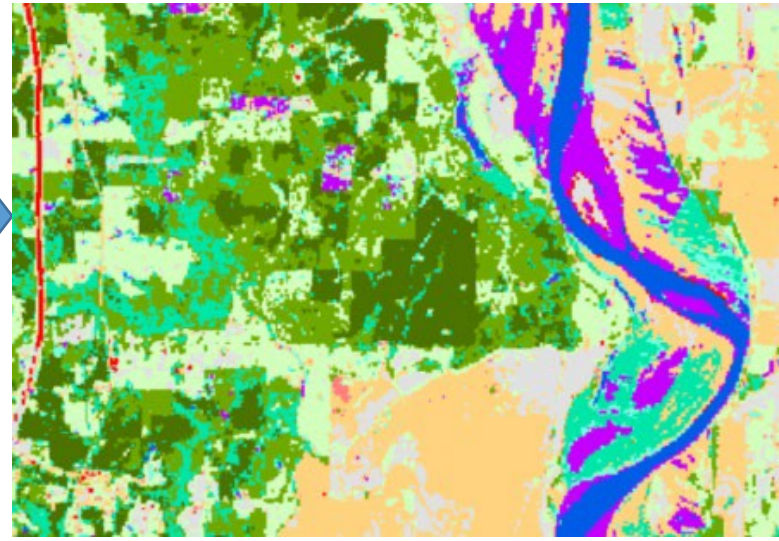
- Multidimensional decision boundary that maximizes value difference between classes
- SVM is updated during training based on predicted/observed class and associated cost value. Update to the gradient improves the classifier.

Compatibility with Sentinel-2 (20m) or Landsat 8 (30m)



Sentinel-2 Automated land cover classification

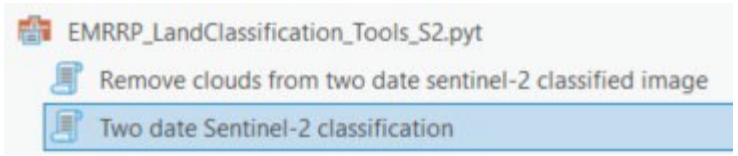


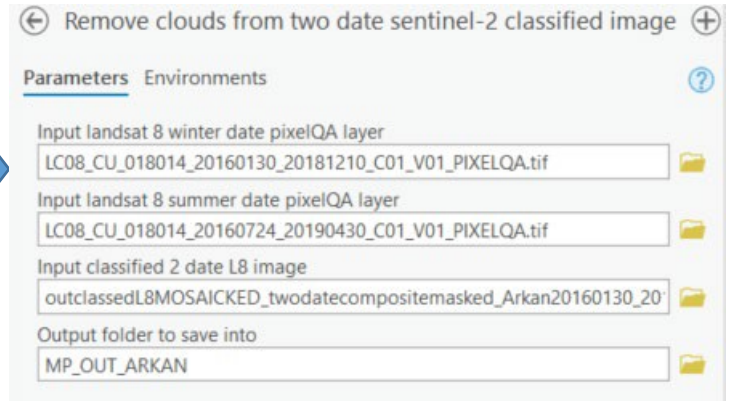


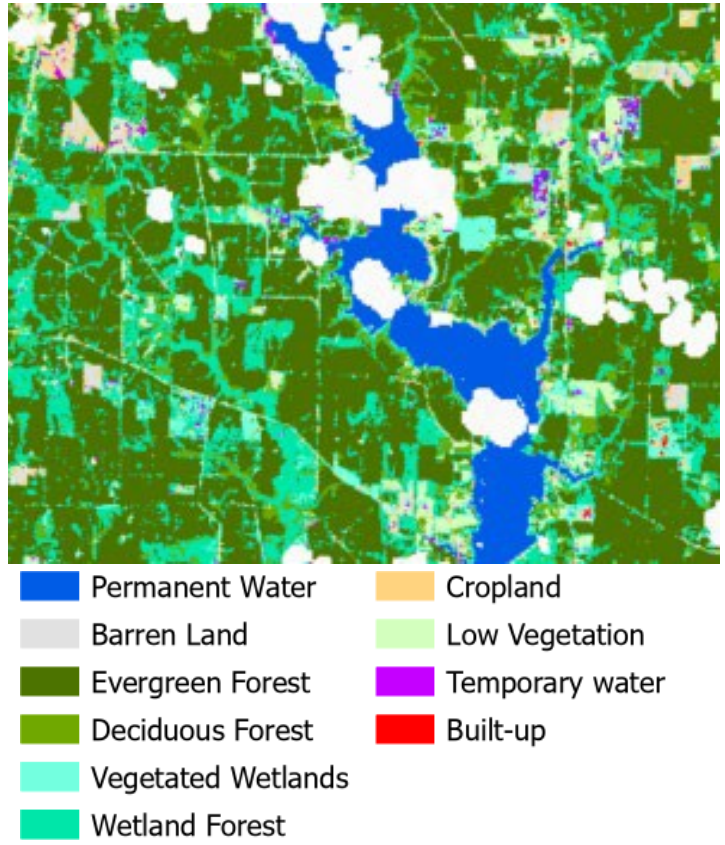
1. Run ‘two date sentinel-2 classification tool’ in ArcGIS Pro
2. Enter tool parameters
    1. Your “stacked” sentinel-2 image combining winter and summer dates
    2. Create an output folder to save your classified land cover map
3. Output will produce a classified image. The tool will take 3-4minutes for a landsat-8 image, and about 5-7 minutes for sentinel-2 image.

