

Modern Remote Sensing and Image Analysis

A Higher Education Webinar
Presented by Esri and AAG



The willingness to experiment with innovative approaches to GIS has yielded benefits for numerous field-based teaching and research activities across the university.

— Peter Knoop | University of Michigan

Webinar Housekeeping

- Microphones will be muted
- Please enter your questions in the chat box
- Q&A session at the conclusion of the webinar
- Webinar & slides will be available
- Survey following the webinar



Presenters



Canserina Kurnia
Senior Solution Engineer
Education Team



Peter Becker
Group Product Manager
Imagery team



Delphine Khanna
Product Engineer
Learn ArcGIS team



Agenda

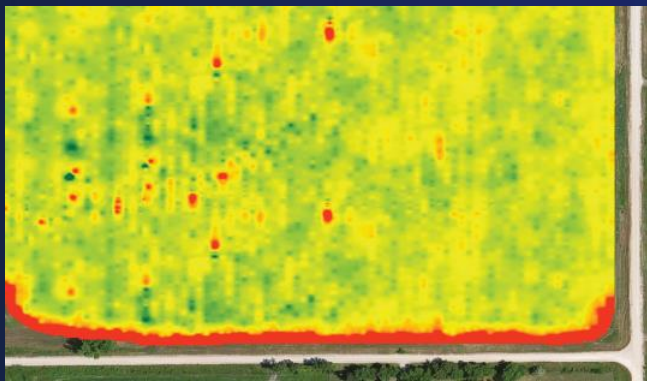
- Modern remote sensing and Image analysis
- Imagery in ArcGIS
- Ready-to-use apps and workflows
- New learning package on introduction to imagery and remote sensing
- QA session and resources



Modern Remote Sensing and Image analysis

- New technologies
 - Drones, LIDAR, microsatellites
 - Greater spatial, temporal, spectral resolution
 - SaaS, Desktop, Server
- New analysis methods
 - Increased volumes of data necessitate automated methods
 - Increased computational power leads to new methods
- New applications
 - New types of data can be applied to new questions/problems
 - New analysis methods can be applied to new questions/problems

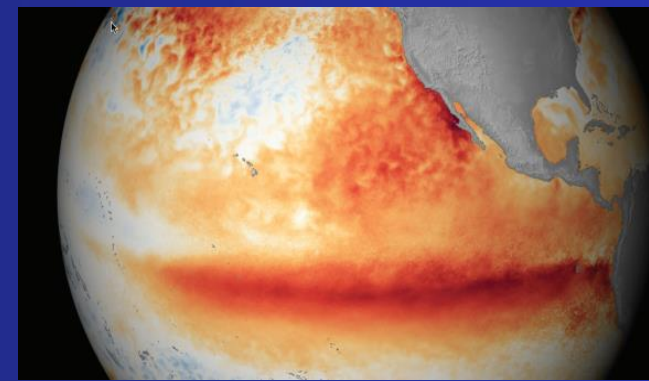
Uses of Imagery



Agriculture



Forestry



Climate and weather



Engineering and construction



Humanitarian aid



Natural disaster response

Imagery in ArcGIS

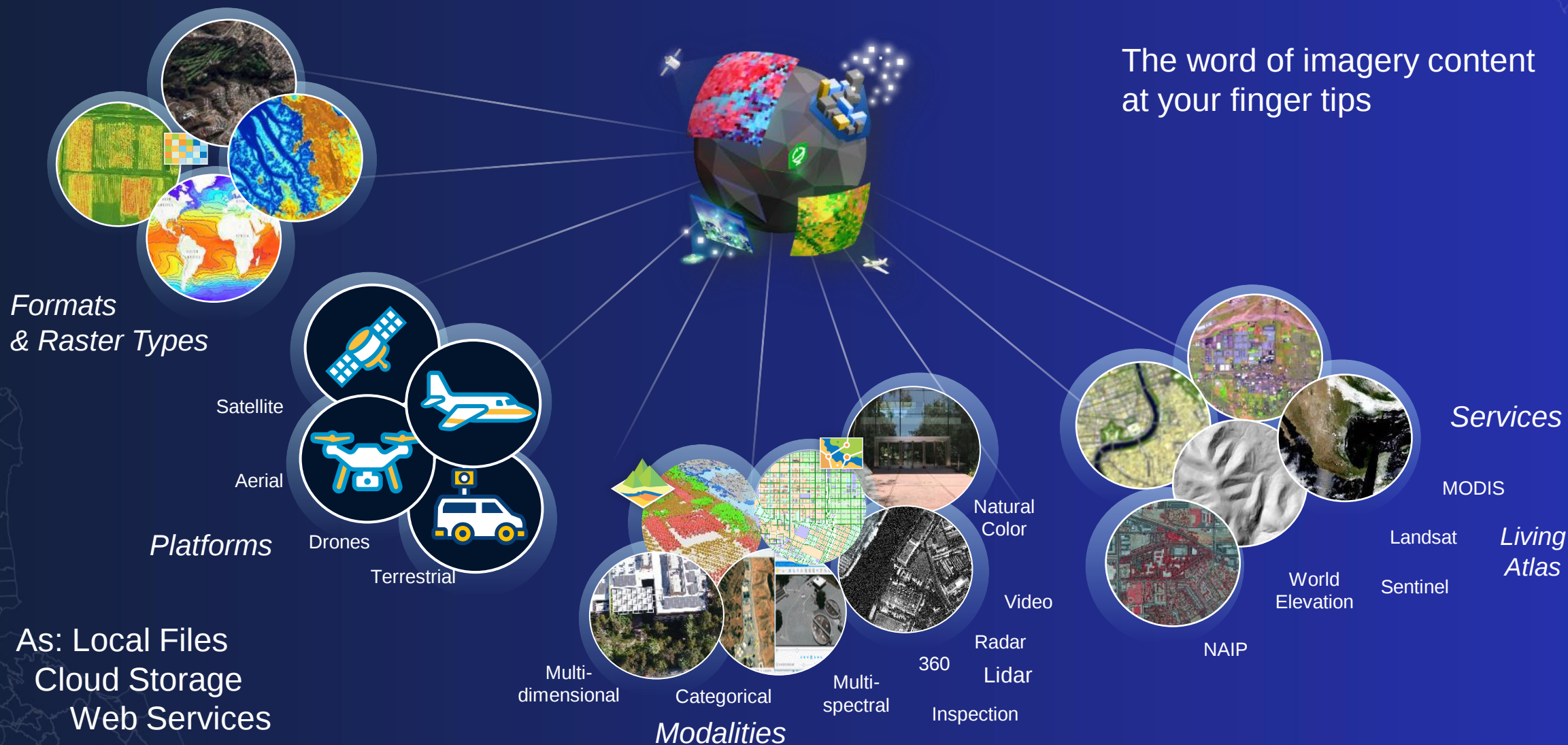


Imagery & Remote Sensing Capabilities

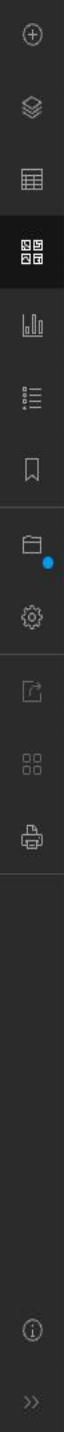
Comprehensive Imagery System



Content – Access to all Imagery and Rasters







Basemap

Current basemap

Topographic

Imagery

Imagery Hybrid

Streets

Topographic

Navigation

Streets (Night)

