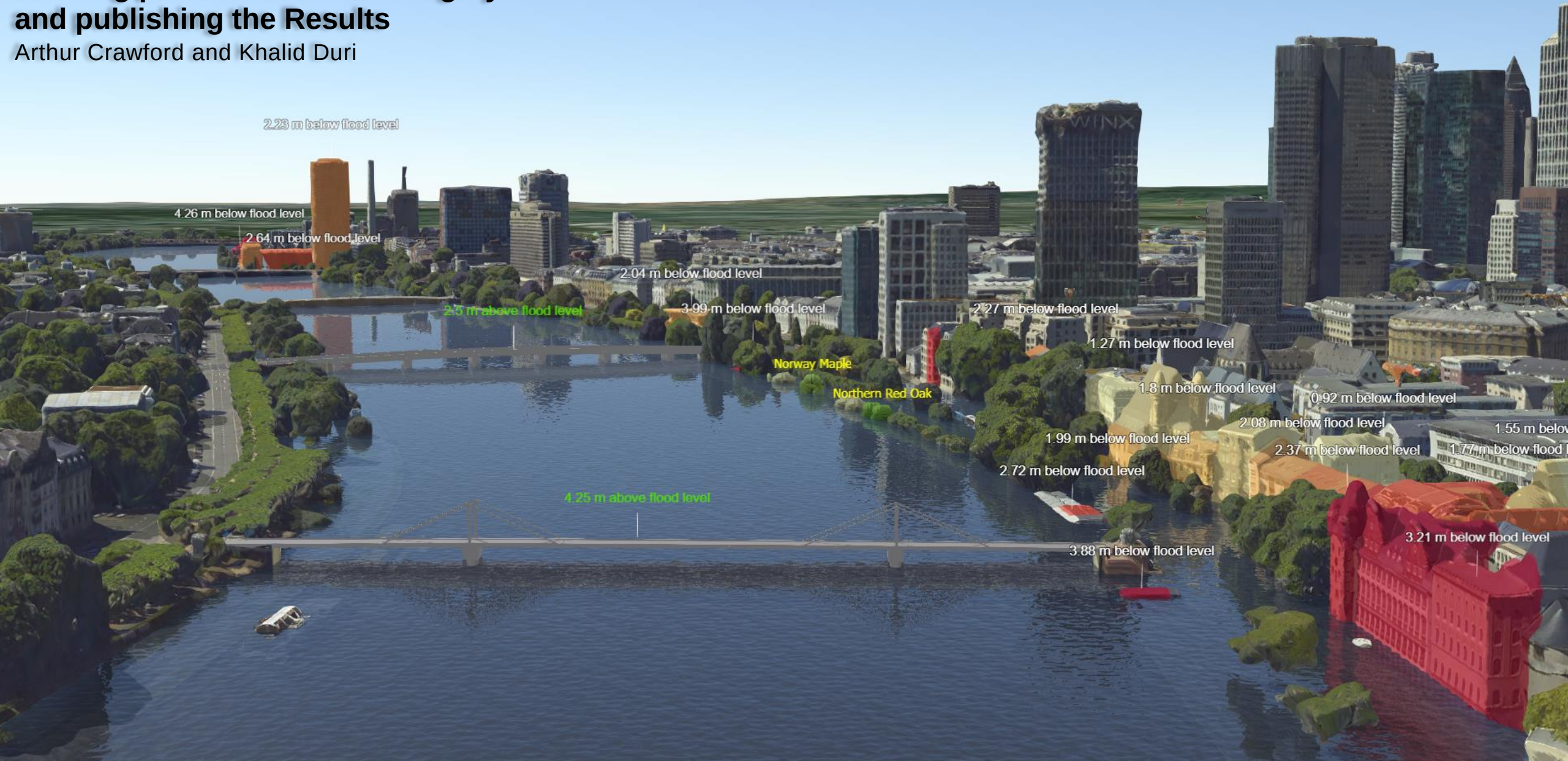
Extracting features from LiDAR with ArcGIS, coloring point clouds with imagery and publishing the Results