Demonstration 8: Sentinel-2 two date automatic land cover classification

Post-classification cloud removal



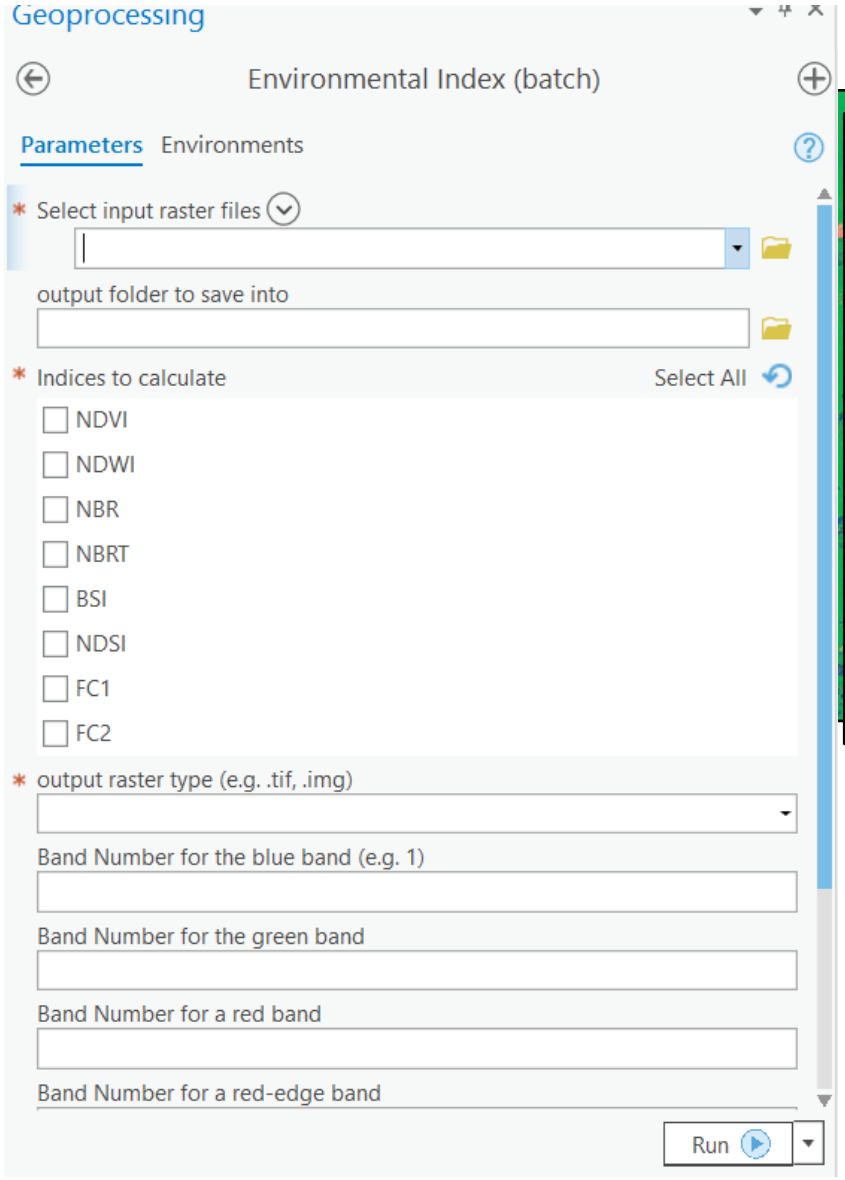




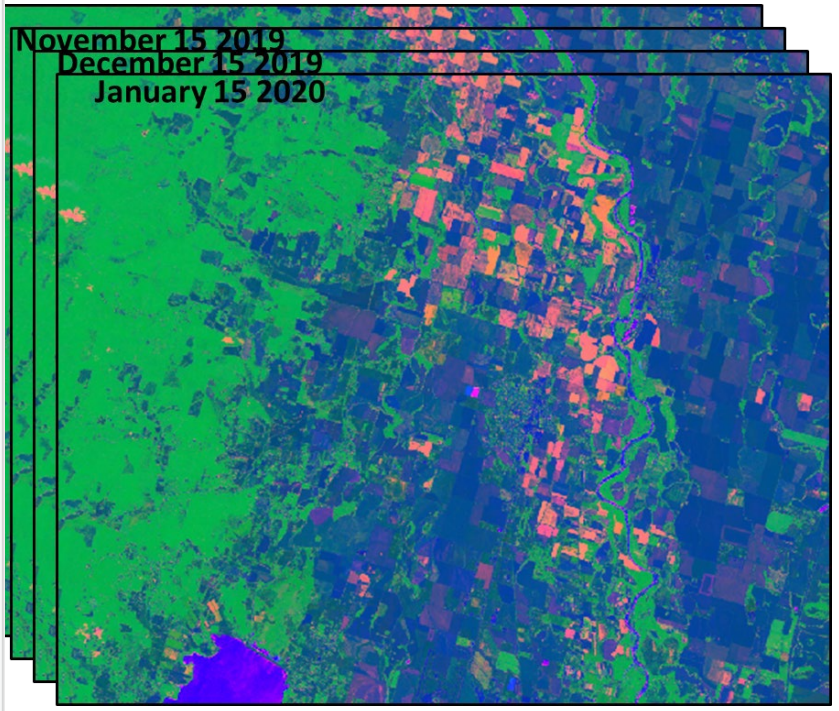
1. Run ‘Remove clouds…’ tool in ArcGIS Pro
2. Enter tool parameters
    1. Your “PIXELQA.tif” layer for landsat-8 winter image(this file is in the original landsat-8 surface reflectance folder)
    2. Your “PIXELQA.tif” layer for landsat-8 summer image
    3. The automatic classified land cover image
    4. The folder where you want to save the output.
3. The new file will remove cloudy areas from the image, they will just be white, no-data pixels (as seen in example image).