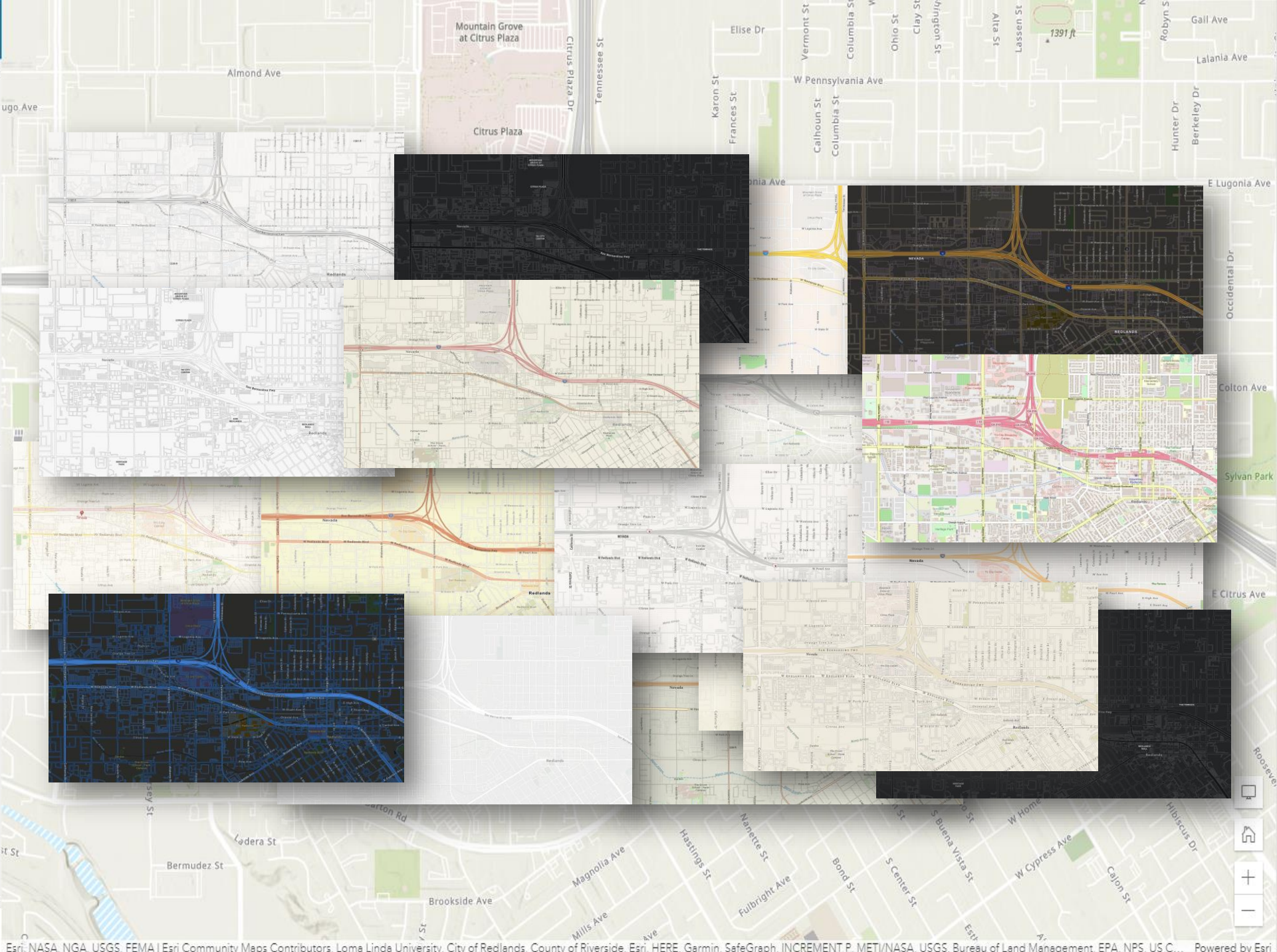
Terrain with Labels

Light Gray Canvas

Dark Gray Canvas

Oceans

Change background color



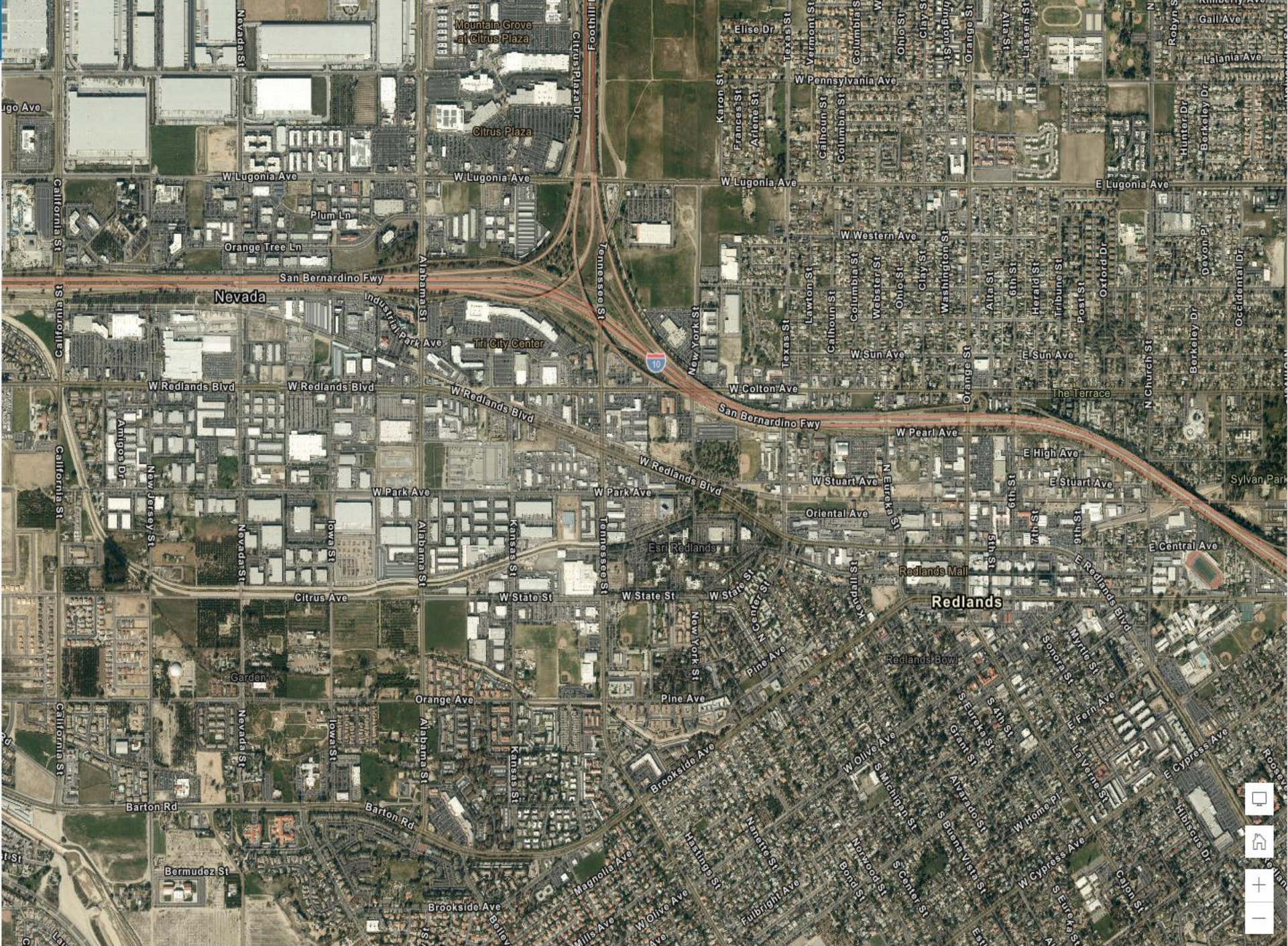
Layers

Layers

No layers

Add layers to your map and they will appear here.

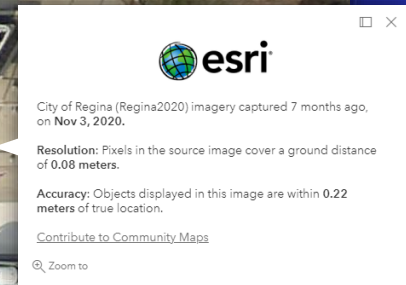
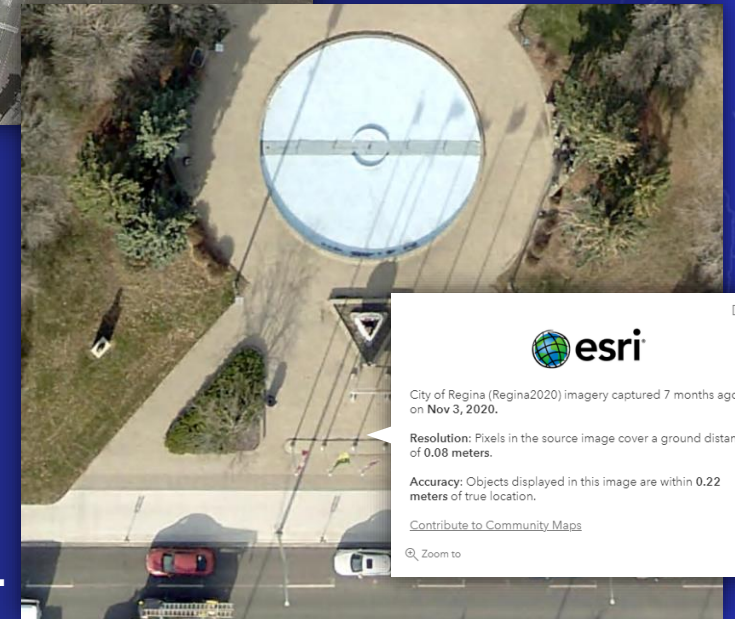
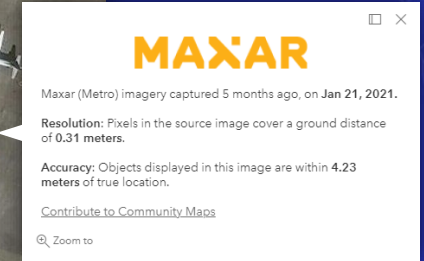
+ Add layer



World Imagery

From Multiple Sources

- **Maxar** - High resolution satellite imagery
 - **Vivid Standard:**
 - Global imagery mosaic, 50 cm to 1.2 m
 - **Vivid Advanced:**
 - 1,000+ metropolitan areas, 30 cm
 - **In the past year:**
 - >100 million sq. km. updated
 - Including ~1,200 metros at 30cm
- **GIS User Community** - High resolution aerial photography
 - **Variable coverage and update cycles**
 - Average spatial resolution 15cm
 - **Notable contributions in the past year**
 - Country wide coverage for Switzerland, Austria, Slovenia, and Slovakia.
 - Significant coverage in Germany, Spain, Canada, and United States



Items: 5,726

My Content

My Favorites

My Groups

My Organization

Subscription Content

Living Atlas

ArcGIS Online

by esri

Updated: 5/27/20

Terrain: Slope Map

 by Esri

Updated: 9/29/21

USA NAIP Imagery: Natural Color

 by Esri

Updated: 11/4/20

Terrain: Elevation Tinted Hillshade

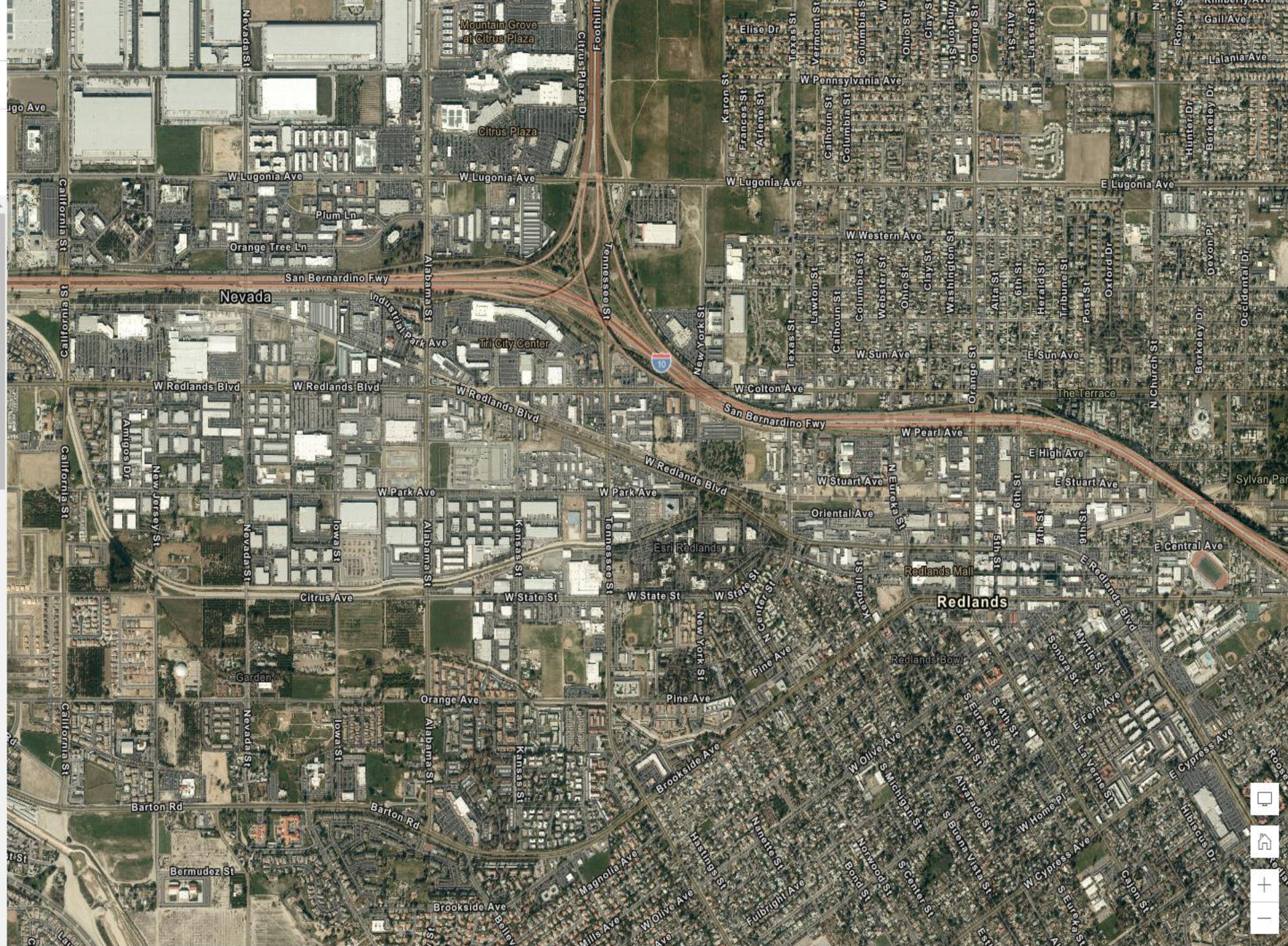
 by Esri

Updated: 9/29/21

Terrain: Multi-Directional Hillshade

 by Esri

Updated: 9/29/21





World Imagery Wayback



Wayback 2015-04-30
Click map for imagery details

☒ Only versions with local changes

- 2021-07-21
- 2020-10-14
- 2020-03-23
- 2018-03-14
- 2018-01-08
- 2016-06-13
- 2015-04-30
- 2014-02-20

