



*Public Works*

LOS ANGELES COUNTY

# Using Esri Deep Learning Algorithms to Create Land Cover 2.0

May 16, 2023

Christine Lam  
GIS Manager

Survey/Mapping & Property Management Division

# Background

- Land Cover 1.0 was produced for us (LARIAC4) by University of Vermont
- Used eCognition
- Advantages:
  - First of its kind in Los Angeles, a complex urban environment
- Disadvantages:
  - Cannot replicate work
  - Limited classes

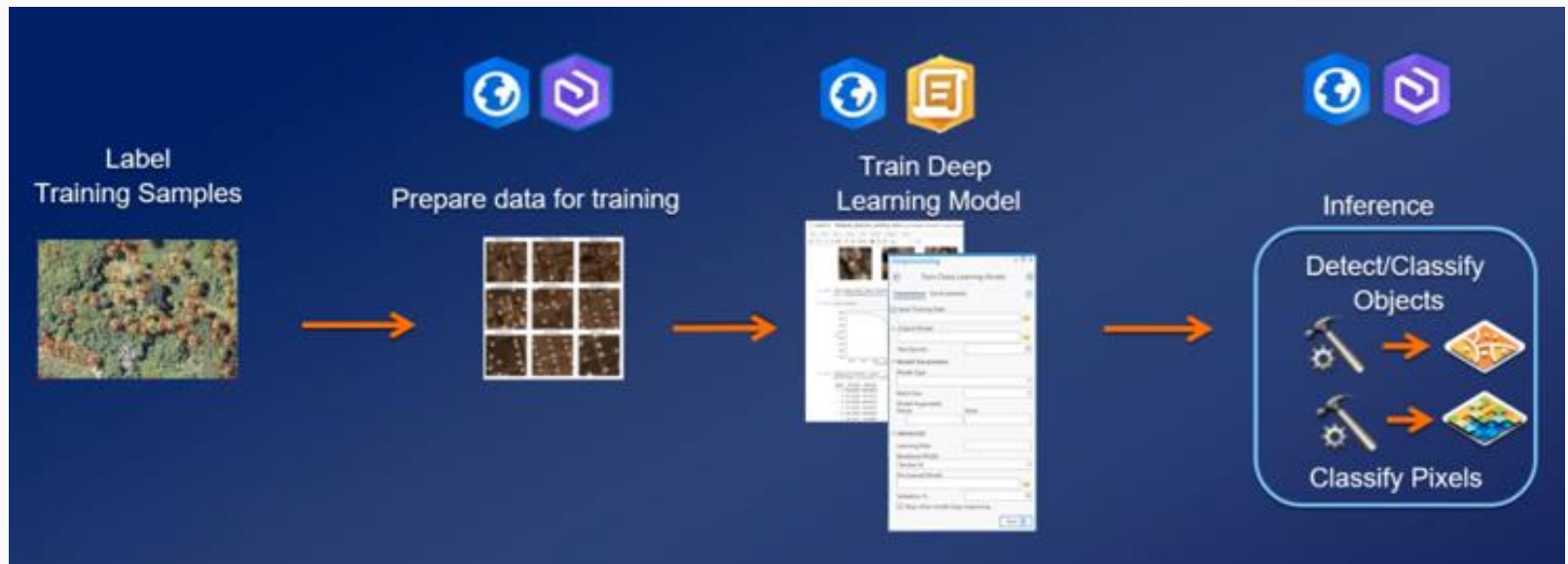


# Goals

- PW Stormwater Planning Division wants to update the parcel-based assessment fee for Measure W
  - The calculated tax is based upon the parcel's impermeable area as determined by the County Landcover Survey or other applicable tool.
- Create a parcel fee change report
- Modify and include additional classes
- Have control over the deep learning algorithms