Environmental Index (batch processing)

- Derive environmental indices such as Normalized difference water index (NDWI), bare soil index, burned area index, etc.
- Just input a data folder and the tool will compute indices for MULTIPLE files, multiple dates, --saving you time and effort on image processing

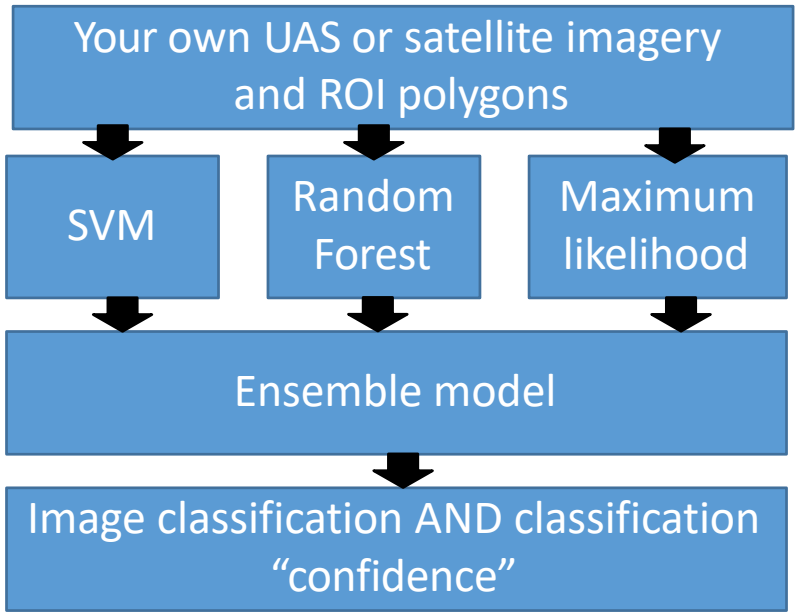


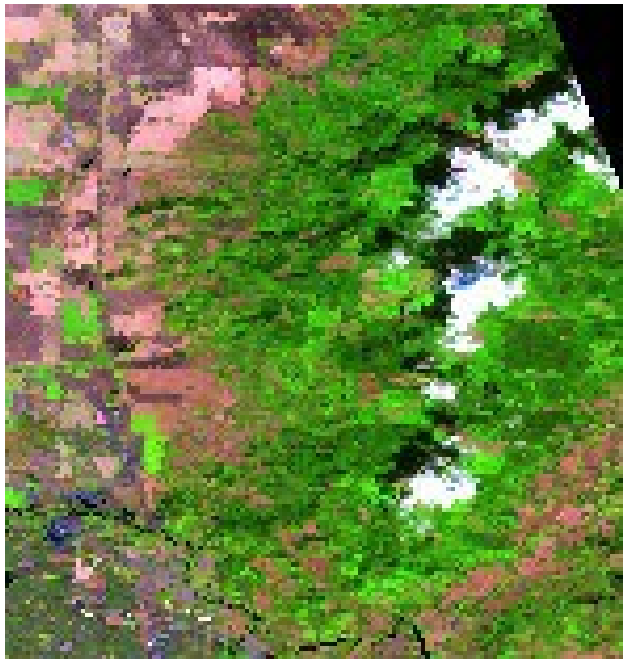
NDVI, NDWI in single image



Ensemble Supervised Classifier

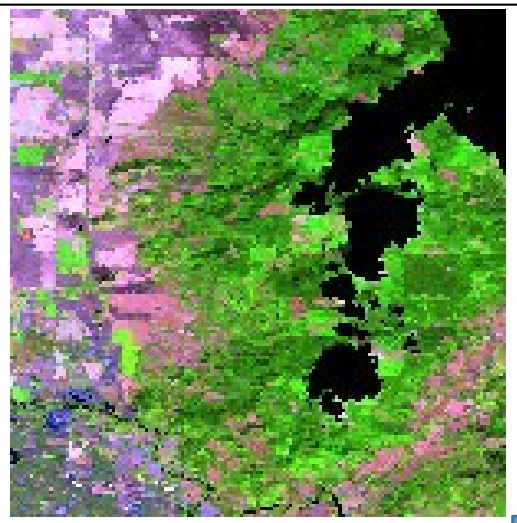
- Pre-process imagery using our tools
- Create your own classification of your phenomena of interest (e.g. burned area)
  - (1) Any satellite or UAS imagery
  - (2) user-generated polygons representing each region of interest.
  - (3) optionally, environmental indices derived from our tools for enhanced classification
- Combine 3 classifiers into a single map for higher-accuracy results.