redlands

☒ reference label overlay

World Imagery Wayback

World Imagery Wayback

redlands

X

Q

+

-

2016

2018

2020

Wayback 2018-01-08

Click map for imagery details

☒ Only versions with local changes

2021-07-21

🗎

🔄

2020-10-14

🗎

🔄

2020-03-23

🗎

🔄

2018-03-14

🗎

🔄

2018-01-08

🗎

🔄

2016-06-13

🗎

🔄

2015-04-30

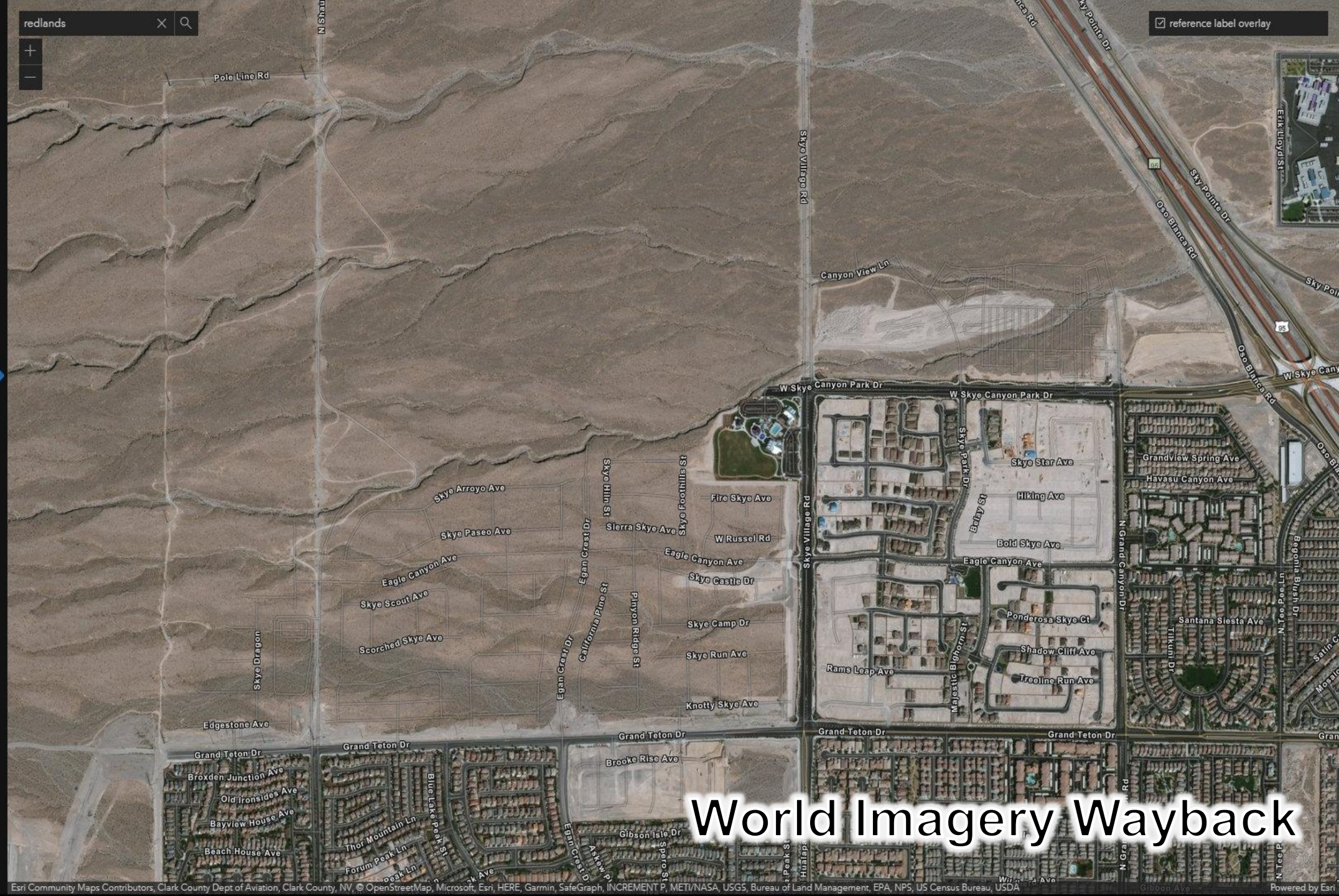
🗎

🔄

2014-02-20

🗎

🔄



World Imagery Wayback

World Imagery Wayback

redlands

+

-

Wayback 2018-03-14

Click map for imagery details

☒ Only versions with local changes

2021-07-21

2020-10-14

2020-03-23

2018-03-14

2018-01-08

2016-06-13

2015-04-30

2014-02-20

World Imagery Wayback

Esri Community Maps Contributors, Clark County Dept of Aviation, Clark County, NV, © OpenStreetMap, Microsoft, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METU/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA

Powered by Esri

World Imagery Wayback

redlands

+

-

Wayback 2020-03-23

Click map for imagery details

☒ Only versions with local changes

2021-07-21

2020-10-14

2020-03-23

2018-03-14

2018-01-08

2016-06-13

2015-04-30

2014-02-20

A satellite map of a residential area in Clark County, NV. The map shows a grid of streets including Skye Canyon Park Dr, Skye Village Rd, Skye Star Ave, Skye Scout Ave, Skye Canyon Ave, Skye Castle Dr, Skye Camp Dr, Skye Run Ave, Knotty Skye Ave, Grand Teton Dr, Brooke Rise Ave, Gibson Isle Dr, and Skye Village Rd. The map is overlaid with a 'World Imagery Wayback' interface. The interface includes a search bar with 'redlands' entered, a zoom control, a date selector showing '2020-03-23', and a list of historical dates. The map is also overlaid with a 'World Imagery Wayback' watermark.

World Imagery Wayback

Esri Community Maps Contributors, Clark County Dept of Aviation, Clark County, NV, © OpenStreetMap, Microsoft, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA

World Imagery Wayback

redlands

+

-

2016

2018

2020

Wayback 2021-07-21

Click map for imagery details

☒ Only versions with local changes

2021-07-21

2020-10-14

2020-03-23

2018-03-14

2018-01-08

2016-06-13

2015-04-30

2014-02-20

A satellite map of a residential area in Clark County, NV, showing streets like Skye Village Rd, Skye Canyon Park Dr, and Skye Star Ave. The map is overlaid with a Wayback interface showing a timeline of imagery from 2014 to 2021. The interface includes a search bar with 'redlands', a zoom control, and a list of dates. The selected date is 2021-07-21. The map shows a mix of developed areas with houses and roads, and undeveloped desert land to the west.

World Imagery Wayback

Esri Community Maps Contributors, Clark County Dept of Aviation, Clark County, NV, © OpenStreetMap, Microsoft, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METU/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA

Powered by Esri

NAIP

As Dynamic Image Services

- **Dynamic Imagery for regional analysis**
- **Continental United States**
- **Source data – Original pixels, No lossy compression/resampling**
 - Approximately half of the US is updated annually
 - 2020 coming soon

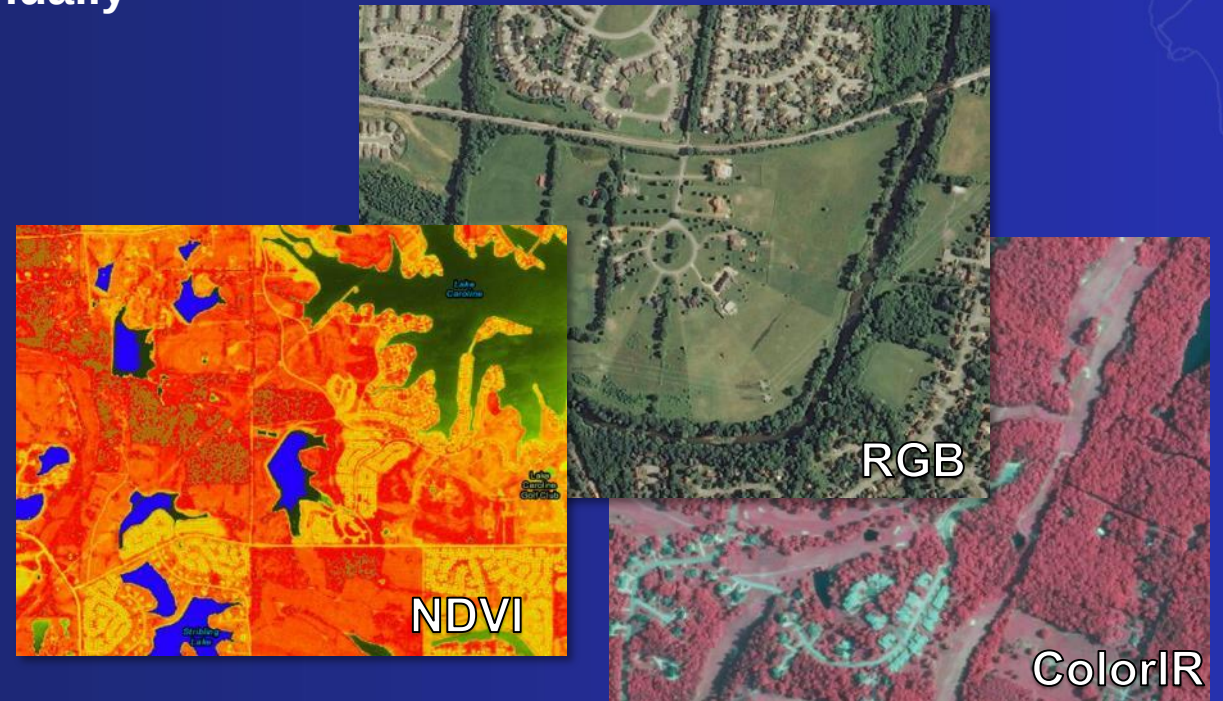
From USDA

4 Bands, 0.60cm & 1.0

Multiple UTM Zones

2010 to 2019

2 year revisit cycle



Landsat 8

As Dynamic Image Services

- **Landsat-8 Collection2 - Level 1**
 - Top of Atmosphere Reflectance
 - Improved geometric and radiometric accuracy
- **Landsat-8 Collection2 - Level 2**
 - Surface Reflectance
 - Analysis Ready

From USGS

11 Bands

1 Pan Band x 15m

8 MS Bands x 30m

2 Thermal Bands x 100m

2013 to present

16 day revisit cycle

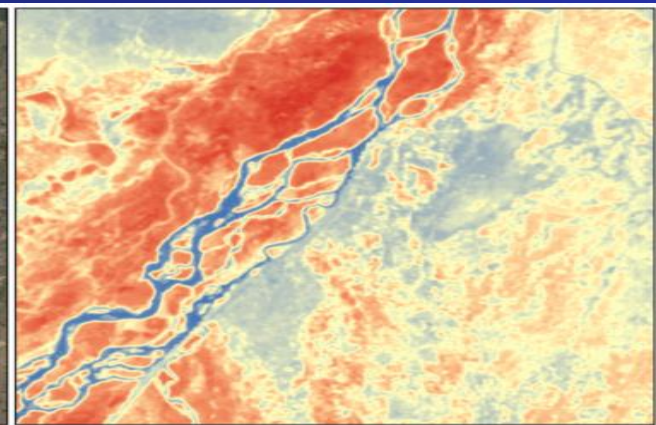
Updated Daily



Level-1 top-of-atmosphere



Level-2 surface reflectance



Level 2 - surface temperature

Sentinel-2

As Dynamic Image Services

- **Sentinel 2 - Level 1C**
 - Top of Atmosphere Reflectance
- **Sentinel 2 - Level 2A**
 - Surface Reflectance
 - Analysis Ready

From ESA

15Bands:

4 Bands x10m

6 Band x20m

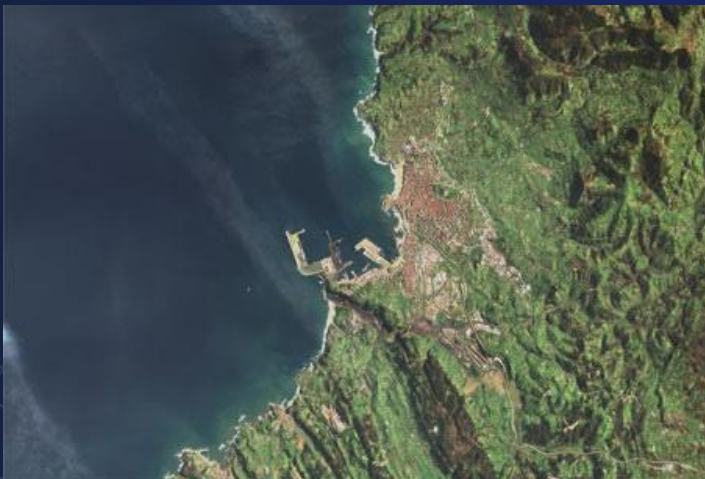
3 Bands x60m

3 AOTMAp, WVPMaP, SCL

2015 to present

5 day revisit cycle

Updated Daily



Sentinel 2 Level-1C
Functions



Sentinel2 Level-2A

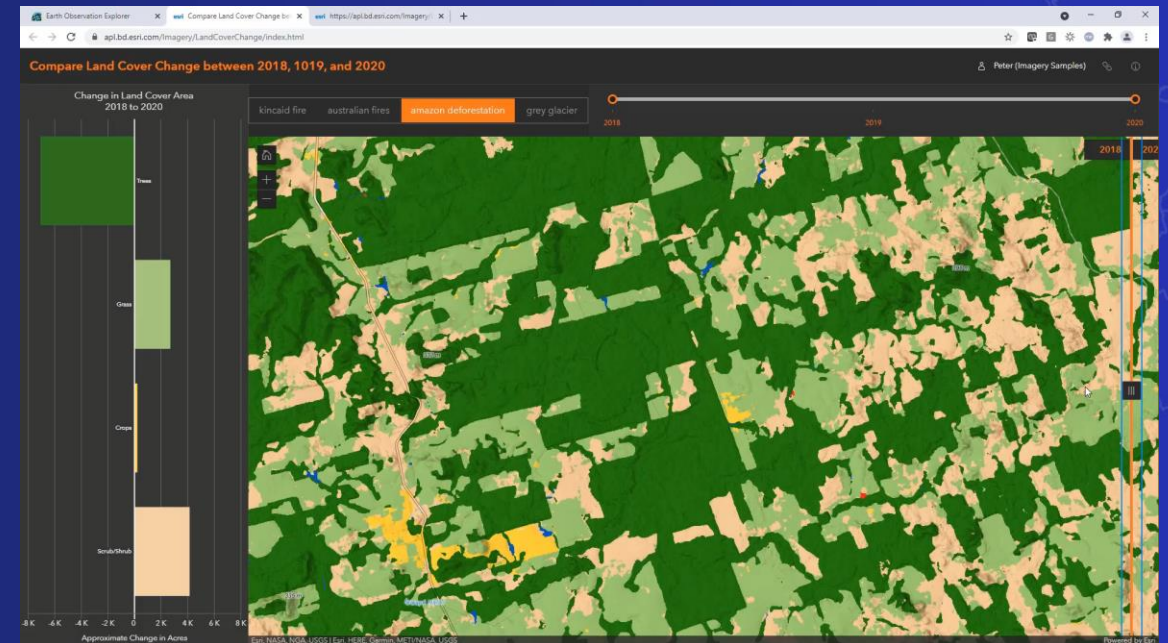


On-The-Fly Raster

Esri 10-Meter Land Cover

Global Land Cover to monitor the world

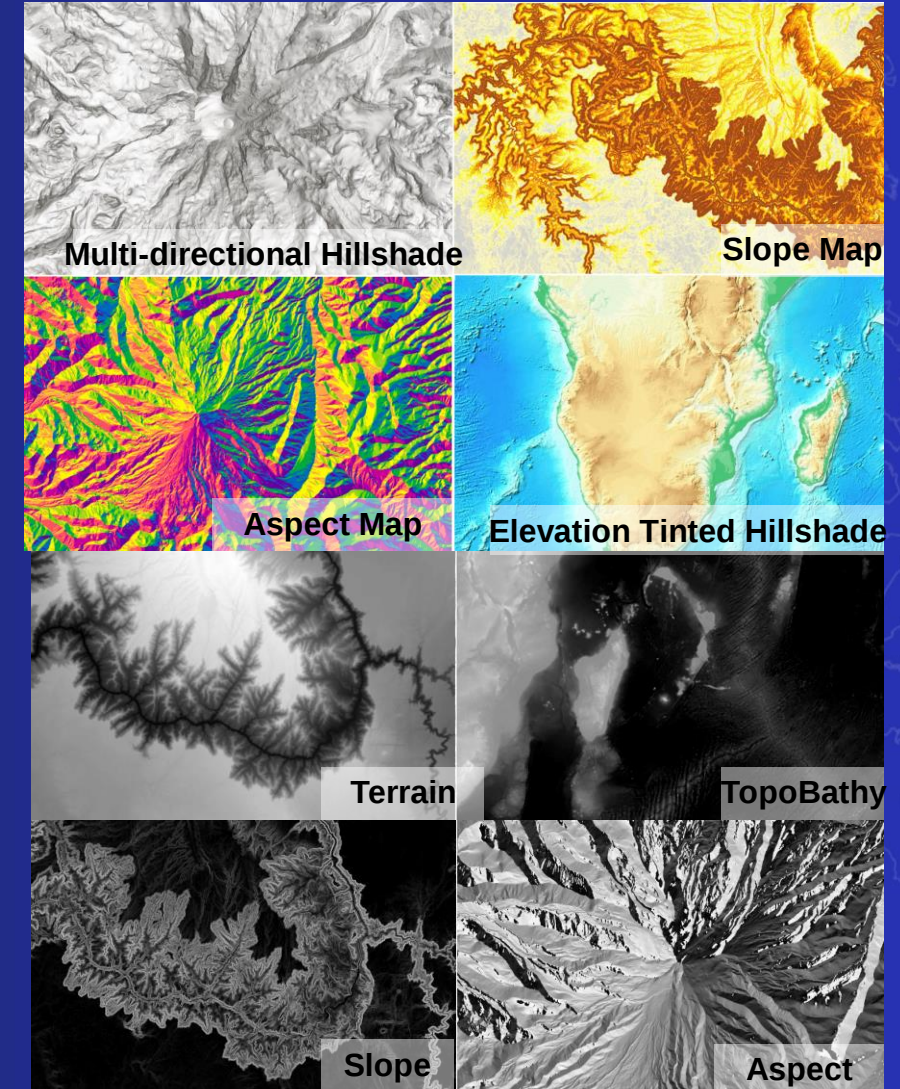
- Esri, Impact Observatory, and Microsoft
- Billions of human labeled training pixels
- Analysis of 2020 Sentinel 2 – 2A - Average 20 scenes / location



World Elevation (Terrain)

As Dynamic Image Services

- For visualization, analysis, orthorectification
- Global collection of multi-resolution & multi-source
 - 1000 meters to 0.25 meters
 - ~ 163,000 rasters (~ 6 TB, LERC compressed)
 - Terrain & TopoBathy
- Requires ArcGIS Online subscription
 - No credits



Many predefined raster functions

- [illegible]

Imagery & Remote Sensing Capabilities

Comprehensive Imagery System



Optimized Data Models

Manage all forms of imagery and rasters

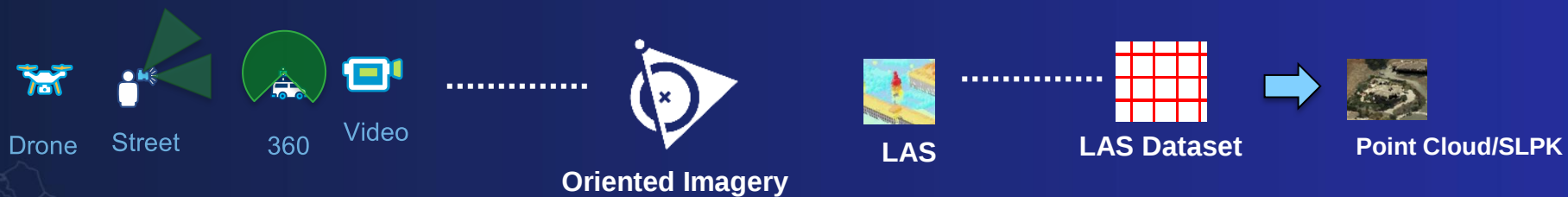
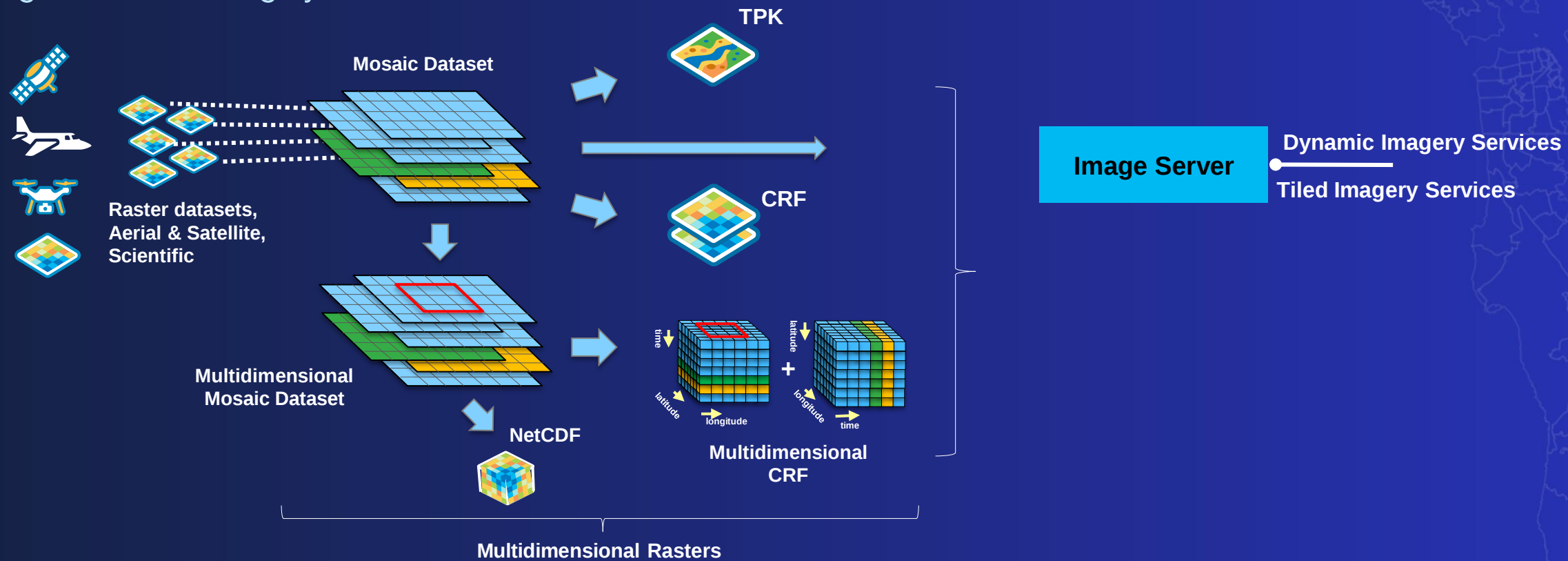
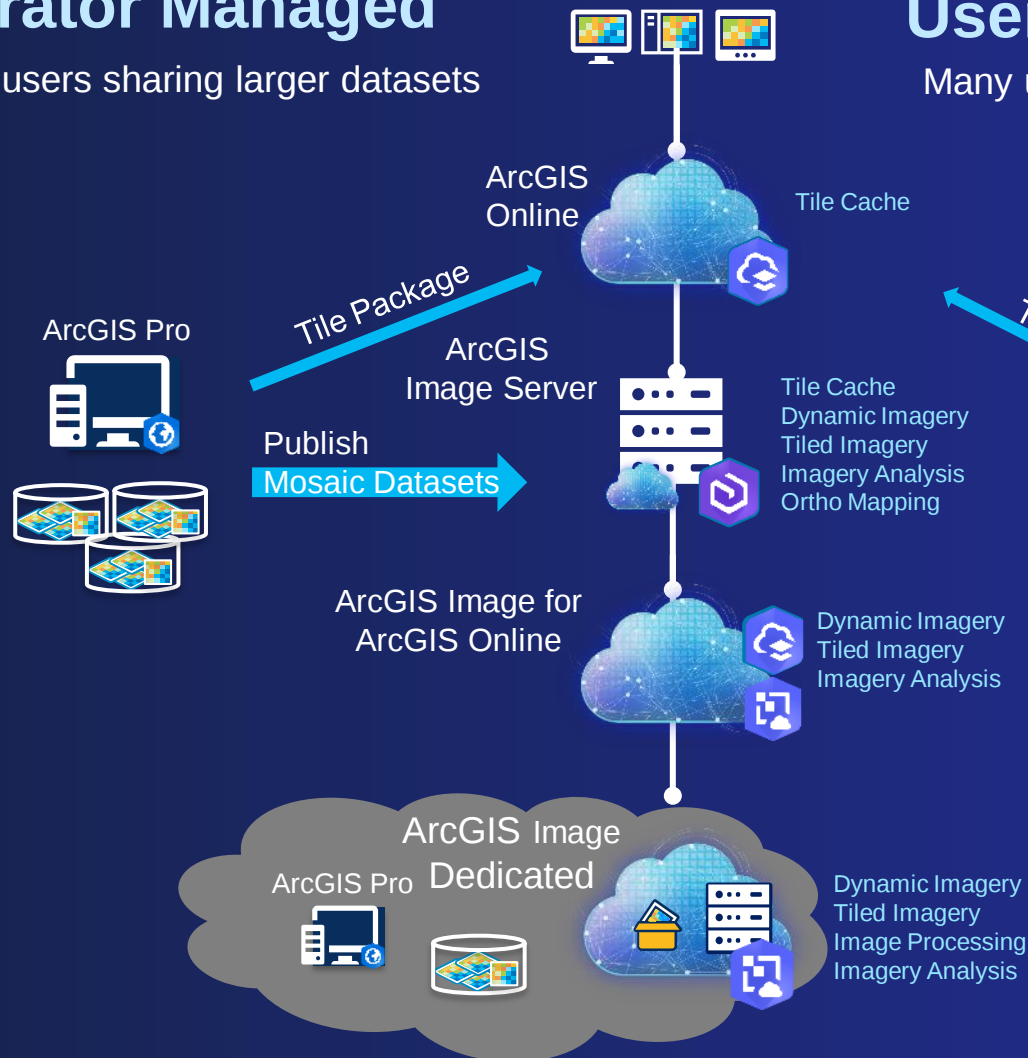