# New Methodology for Land Cover 2.0

- Deep learning with imagery in ArcGIS Pro



Source: Esri

End-to-end process from raw imagery to structured information products

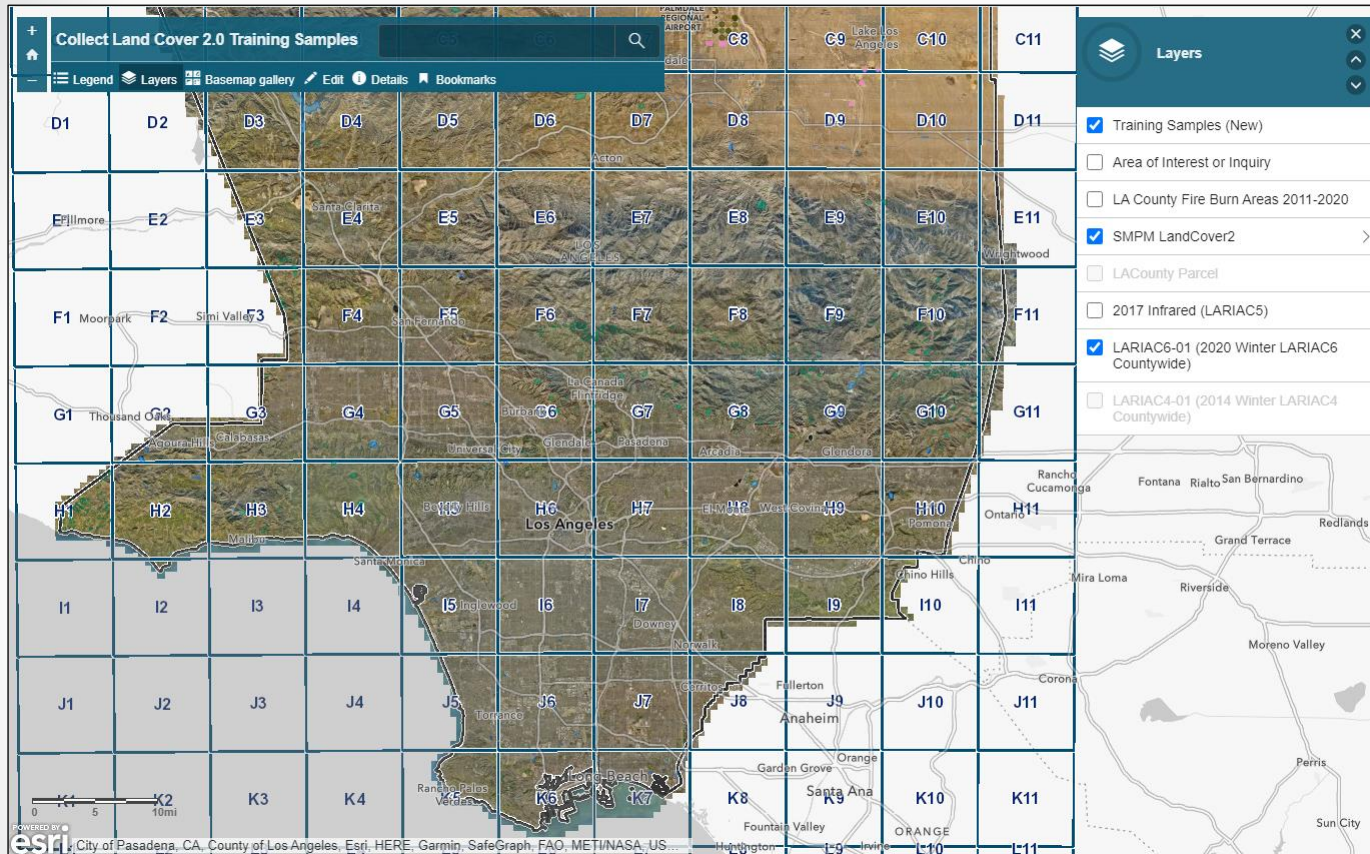
# Data Inventory

- **LARIAC4 Land Cover (2016)**
- **LARIAC5 Imagery (2017): 4-inch, 4 band RGB-IR ortho**
- LARIAC5 Building outlines (2017)
- CAMS street centerlines
- Parcels with appeals (e.g. gravel)

# Land Cover Classes

- Tree Canopy
  - Grass/Shrubs
  - Tall Shrubs
  - Bare Soil
  - Water
  - Buildings
  - Roads/Railroads
  - Other Paved
- Wish List
    - Pools
    - Gravel