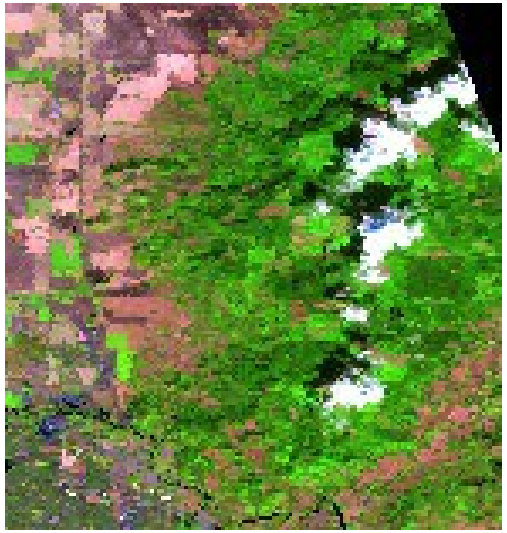




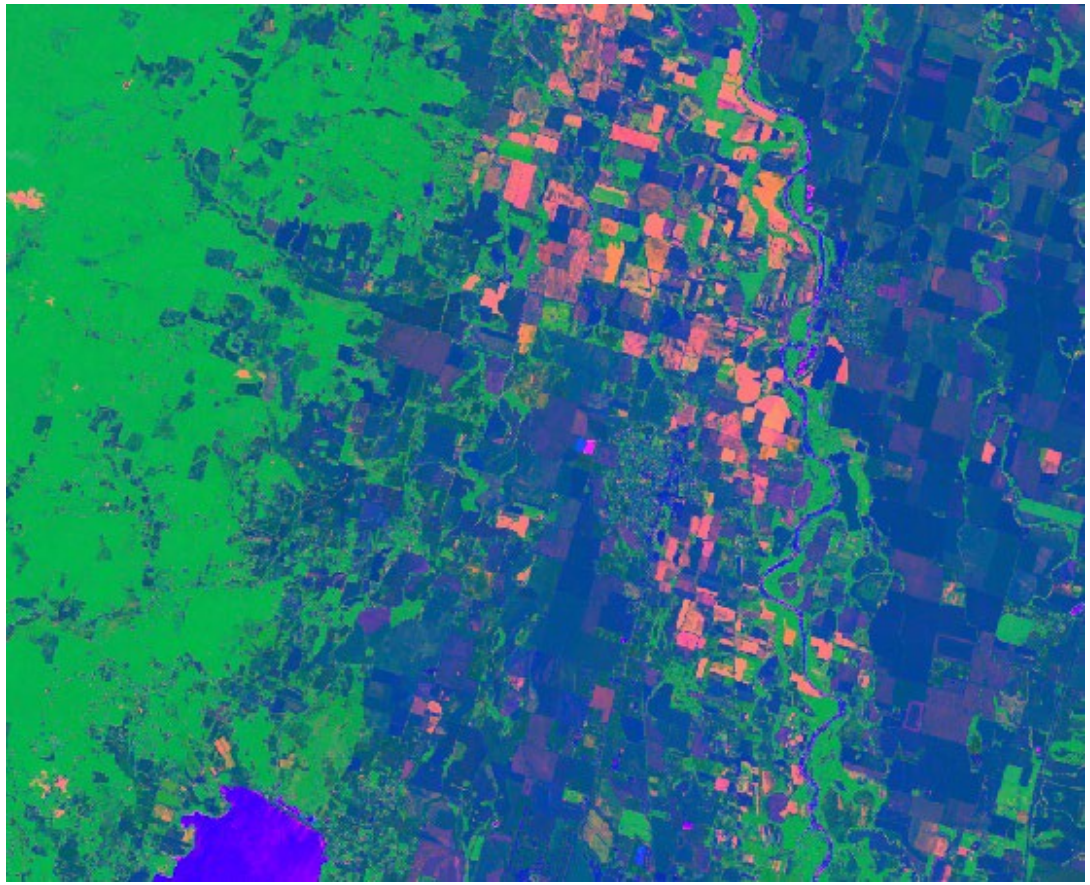
Ensemble Supervised Classifier

Atmos. Correction and cloud masking

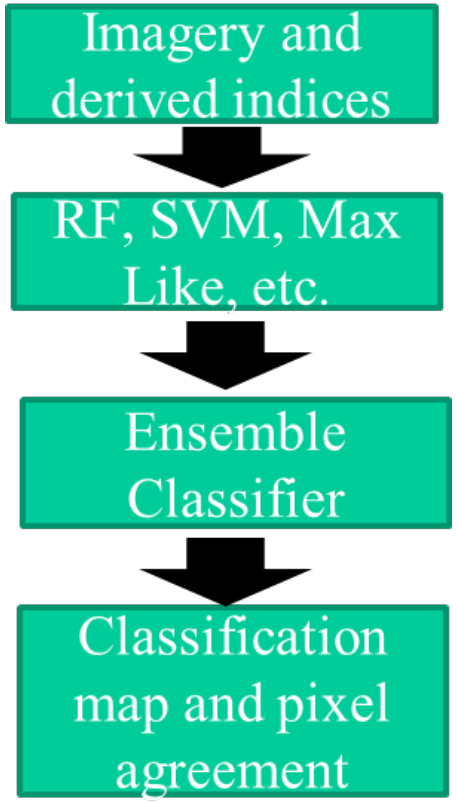




Environmental Indices (NDVI, NDSI, etc.)