Image Management Methodologies

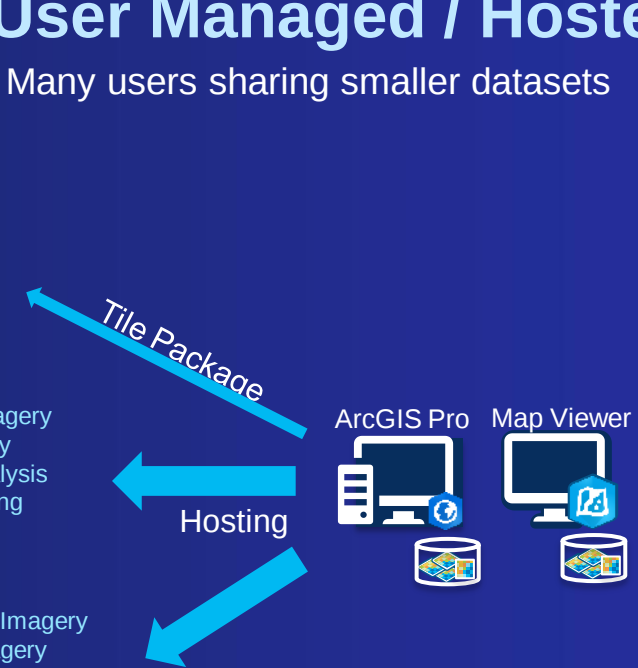
Curator Managed

Few users sharing larger datasets



User Managed / Hosted

Many users sharing smaller datasets



Imagery & Remote Sensing Capabilities

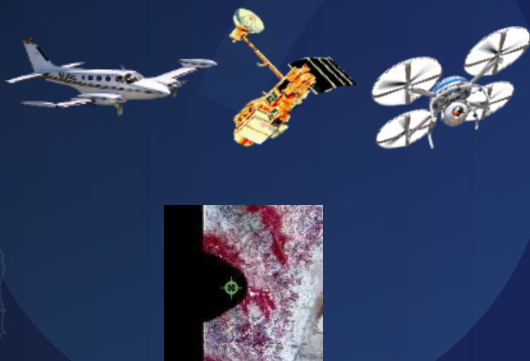
Comprehensive Imagery System



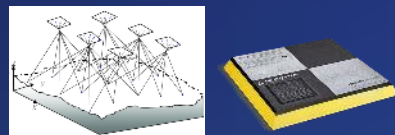
Image Mapping in ArcGIS

From sensor to accurate derived products

Data Capture



Aerial Triangulation & Block Adjustment



Product Creation



Feature Extraction & Editing



ArcGIS
Site Scan



ArcGIS
Drone2Map



Ortho Mapping



SURE
For ArcGIS

Aerial Triangulation & Block Adjustment

Robust, scalable, accurate photogrammetry

Imaging Modes



Nadir
Oblique

Supported Sensors

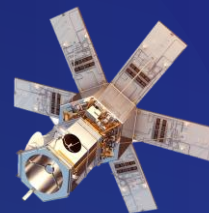
Satellite

Digital aerial

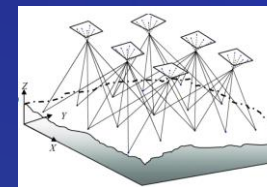
Scanned Film

Drone RGB & multispectral

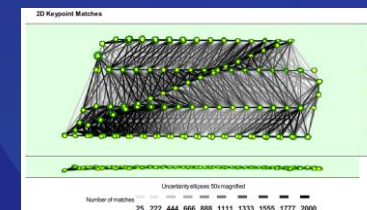
Drone thermal infrared



Calibration & Adjustment



Frame camera
self calibration

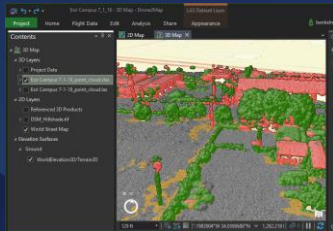


High performance
Improved accuracy

Creating Mapping Products

Maps from Imagery

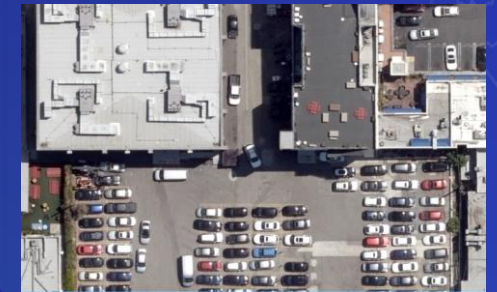
Photogrammetric Point Cloud



Dynamic Ortho Mosaic

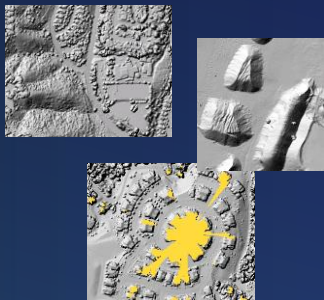


DTM (terrain) Ortho Mosaic



DSM (Surface) Ortho Mosaic

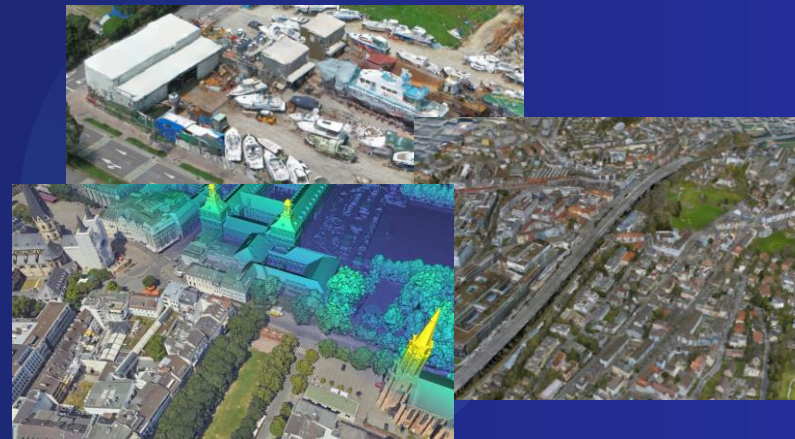
Digital Surface Model (DSM)



Digital Terrain Model (DTM)



3D Mesh



Feature Extraction & Editing

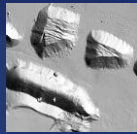
For further visualization and analysis



Oriented Imagery



Stereo models



Elevation models



Point Clouds



Orthomosaics

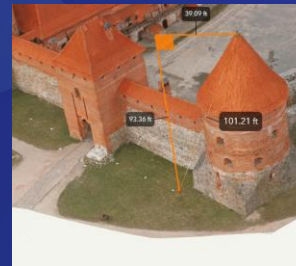


2.5D & 3D mesh

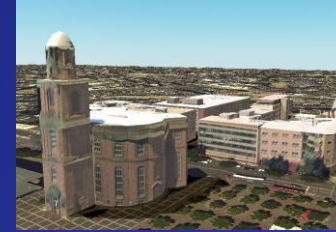
*Manual &
Automated tools*



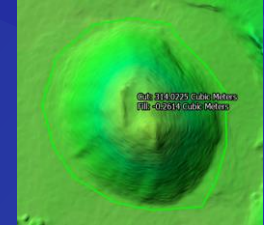
Building footprints



3D measurements



Façade mapping



Stockpile volumes



Pixel Editor



Classified point clouds



Powerlines



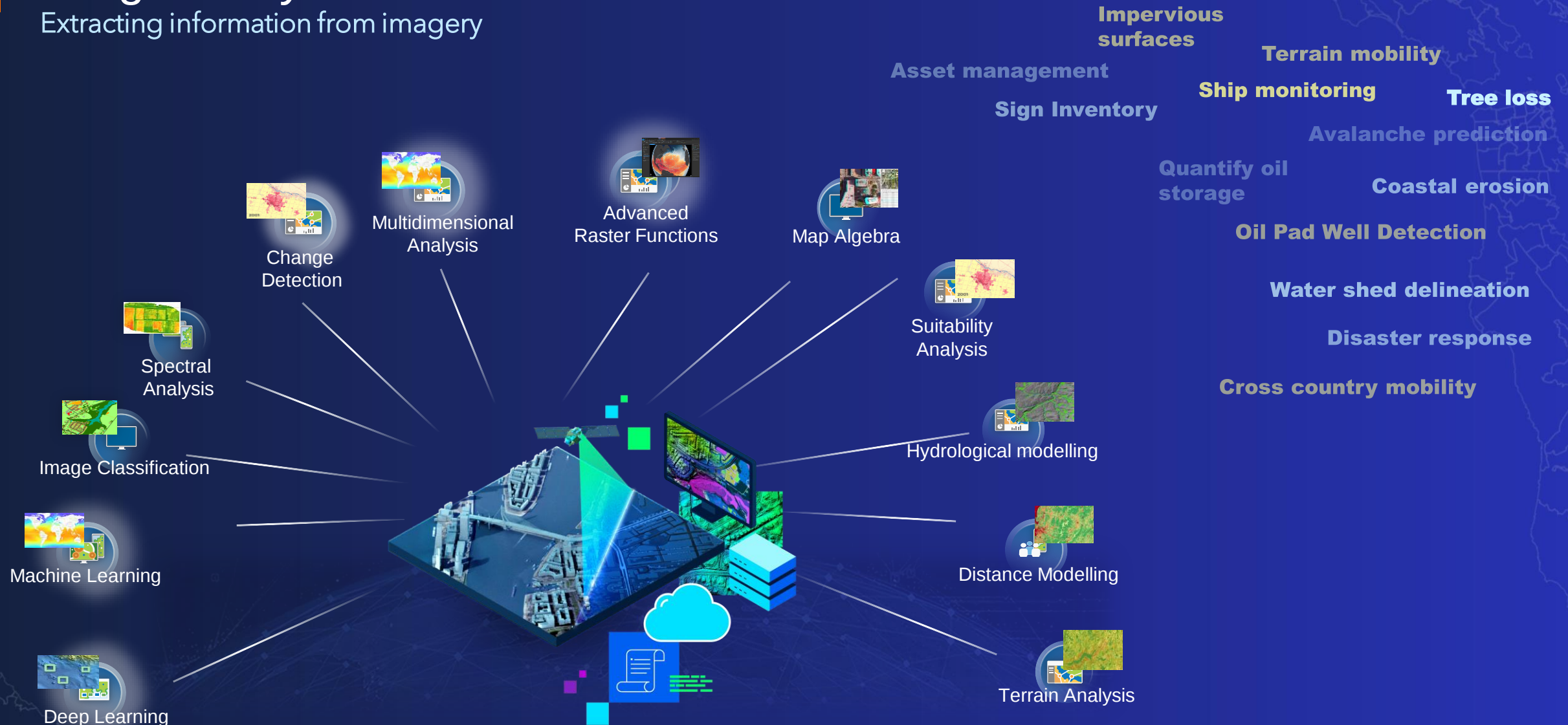
Imagery & Remote Sensing Capabilities

Comprehensive Imagery System



Image Analysis

Extracting information from imagery

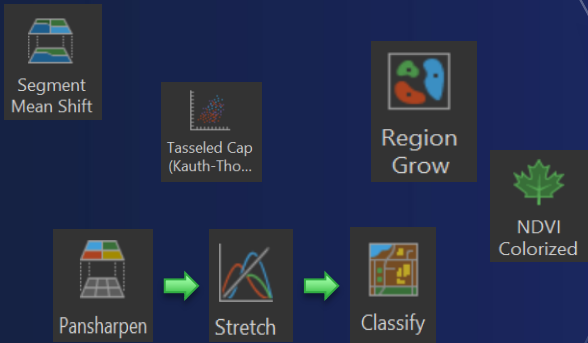


Finding Spatial Patterns

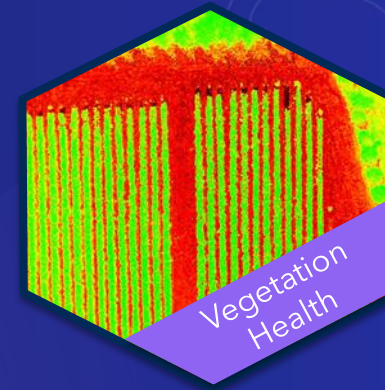
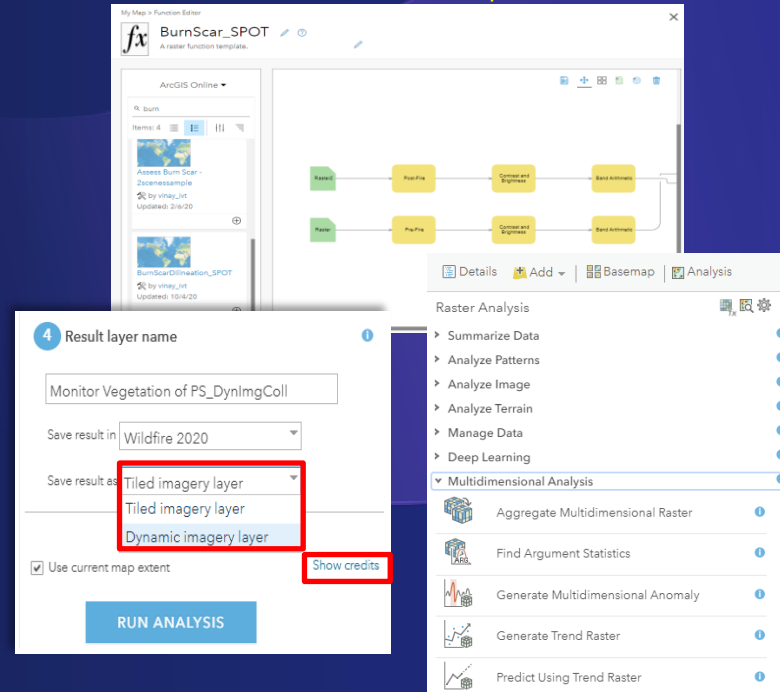
Extensive imagery analysis and raster analytics