# Collect Land Cover 2.0 Training Samples Web App



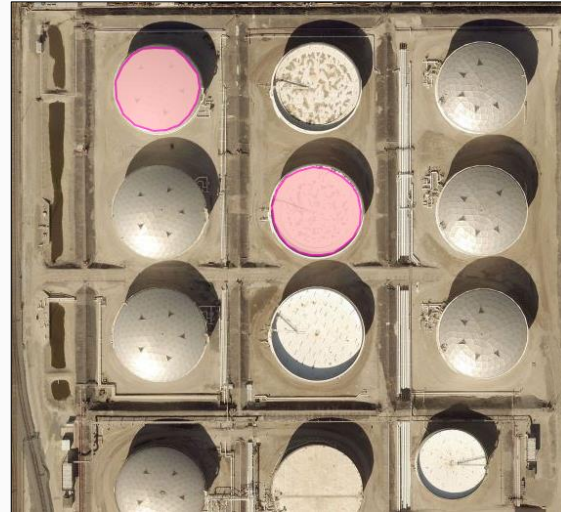
## Training Samples (New)

-  Water Bodies
-  Pools/Fountains
-  Urban Grass/Shrubs
-  Rural Shrubland
-  Tree Canopy
-  Other Paved
-  Bare Soil
-  Gravel

Not included:

Buildings  
Roads/railroads

# Create Training Polygons





# Training Polygon Counts

## Classname

### Summary

Top 10 Values	Count
Urban Grass/Shrubs	1354
Rural Shrubland	1335
Tree Canopy	1316
Other Paved	1303
Transportation	1277
Buildings	1142
Bare Soil	1064
Snow	950
Pools/Fountains	838
Gravel	441

**Total Features: 11,398**

# Geoprocessing Tools in ArcGIS Pro

- Export Training Data for Deep Learning to create image chips



The screenshot shows the 'Export Training Data For Deep Learning' tool interface. The title bar indicates the tool is completed. The 'Parameters' tab is active, displaying a list of tool settings.

**Export Training Data For Deep Learning**  
(Image Analyst Tools)

**Started:** Wednesday, September 8, 2021 at 8:23:45 AM  
**Completed:** Thursday, September 9, 2021 at 11:31:17 PM  
**Elapsed Time:** 1 Day 15 Hours 7 Minutes 32 Seconds

**Parameters** Environments Messages

Input Raster	Countywide
Output Folder	E:\Land_Cover_Working \Export_Training_20210908v5
Input Feature Class Or Classified Raster Or Table	TrainingSamples_Vin
Image Format	TIFF
Tile Size X	512
Tile Size Y	512
Stride X	256
Stride Y	256
Output No Feature Tiles	ONLY_TILES_WITH_FEATURES
Metadata Format	Classified_Tiles
Start Index	0
Class Value Field	Classvalue
Buffer Radius	0
Input Mask Polygons	
Rotation Angle	0
Reference System	MAP_SPACE
Processing Mode	PROCESS_AS_MOSAICKED_IMAGE
Blacken Around Feature	NO_BLACKEN
Crop Mode	FIXED_SIZE
Additional Input Raster	

# Geoprocessing Tools in ArcGIS Pro

- Train Deep Learning Model

The screenshot shows the 'Train Deep Learning Model' tool interface in ArcGIS Pro. The tool is titled 'Train Deep Learning Model' and has a 'Pending edits.' status bar. The 'Parameters' tab is active, showing the following settings:

- Input Training Data:** Export\_Training\_20210908v5
- Output Model:** Deep\_Learning\_v3
- Max Epochs:** 20
- Model Parameters:**
  - Model Type:** U-Net (Pixel classification)
  - Batch Size:** 2
- Model Arguments:**

Name	Value
class_balancing	False
mixup	False
focal_loss	False
ignore_classes	
chip_size	224

At the bottom, there is a link to '> Advanced'.