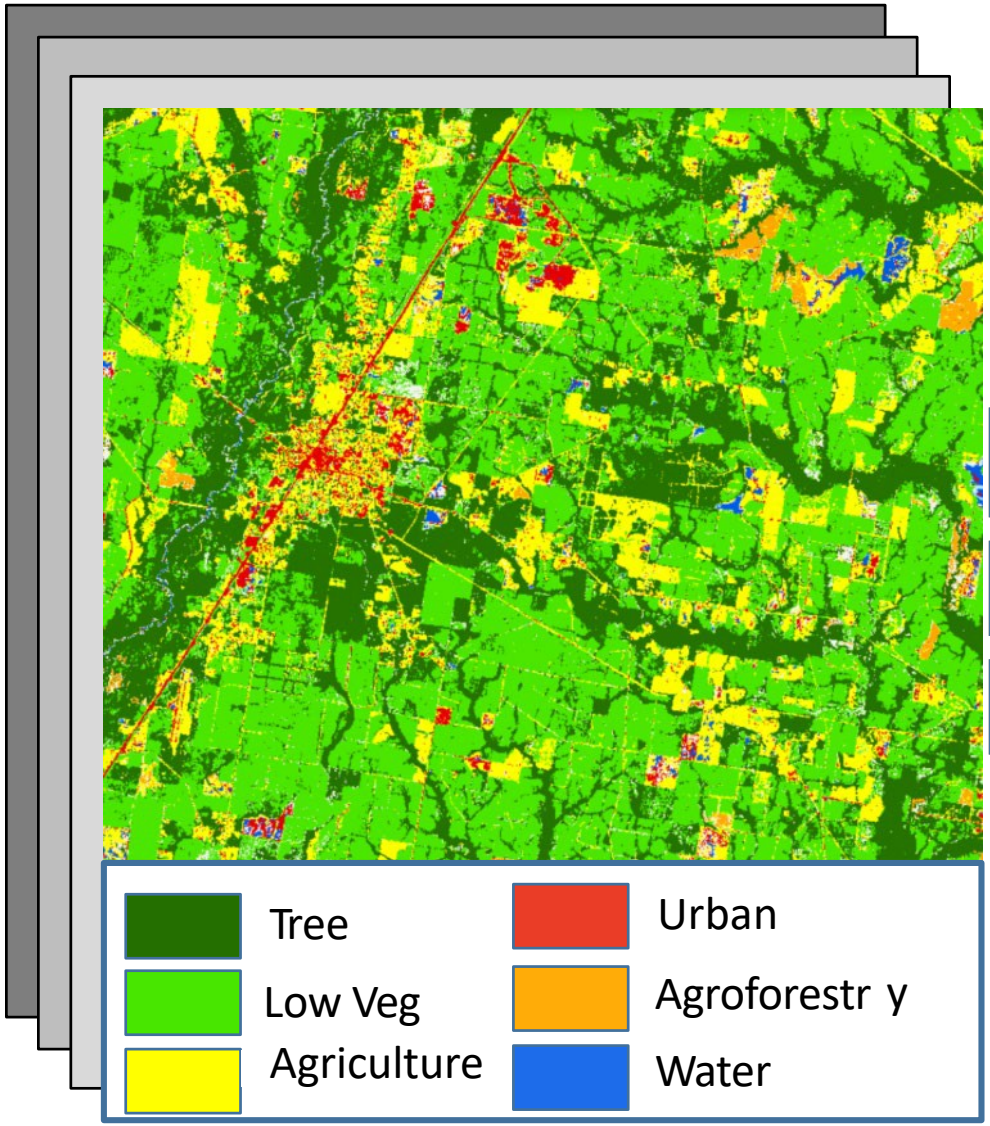


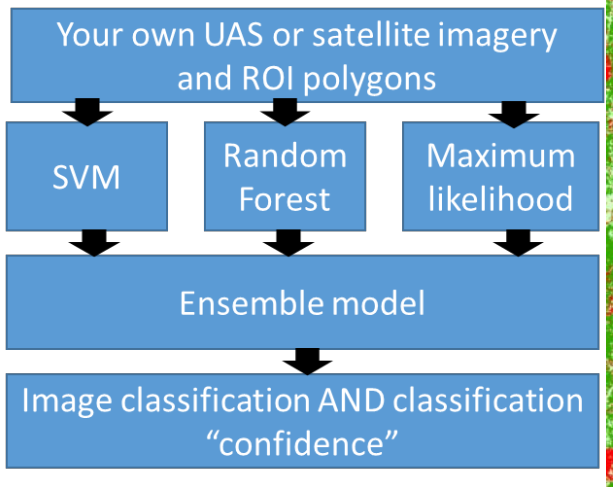
Ensemble Supervised Image Classification



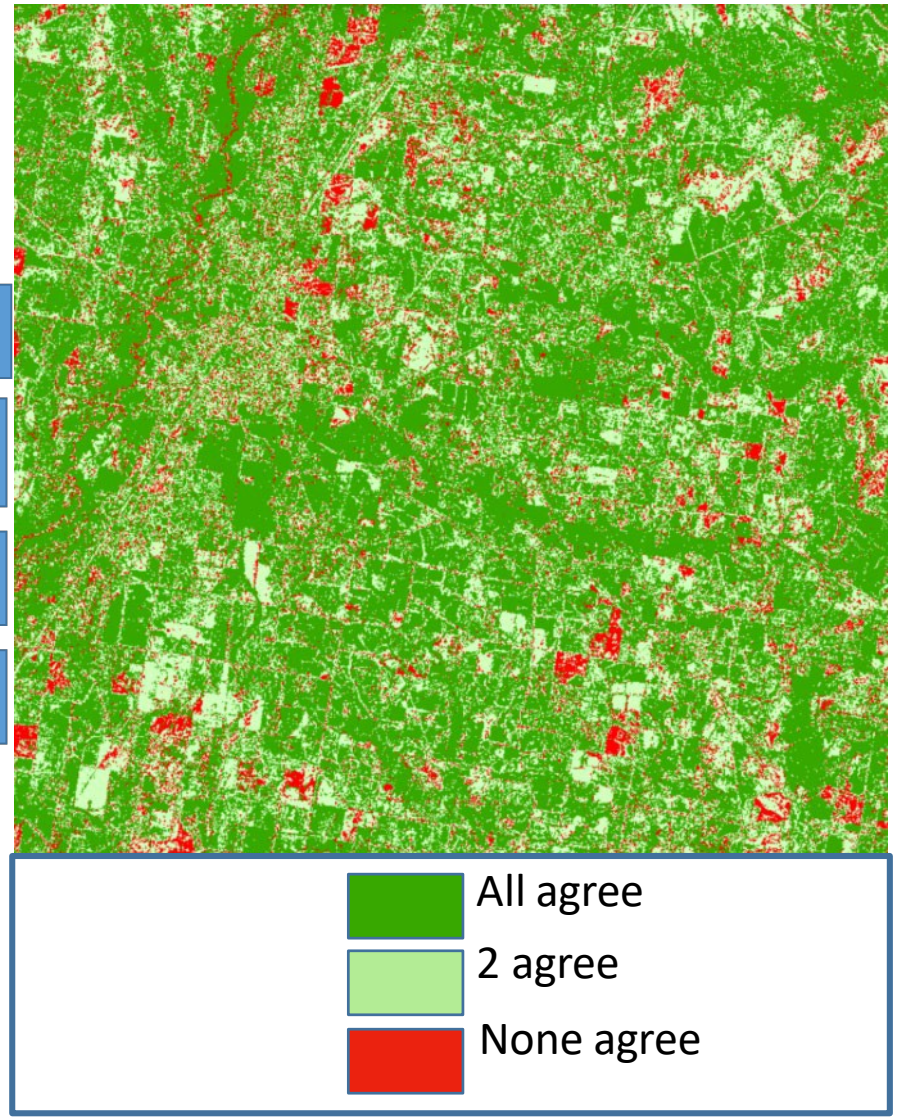
Ensemble Supervised Classifier

Supervised Classification Result (Ensemble Classifier)