Finding Spatial
Patterns

Raster Functions



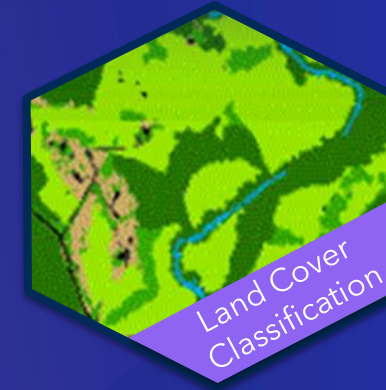
Raster Function Templates



Vegetation
Health



Impervious
Surfaces



Land Cover
Classification

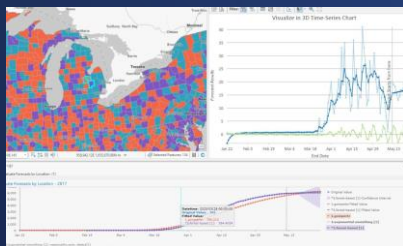


Change
Detection



Multidimensional Analysis

Across times, dimensions and variables



Space time pattern mining

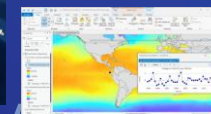
Features



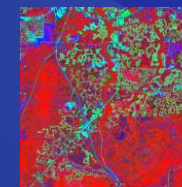
Multidimensional
Analysis



Trend
Analysis



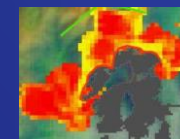
Anomaly
detection



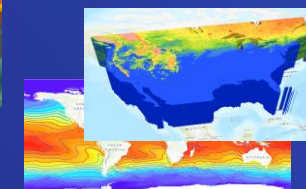
Spectral
unmixing



Predictive
analysis



Change
detection



Data
Aggregation

Imagery and
Rasters

Deep Learning

Information Extraction



Deep Learning in ArcGIS

Data Management



Labelling



Data Prep



Train Model



Inferencing



Derive Insights



Sharing



ArcGIS provides comprehensive deep learning workflows

For Wide Range of Data Types

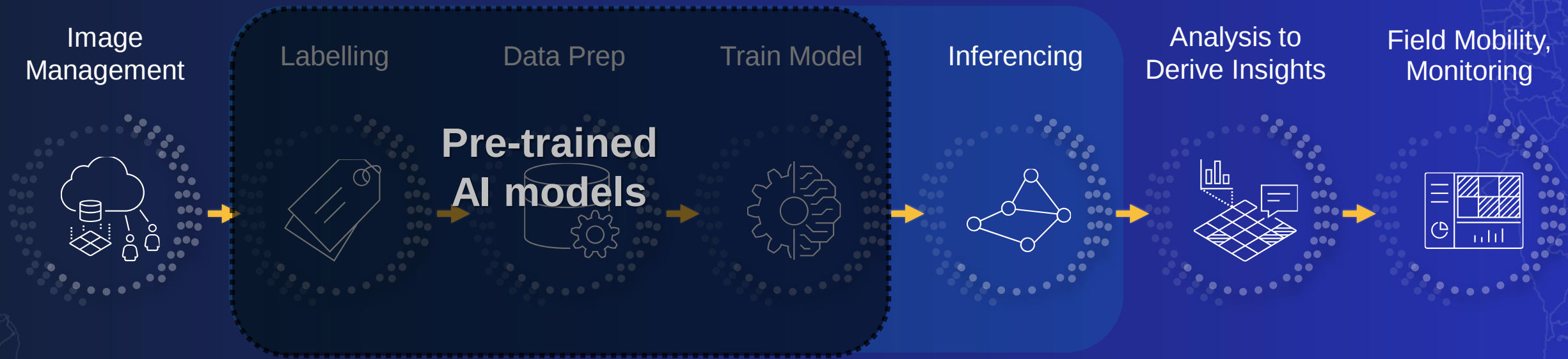
- Aerial
- Satellite
- Radar
- Text
- Lidar
- Features
- Motion Imagery
- Bathymetry
- Point Cloud
- Drone

Implementing Many Tasks

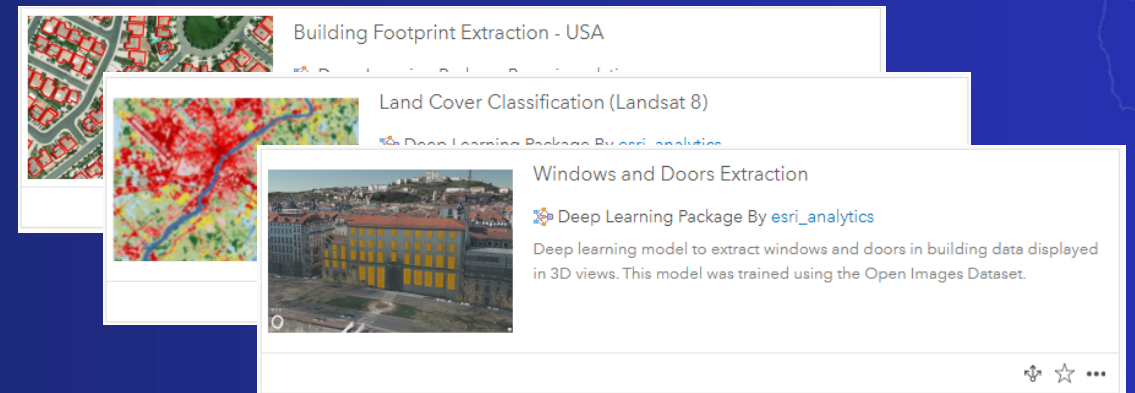
- Object Classification
- Object Detection
- Pixel Classification
- Image Translation
- Object Tracking
- Scanned Maps
- Feature processing
- Unstructured text processing

Deep Learning in ArcGIS

Pre-trained models



- Eliminates:
 - Imagery requirements for model training
 - Labelling requirements
 - Training AI models
 - Massive compute requirements



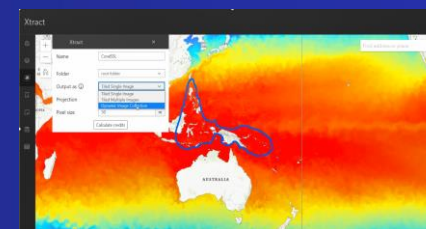
Raster Analytics in ArcGIS Online

ArcGIS Image for ArcGIS Online



ArcGIS Image for ArcGIS Online

- 150 + raster functions
- 27 Ready-to-use tools
- Deep learning tools
- Raster function editor
- Server and client-side processing
- Supports tiled and dynamic layers
- Can output tiled and dynamic layers



Xtract

Extract subset of the living Atlas to ArcGIS Image for ArcGIS Online

Imagery & Remote Sensing Capabilities

Comprehensive Imagery System



Image Visualization & Exploitation

Enabling human interpretation of imagery & rasters



Motion Imagery



Image Space



ArcGIS Excalibur



Operations apps



ArcGIS API for JavaScript



Configurable app templates



Web AppBuilder &
Experience Builder



Oriented Imagery



Make informed decisions

User experiences designed for your imagery
Visualize & share imagery on desktop or the web
Use imagery to share your story

Moving target tracking

Agricultural assessment

Natural disaster response

forensic video review

Property inspection

Digitizing roads

Imagery search & discovery

Pipeline inspection

Construction monitoring

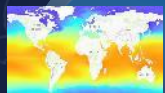
Dynamic reporting

Damage assessment

Structured observation
management



Stereo Imagery



Multidimensional Data

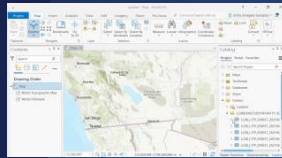


ArcGIS Pro

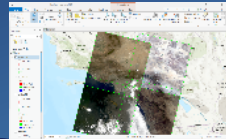
Visualization & Exploitation in ArcGIS Pro

User experiences designed to make sense of your imagery

Raster products & raster types

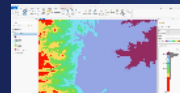


Band combinations



RGB

Rendering



Stretch



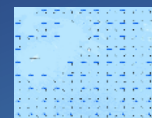
DRA



Resampling



Classify



Vector field



Location info

Pixel-level data

Raster functions

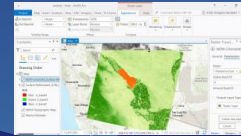
Function chains



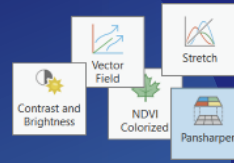
Metadata



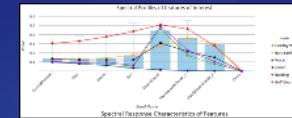
Enhancements



On-the-fly processing



Spectral profiles



Charts

Change over time



Image scatterplot

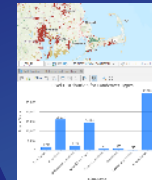
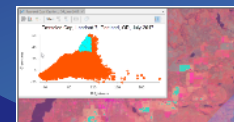


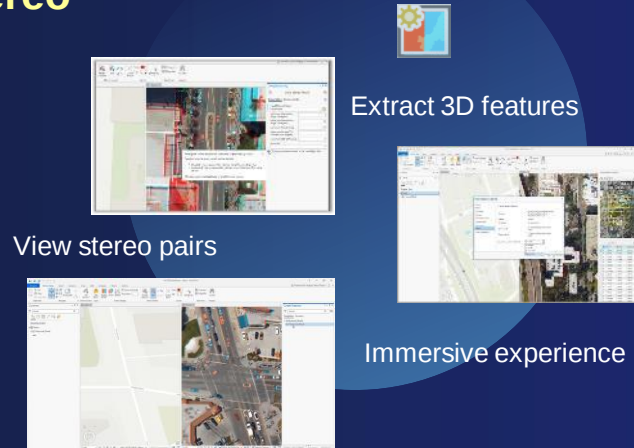
Image histogram



Visualization & Exploitation with ArcGIS Image Analyst

User experiences designed to make sense of your imagery

Stereo



Motion imagery

Livestream or recorded video

Quickly report findings

Intuitive video player



Multidimensional data

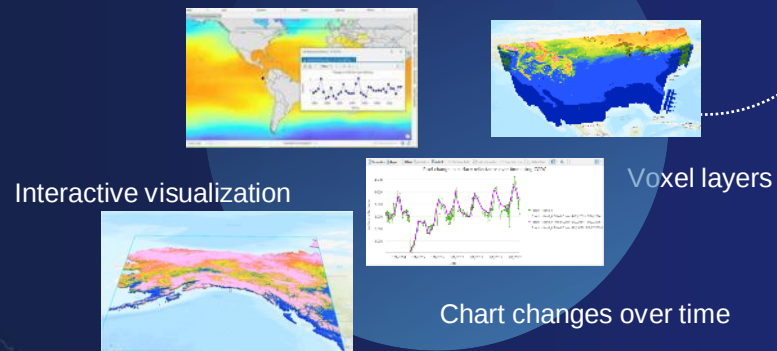
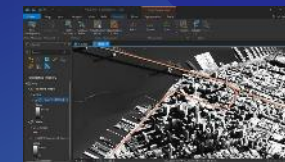


Image space

Sensor's perspective

Overlay features



Building Apps for Imagery

No Code or Low Code

- **ArcGIS Instant Apps**
 - Imagery Viewer template—Create apps to explore collections of imagery through time and space
 - Image Mask and Image Visit (Map Viewer classic only)
- **ArcGIS Experience Builder**
 - Build multimodal apps to tell stories with your imagery
 - Oriented Imagery widget
- **ArcGIS Web AppBuilder**
 - WABIS—Add-in imagery widgets for Developer Edition



Oriented Imagery

Access imagery at any angle for any location



Pick a location to view the best available imagery.