# Geoprocessing Tools in ArcGIS Pro

- Classify Pixels Using Deep Learning

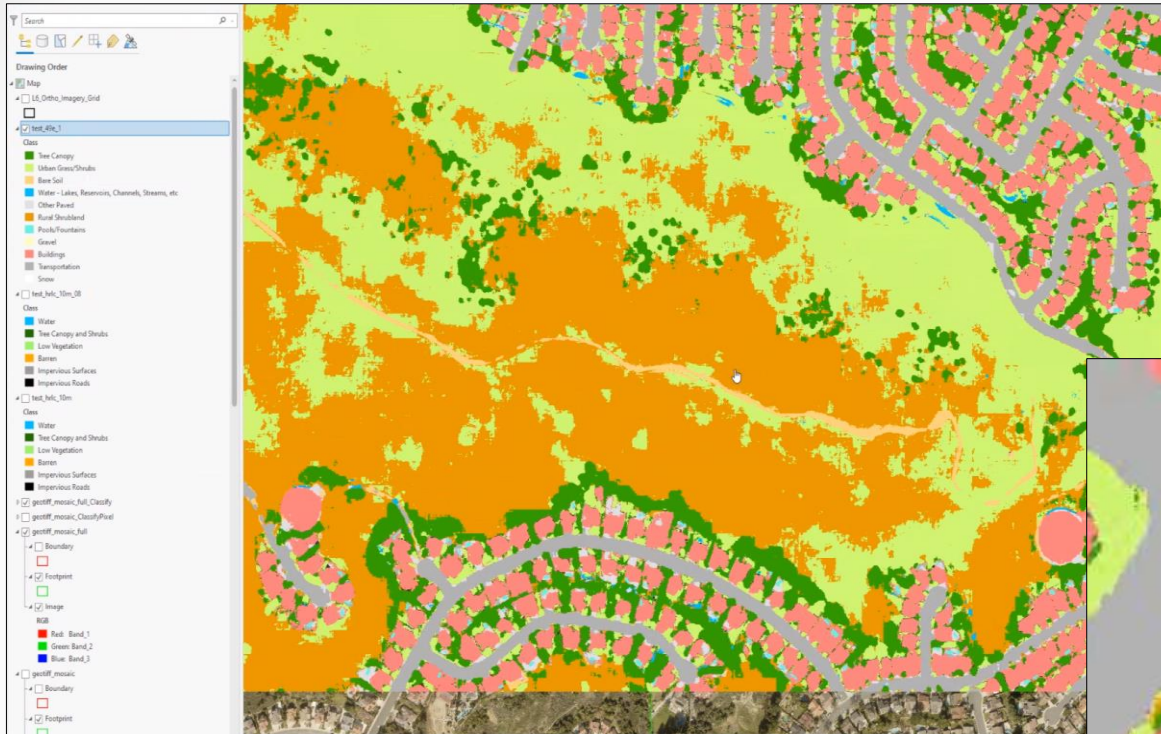
The screenshot shows the 'Classify Pixels Using Deep Learning' tool interface in ArcGIS Pro. The tool is titled 'Classify Pixels Using Deep Learning' and has two tabs: 'Parameters' (selected) and 'Environments'. The 'Parameters' tab contains the following fields:

- Input Raster:** A dropdown menu showing 'Imagery'.
- Output Classified Raster:** A text field containing 'predicted\_Jargearea'.
- Model Definition:** A text field containing the file path 'C:\Esri\_project\Edge\_detection\_Ready\_to\_use\_model\data\_for\_ec'.