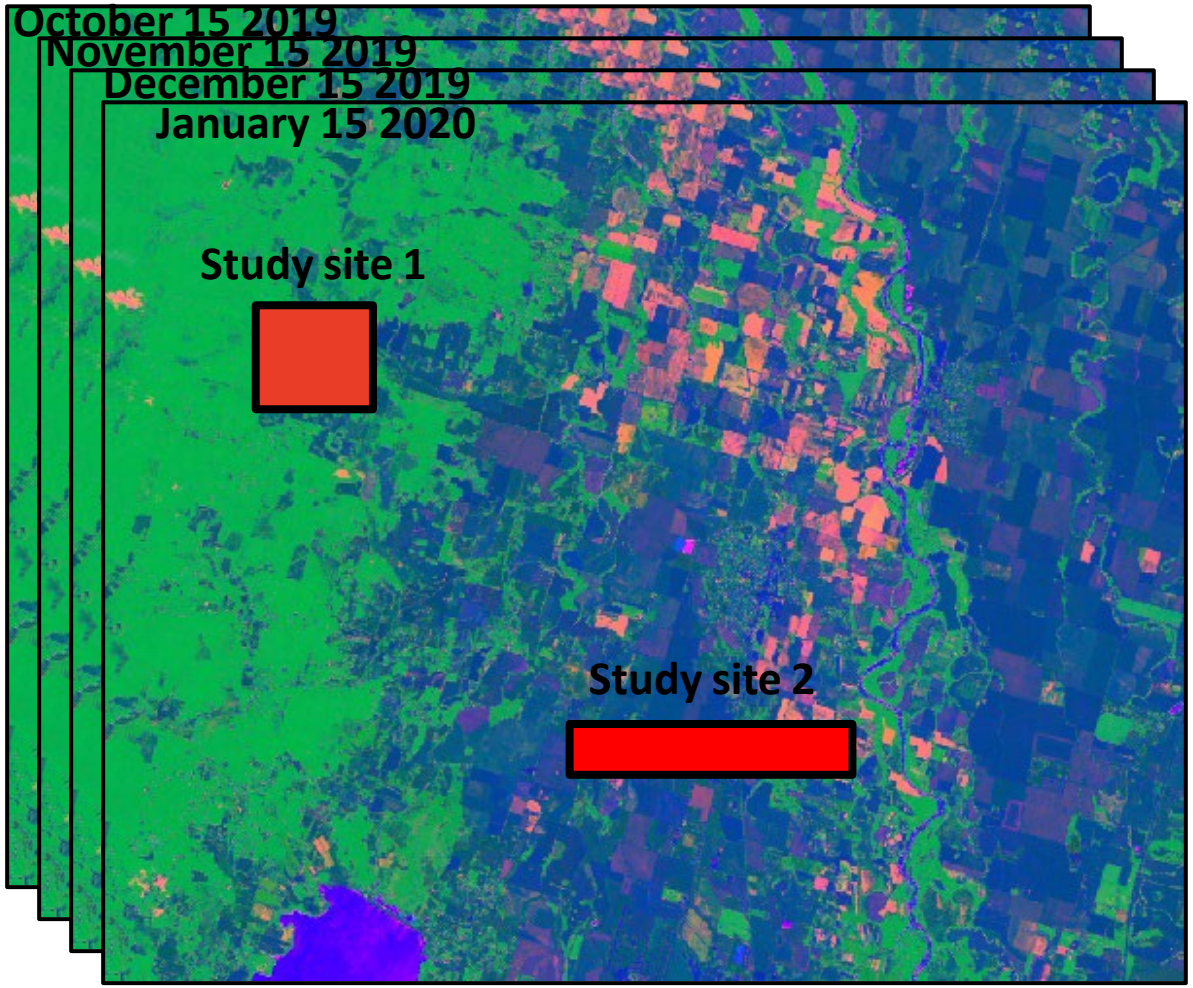


Pixel Agreement/Classifier Confidence



Time series of regional statistics

Multiple dates of Environmental Indices (NDVI, NDSI, etc.)