All forms of non-nadir imagery

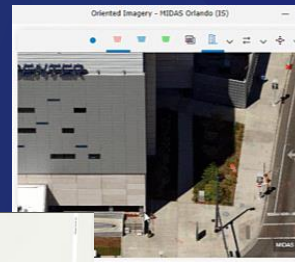
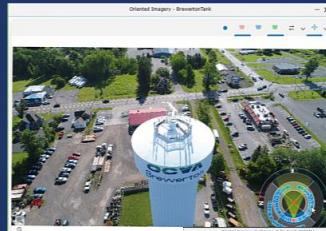


Easy-to-use



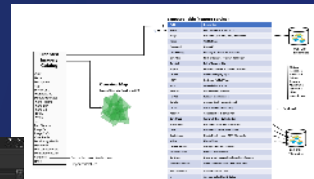
Web Apps

View asset from multiple directions



Measurement

Feature Collection



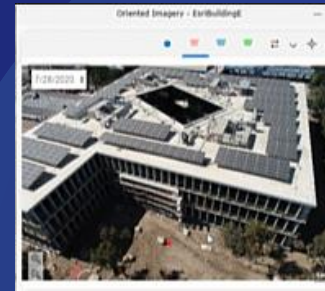
Lightweight Data Model

Feature superposition



ArcGIS Pro

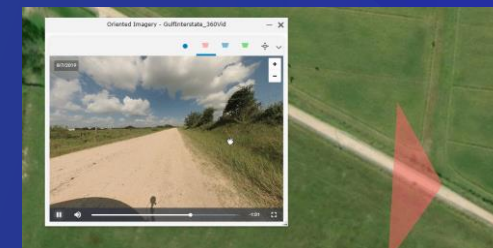
Geospatial Video Image type



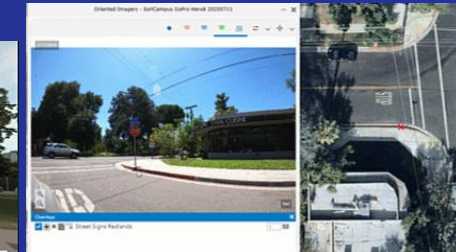
Time Selector



3D Superimpose view



360-degree video



Label collection

Updated UI/UX

Experience Builder widget

QuickCapture Integration

Imagery & Remote Sensing Capabilities

Comprehensive Imagery System





Resources



Ready-to-use Imagery and Apps

- ArcGIS Living Atlas
- Imagery Explorer apps

Check out a tutorial for working with image services in ArcGIS Pro:
esriurl.com/ImageServiceTutorial

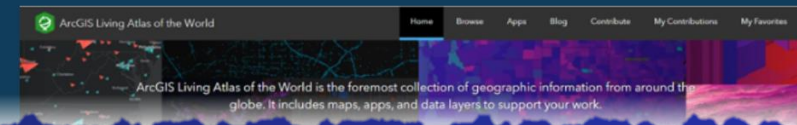
Ready-to-use imagery and apps

Learn about Esri's ready-to-use resources for imagery, including massive collections of data and demo web apps

Imagery Workflows team | February 23, 2021

Massive imagery collections | Imagery web apps

Massive imagery collections



<https://esriurl.com/ImageryContentApps>

Build Your Own Imagery Apps

Configurable apps for imagery

1. Build a web map with imagery
2. Share it as a web app
3. Configure the app's tools and options
4. Publish and share

Imagery Viewer

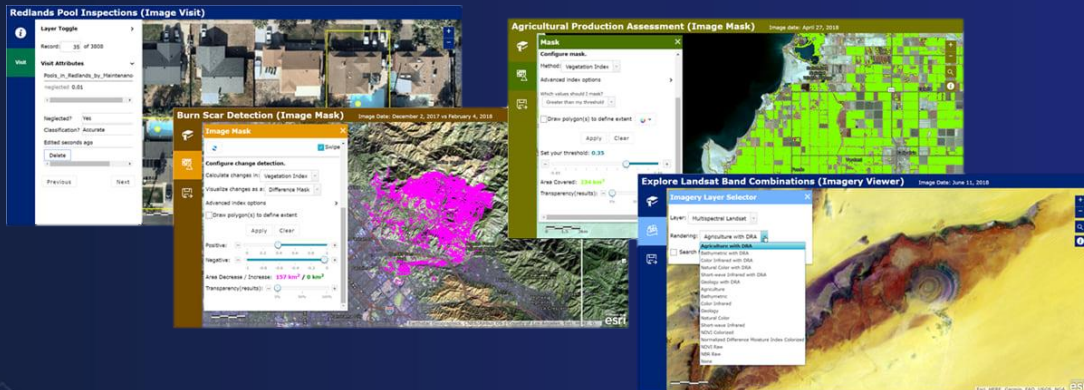
Visualize imagery through time and space

Image Mask

Highlight change between two images or areas that meet a user-defined threshold

Image Visit

Review the attributes of a predetermined sequence of locations in imagery

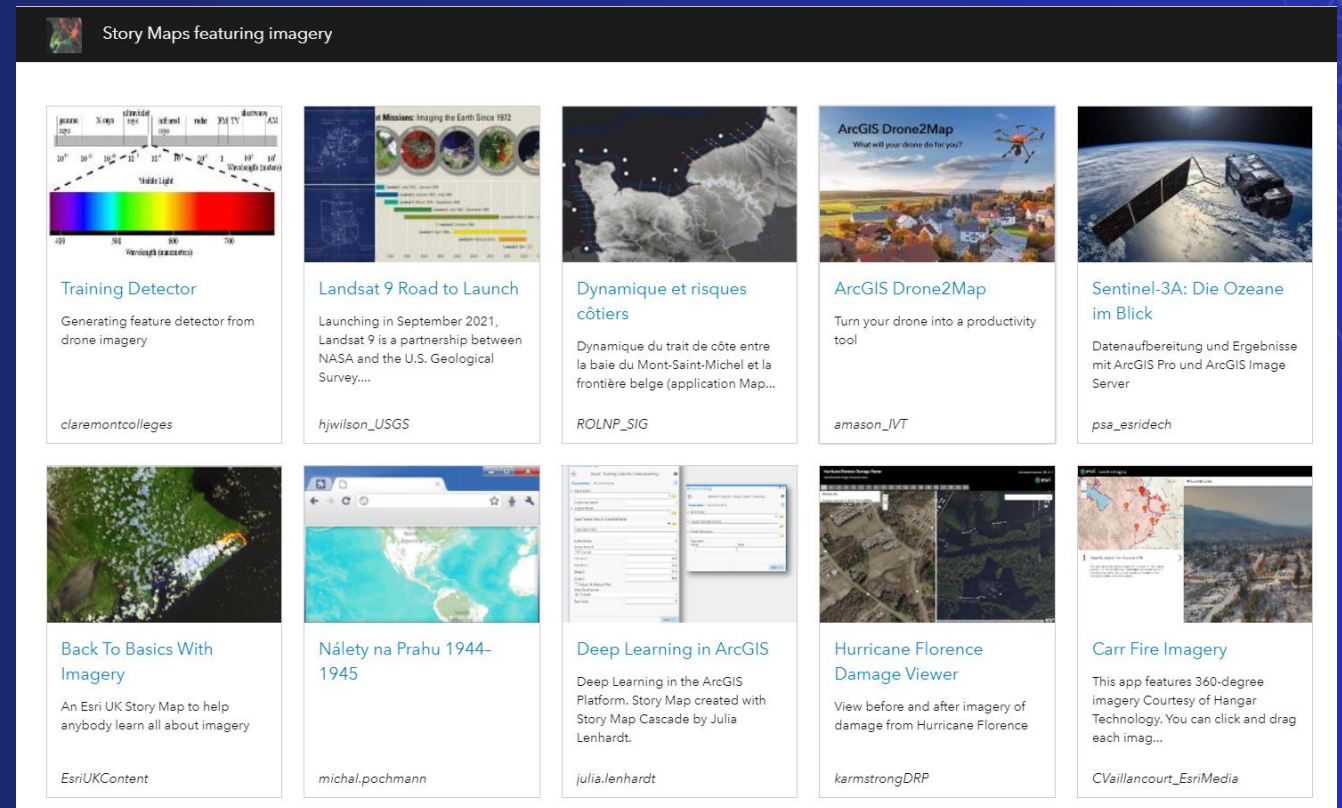


<https://esriurl.com/BuildImageryApp>

Story Maps Featuring Imagery

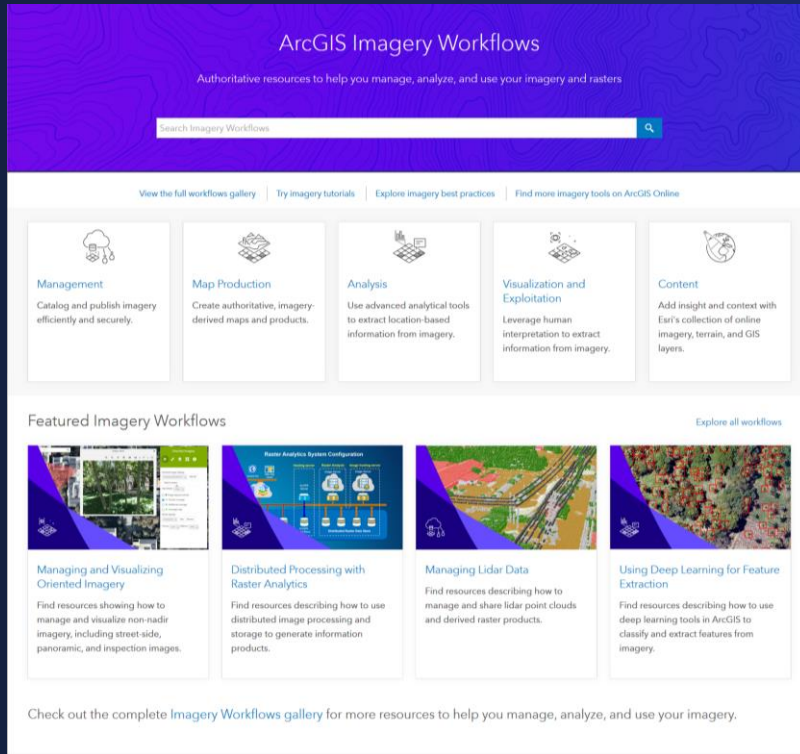
Story maps

- Powerful way to tell stories about imagery
- Use imagery to tell powerful stories



esriurl.com/ImageryStoryMaps

ArcGIS Imagery Workflows



esriurl.com/ImageryWorkflows/

Workflows

Managing and Visualizing Oriented Imagery
Using Deep Learning for Feature Extraction
Analyzing Multidimensional Data
Site Suitability Analysis
Performing Image Classification
Visualizing Spectral Indices
Analyzing Imagery Using Raster Functions
Exploiting Imagery in Image Space
Visualizing Stereo Imagery
Visualizing Full Motion Video
Visualizing and Exploiting Lidar and Elevation
Distributed Processing with Raster Analytics
Using Mosaic Datasets to Manage Imagery
Serving Cached Imagery
Managing Browse Imagery
Managing Drone Imagery
Managing Elevation
Managing Lidar Data
Managing Frame Camera Imagery
Managing High-Resolution Satellite Imagery
Managing Medium-Resolution Satellite Imagery
Managing Multidimensional Data
Managing Scanned Maps
Managing Preprocessed Orthophotos
Creating Drone Imagery Products with ArcGIS Drone2Map
Creating Drone Imagery Products with Ortho Mapping
Creating Scanned Aerial Imagery Products with Ortho Mapping
Creating Satellite Imagery Products with Ortho Mapping
Creating Digital Aerial Imagery Products with Ortho Mapping