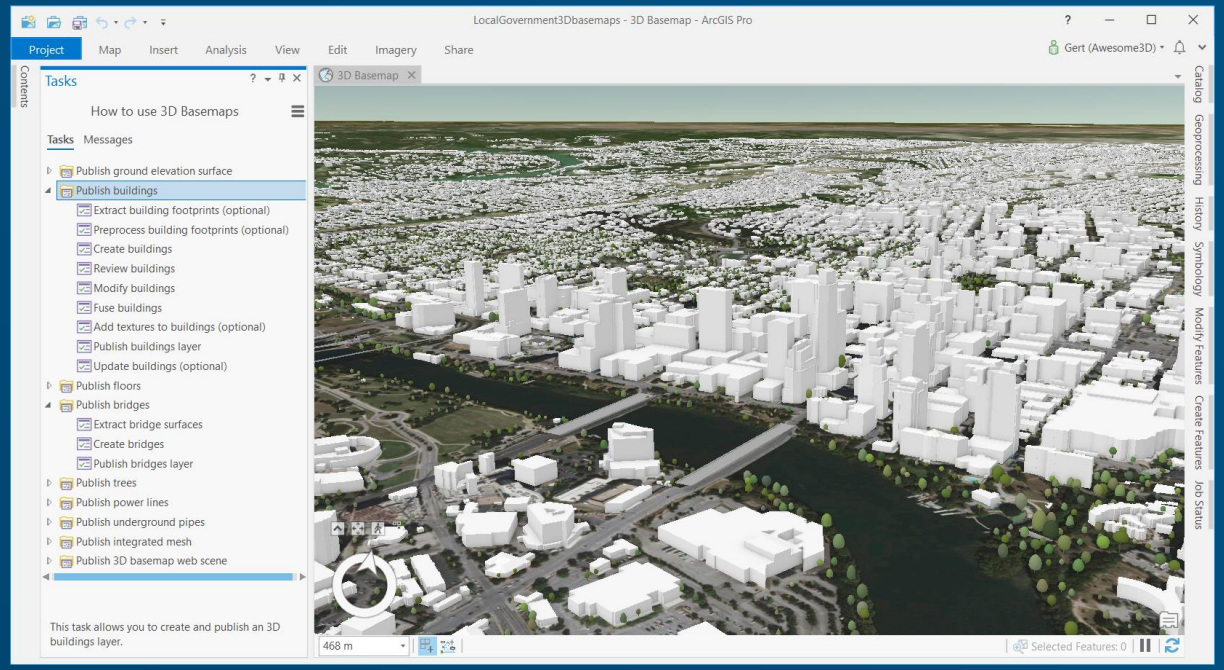
Arthur Crawford and Khalid Duri



Getting value out of your lidar and imagery: 3D Basemaps solution

Create and maintain a collection of 3D layers leveraging existing data within an organization

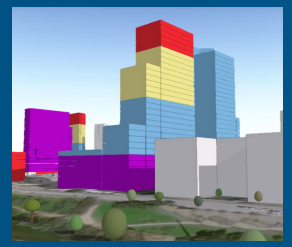
ArcGIS Pro project with task based workflows