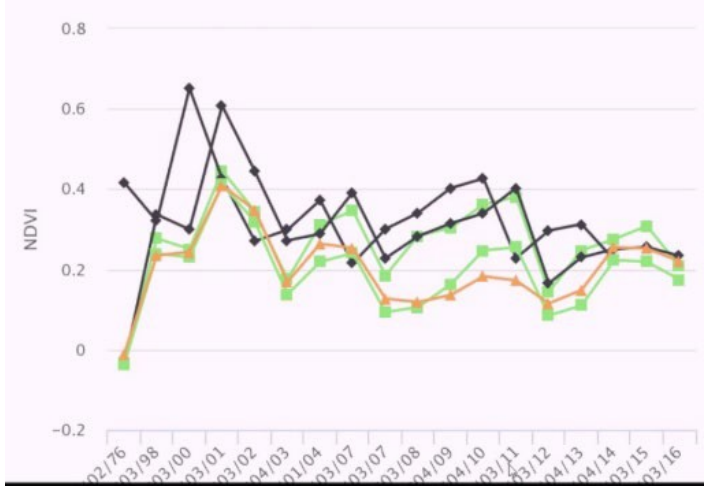
EMRRP ArcGIS Pro Tool

Merged, tabular output

mbinedfile149

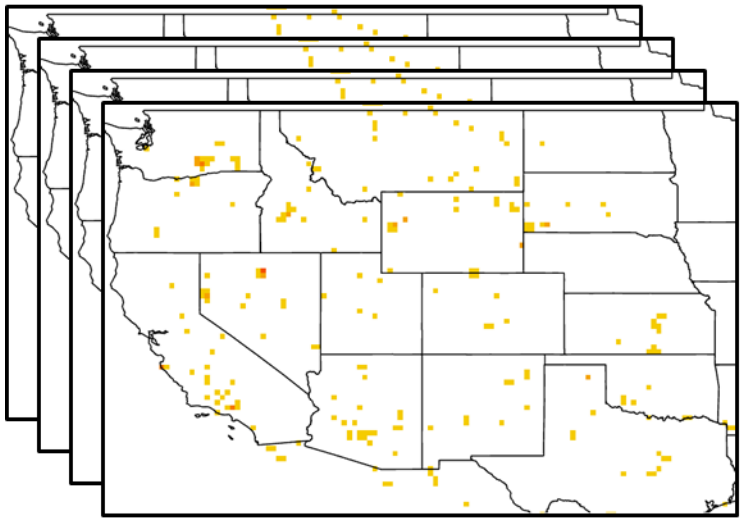
ZONE_CODE	COUNT	MIN	MAX	RANGE	MEAN	STD	SUM
1	175807	766	9948	9182	5676.91667	912.741087	998041689
1	175807	305	9962	9657	5950.467917	940.129756	1046133913

MAJORITY	MINORITY	MEDIAN	date	month	year	monthday
5690	766	5759	06/01/2020	06	2020	06/01
6250	305	6055	06/16/2020	06	2020	06/16

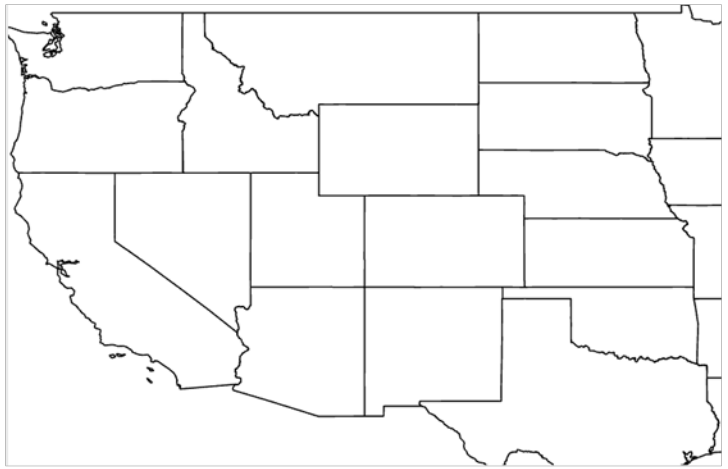


Time series of regional statistics

Monthly Burned Area Data

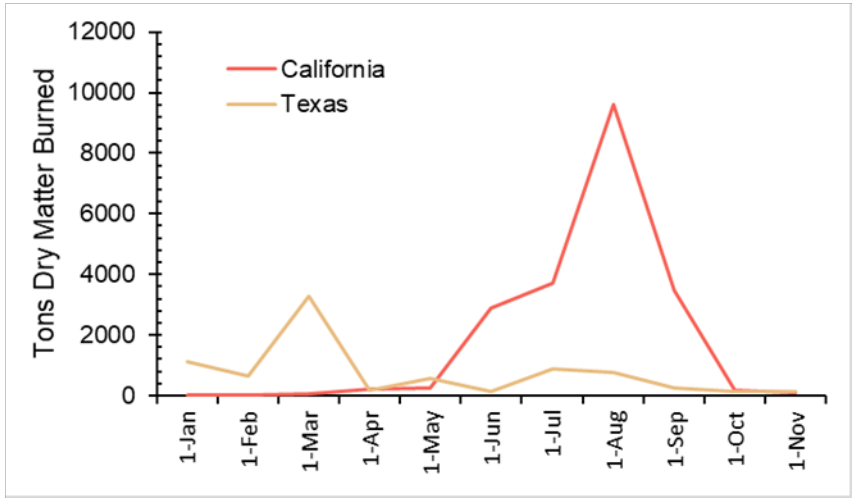


Shapefile of each state of interest



EMRRP GIS Region Analysis Tool

monthday	STATE_NA	SUM_ton
1-Jan	California	4.287
1-Feb	California	2.144
1-Mar	California	55.733
1-Apr	California	210.073
1-May	California	265.807