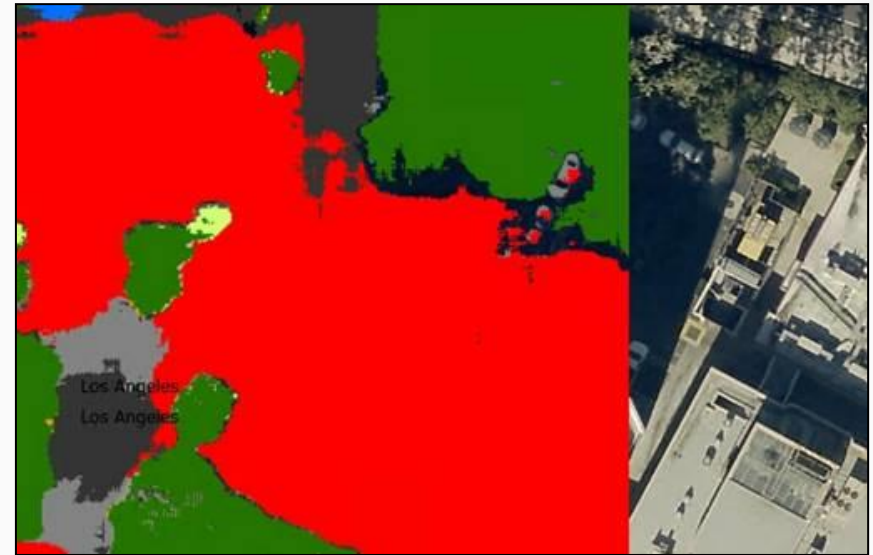
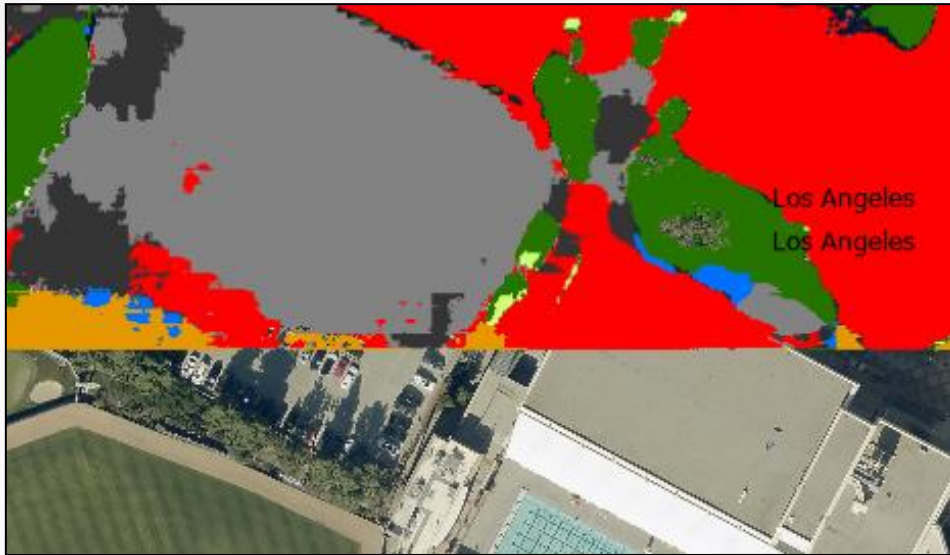
Below the parameters is an 'Arguments' section with a table:

Name	Value
padding	56
batch_size	4
thinning	False

# Initial Results for Pixel-based Classification

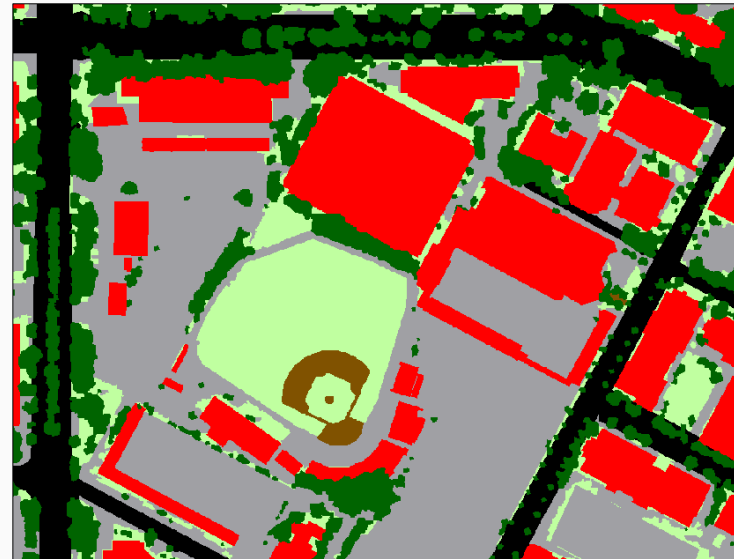
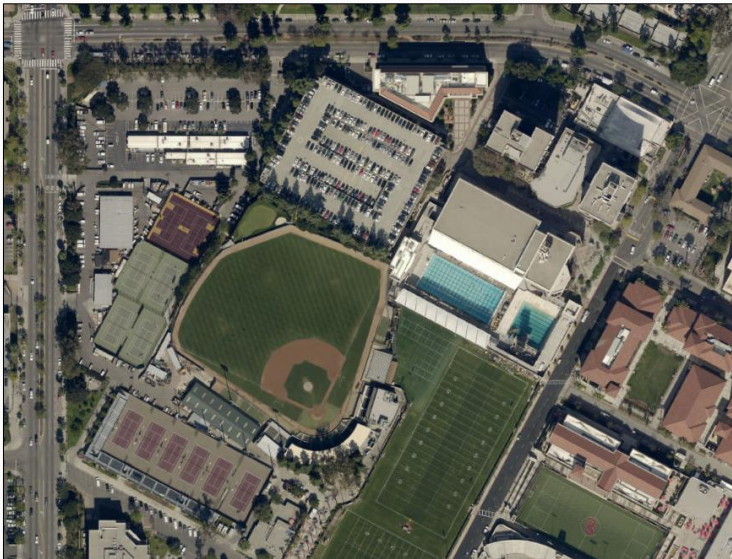