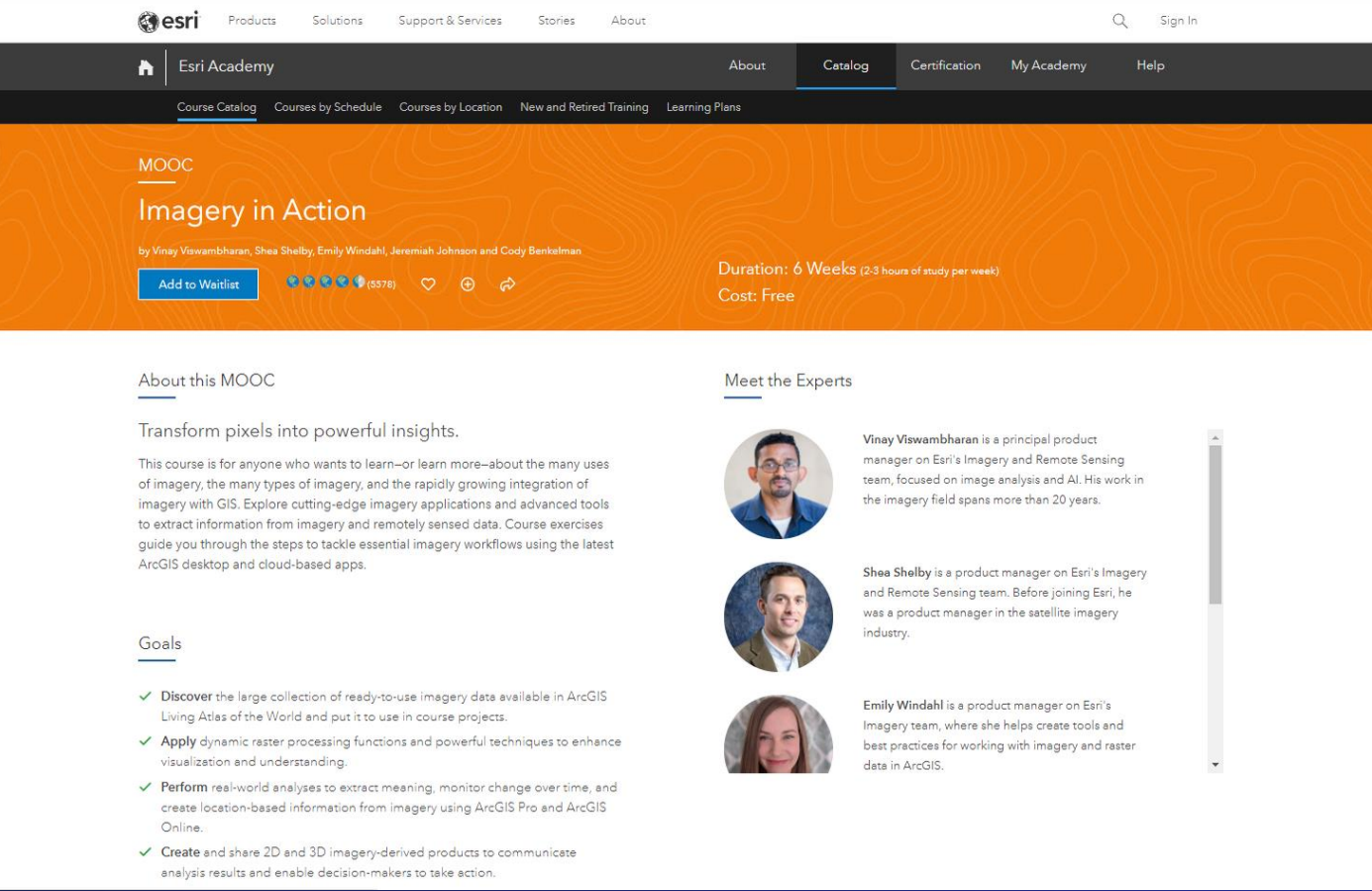
Tutorials

Creating an oriented imagery catalog
Creating an Image Visit configurable app
Working with the Full Motion Video player
Add features to your video in FMV
Using the FMV Video Multiplexer
Getting started with raster functions in ArcGIS Pro
Multidimensional raster analysis in ArcGIS Pro
Work with image services in ArcGIS Pro
Create drone imagery products in ArcGIS Pro
Create scanned aerial imagery products in ArcGIS Pro
Create satellite imagery products in ArcGIS Pro

Best Practices

Structuring and formatting imagery and rasters
Creating and maintaining mosaic datasets
Working with imagery in the cloud
Managing aerial lidar data
Managing multidimensional data
Ortho mapping in ArcGIS Pro – Scanned aerial imagery

Imagery in Action - MOOC



The screenshot shows the Esri Academy website with a dark blue header and a white navigation bar. The main content area has an orange background with a topographic map pattern. The MOOC title 'Imagery in Action' is prominently displayed in white. Below the title, the instructors' names are listed, followed by a blue 'Add to Waitlist' button and social media share icons. To the right, the duration and cost are specified. The page is divided into three main sections: 'About this MOOC', 'Goals', and 'Meet the Experts'. The 'About' section describes the course's focus on GIS and imagery. The 'Goals' section lists four objectives with green checkmarks. The 'Meet the Experts' section features three circular portraits of the instructors with their names and roles.

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Esri Academy About Catalog Certification My Academy Help

Course Catalog Courses by Schedule Courses by Location New and Retired Training Learning Plans

MOOC

Imagery in Action

by Vinay Viswambharan, Shea Shelby, Emily Windahl, Jeremiah Johnson and Cody Benkelman

[Add to Waitlist](#)     (5378)   

Duration: 6 Weeks (2-3 hours of study per week)
Cost: Free

About this MOOC

Transform pixels into powerful insights.

This course is for anyone who wants to learn—or learn more—about the many uses of imagery, the many types of imagery, and the rapidly growing integration of imagery with GIS. Explore cutting-edge imagery applications and advanced tools to extract information from imagery and remotely sensed data. Course exercises guide you through the steps to tackle essential imagery workflows using the latest ArcGIS desktop and cloud-based apps.

Goals

- ✓ **Discover** the large collection of ready-to-use imagery data available in ArcGIS Living Atlas of the World and put it to use in course projects.
- ✓ **Apply** dynamic raster processing functions and powerful techniques to enhance visualization and understanding.
- ✓ **Perform** real-world analyses to extract meaning, monitor change over time, and create location-based information from imagery using ArcGIS Pro and ArcGIS Online.
- ✓ **Create** and share 2D and 3D imagery-derived products to communicate analysis results and enable decision-makers to take action.

Meet the Experts

 **Vinay Viswambharan** is a principal product manager on Esri's Imagery and Remote Sensing team, focused on image analysis and AI. His work in the imagery field spans more than 20 years.

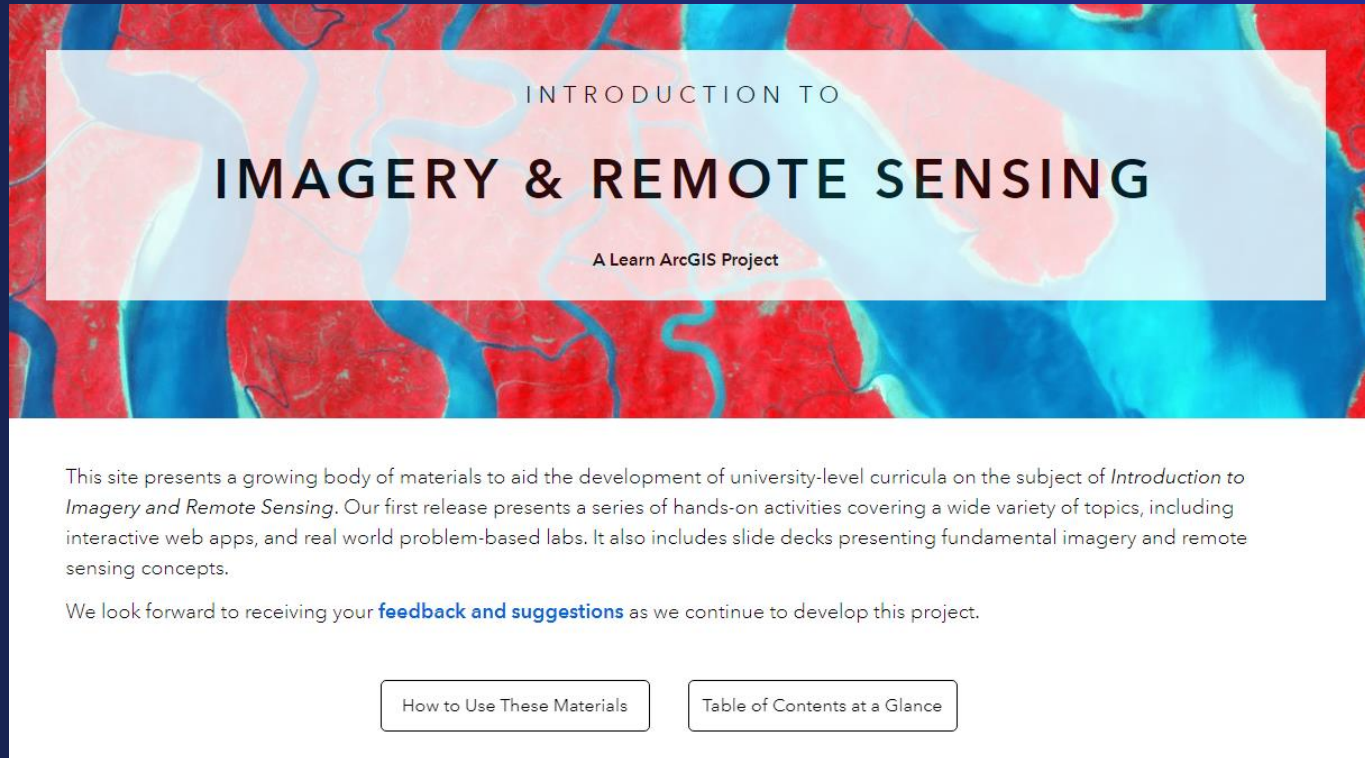
 **Shea Shelby** is a product manager on Esri's Imagery and Remote Sensing team. Before joining Esri, he was a product manager in the satellite imagery industry.

 **Emily Windahl** is a product manager on Esri's Imagery team, where she helps create tools and best practices for working with imagery and raster data in ArcGIS.

<https://www.esri.com/training/mooc/>

Introduction to Imagery and Remote Sensing

A new learning package



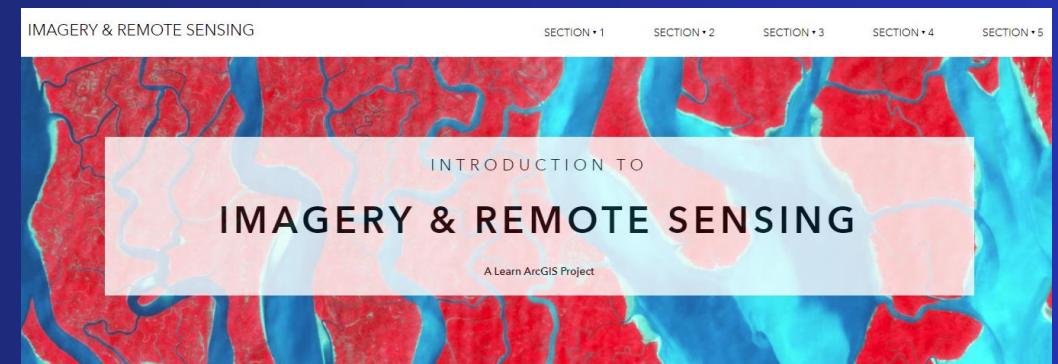
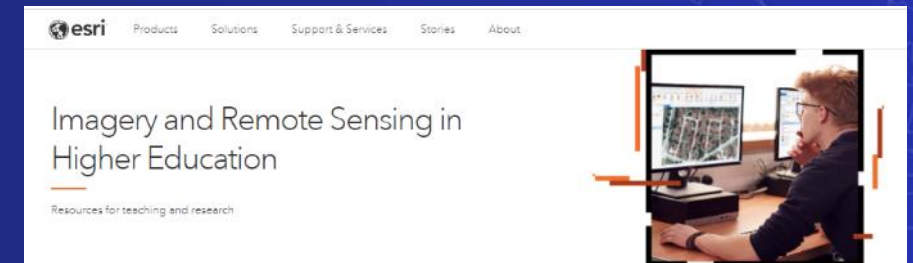
<https://introduction-to-remote-sensing-learngis.hub.arcgis.com>

Resources

Imagery & Remote Sensing

We will send all the list of resources:

- Imagery Workflows:
 - [Imagery Workflows](#)
 - [ArcGIS Living Atlas – Imagery content](#)
 - [Earth Observation Explorer app](#)
 - [Gallery of imagery apps from Esri](#)
 - [Ready-to-use imagery and apps \(StoryMap\)](#)
 - [Build a web app with imagery \(StoryMap\)](#)
- Educational Resources:
 - [Materials to aid the development of university-level curricula](#)
 - [Imagery in Action MOOC \(check next offering\)](#)
- Webpages:
 - [Imagery and Remote Sensing in Higher Education](#)
 - [Imagery & Remote Sensing product page](#)



Upcoming Events

- Esri Webinar on Manage Imagery and Rasters for Campus Access - Dec 2
- Esri - AAG webinar on Equity - GIS Day (Nov 17)
- Esri at AAG 2022 NYC Annual Meeting - Feb 25

WEBINAR

EXPLORING COMMUNITIES THROUGH AN EQUITY LENS

November 17, 2021
10:00 AM - 11:00 AM (PT)

REGISTER NOW



 **esri**
THE SCIENCE OF WHERE®

 **AAG**
AMERICAN ASSOCIATION
OF GEOGRAPHERS

<https://go.esri.com/equity-lens-webinar>

WEBINAR

MANAGE IMAGERY AND RASTERS FOR CAMPUS ACCESS

December 2, 2021
10:00 AM (PT)

REGISTER NOW



Thank you and please fill in the exit survey



To connect, please reach out to Canserina at:

ckurnia@esri.com