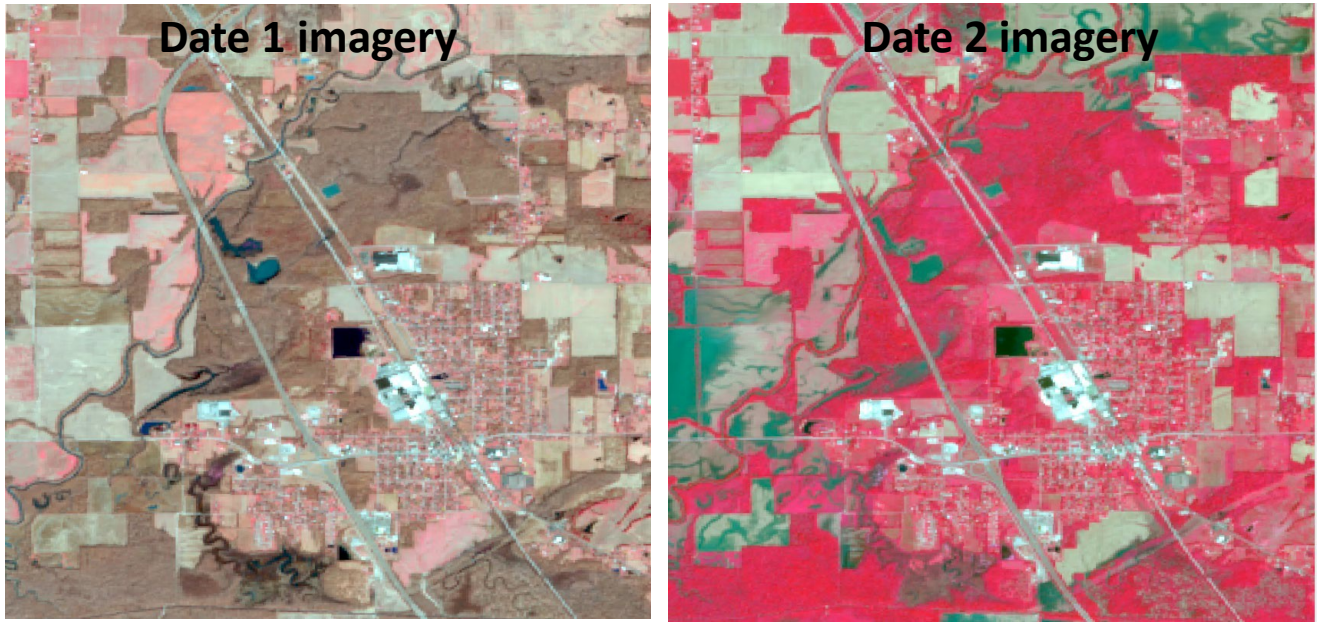


Demonstration 9: Time series of region/study site statistics (multitemporal zonal statistics)

Surface water mapping

Input: Sentinel-2 20m imagery from .SAFE folder (L2A)
Process: Water map is created based on a random forest classifier using automatically created training points selected from an ensemble of spectral indices with quality checks
Output: 20m Water map

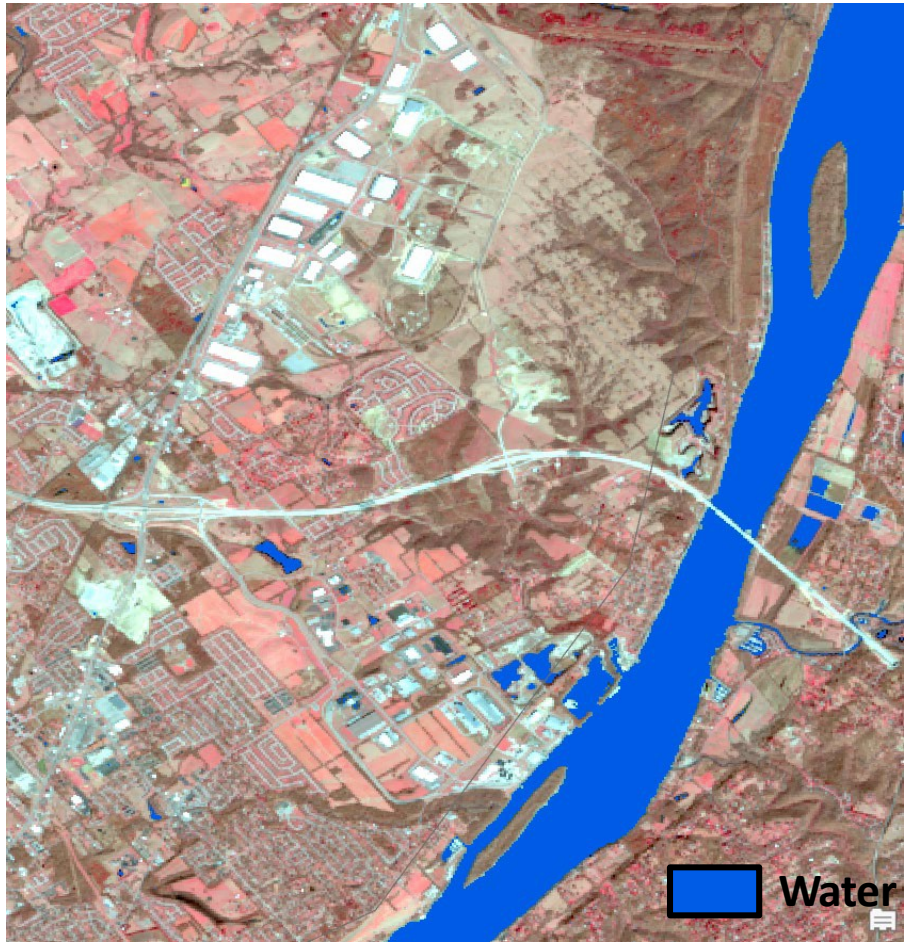
Task: Map flooded area of our district/zone by running the tool twice. Once using an image from pre-flood date (e.g. February) and once using imagery from the flood date (e.g. May). Then, compute the difference between the two images to observe surface water dynamics/flooding.



Surface water mapping

Sentinel-2 Imagery

Sentinel-2 Imagery + Output layer



Demonstration 10: Mapping surface water area changes after a flood event

Dr. Kristofer Lasko, Mr. Sean Griffin
Geospatial Research Laboratory
Engineer Research and Development Center
U.S. Army Corps of Engineers
Kristofer.d.lasko@erdc.dren.mil
Sean.p.griffin@erdc.dren.mil

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

US Army Corps of Engineers®

Questions & Answers

Please post any questions to the "CHAT".

Missed the last webinar?

June 15th

Topic: Model to Assess Species and Habitat Migration Due to Climate Change

Dr. Jacob Jung and Ms. Christina Saltus

POSTED:
https://emrrp.el.erdc.dren.mil/webinars.html.