# Initial Results

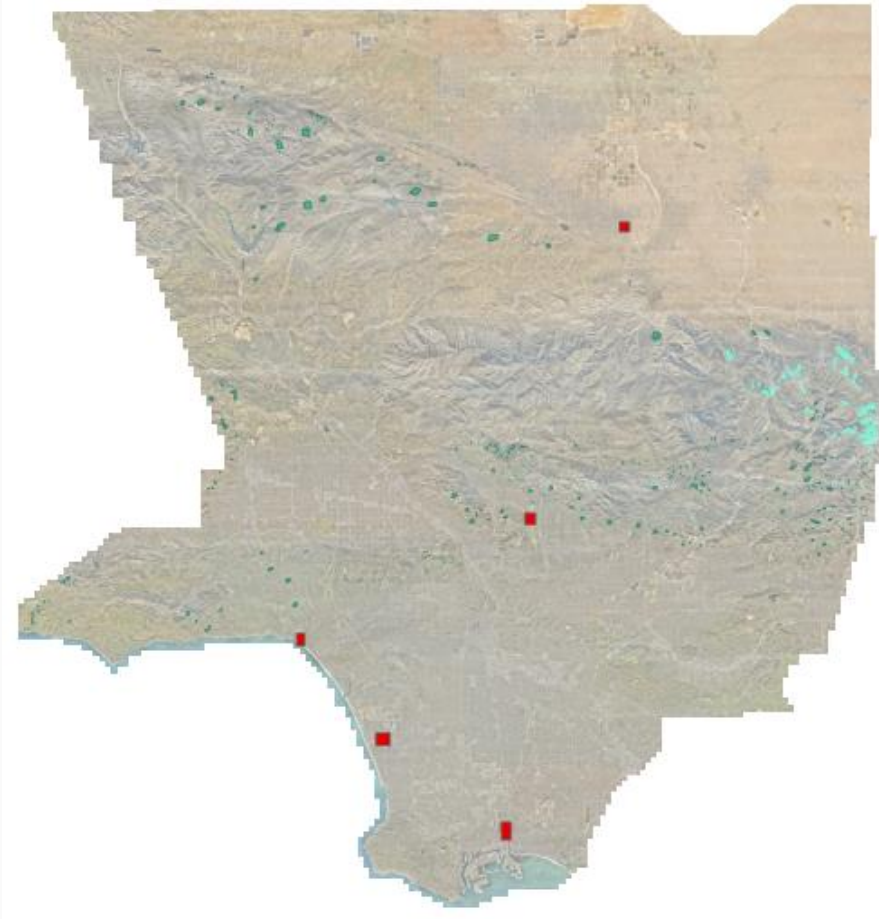


# Modified Methodology

- Took LARIAC4 Land Cover (2016) as training samples to generate image chips
- Switched to object-based classification method



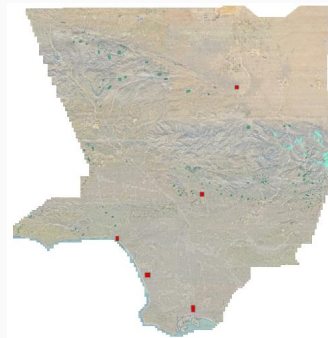
# Five Area of Interests





# Five Area of Interests

Classification	AOI	Cells		Percent		Difference	
		Pervious	Impervious	Pervious	Impervious	Pervious	Impervious
Living Atlas Model	1	21730702	48290982	0.31	0.69	0.052	-0.052
	2	27372956	12138772	0.69	0.31	0.010	-0.010
	3	20821832	49357168	0.30	0.70	0.027	-0.027
	4	21671288	12885410	0.63	0.37	-0.025	0.025
	5	31506536	16066983	0.66	0.34	-0.010	0.010
Previous Classification	1	18065561	51956123	0.26	0.74		
	2	26978462	12533266	0.68	0.32		
	3	18911908	51267092	0.27	0.73		
	4	22546819	12009879	0.65	0.35		
	5	31993646	15579873	0.67	0.33		



# Comparison

2014

2017



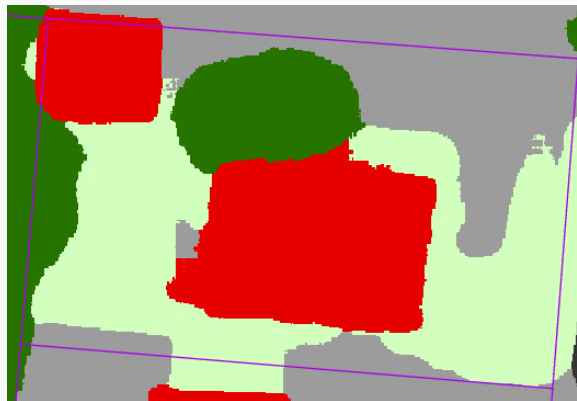
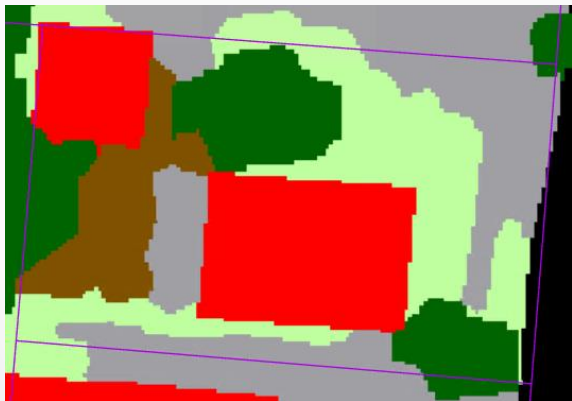
LC1_Permeable	LC1_Impermeable	LC2_Permeable	LC2_Impermeable
537.277022	5900.823723	1922.750667	4515.352696

# Comparison

2014



2017



LC1_Permeable	LC1_Impermeable	LC2_Permeable	LC2_Impermeable
3036.276853	2932.853031	2967.43765	3001.699083

# Changes in Land Cover Classes

- Development or greening the landscape
- Presence of gravel
- Good wet season or drought
- Tree canopy growth or tree removal
- Shadows
- Edge effects from processing




# Final Steps

- QA/QC and Accuracy Assessment
  - Manual inspection
  - Accuracy report
- Parcel Fee Change Report
  - All parcels will have a new impervious surface calculation and a difference is calculated for each parcel.
- Release to LARIAC5 members

# Esri Published DLPK on Living Atlas

## Land Cover Classification (Aerial Imagery)

Overview



Deep learning model to perform land cover classification on aerial Imagery

Deep learning package by [esri\\_analytics](#)

Item created: Sep 18, 2022   Item updated: Sep 30, 2022   Number of downloads: 2,517

[Living Atlas](#)

[Download](#)

### Description

Land cover describes the surface of the earth. Land-cover maps are useful in urban planning, resource management, change detection, agriculture, and a variety of other applications in which information related to the earth's surface is required. Land-cover classification is a complex exercise and is difficult to capture using traditional means. Deep learning models are highly capable of learning these complex semantics and can produce superior results.

There are a few public datasets for land cover, but the spatial and temporal coverage of these public datasets may not always meet the user's requirements. It is also difficult to create datasets for a specific time, as it requires expertise and time. Use this deep learning model to automate the manual process and reduce the required time and effort significantly.

### Licensing requirements

ArcGIS Desktop - ArcGIS Image Analyst extension for ArcGIS Pro  
ArcGIS Enterprise - ArcGIS Image Server with raster analytics configured  
ArcGIS Online - ArcGIS Image for ArcGIS Online

### Using the model

Follow the [guide](#) to use the model. Before using this model, ensure that the supported deep learning libraries are installed. For more details, check [Deep Learning Libraries Installer for ArcGIS](#).

### Details

Size: 147.778 MB  
ID: c1bca075efb145d9a26394b866cd05eb

★★★★☆

[f](#) [t](#) [s](#)

### Share

[🌐](#)

### Owner

[EA](#) esri\_analytics

### Tags

# ANY QUESTIONS?

Christine Lam

[CLam@dpw.lacounty.gov](mailto:CLam@dpw.lacounty.gov)

(626) 458-3542