Output layers

bridges

buildings



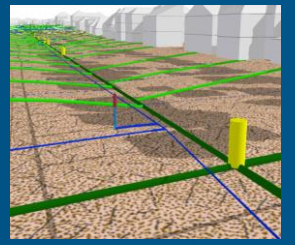
floors

colorized lidar

elevation

power lines

trees

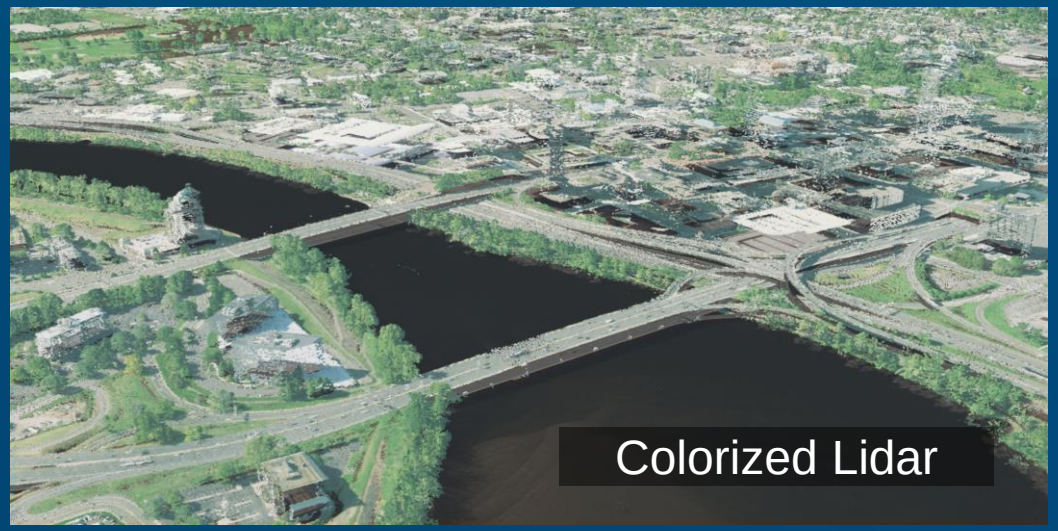


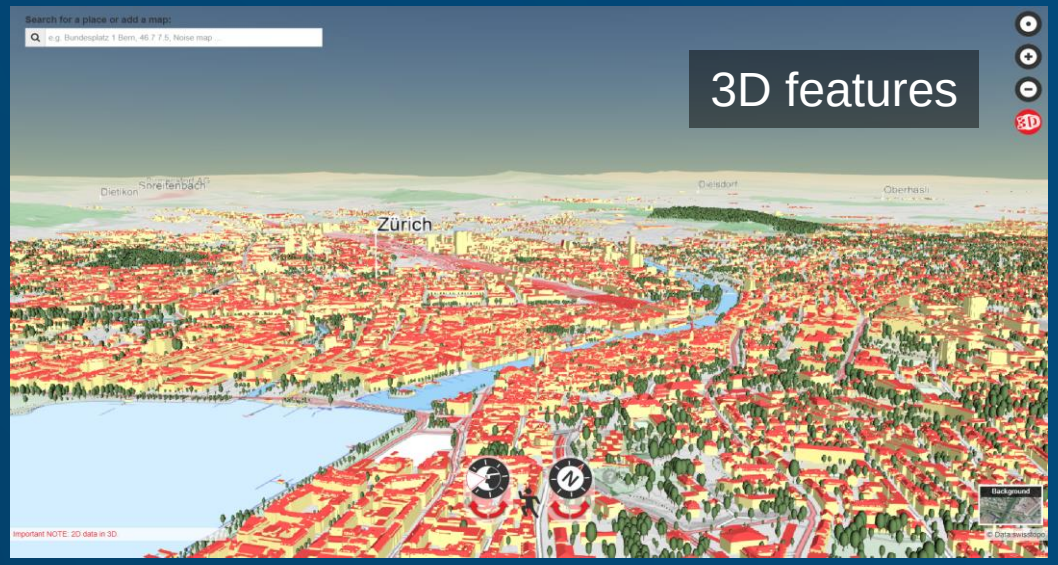
underground pipes

modified mesh

What is a 3D basemap?

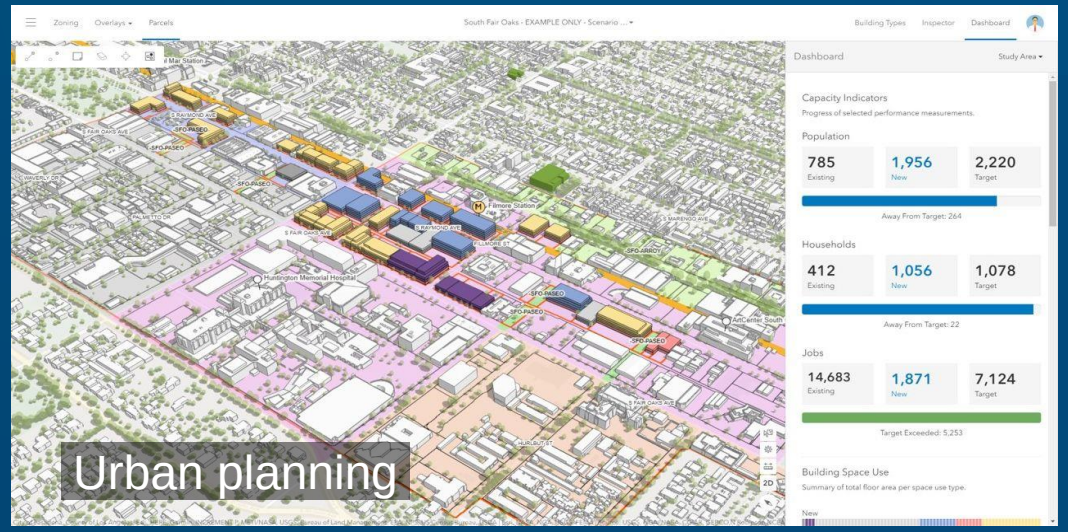
Scene with one or more 3D layers for your area of interest (at different scales)

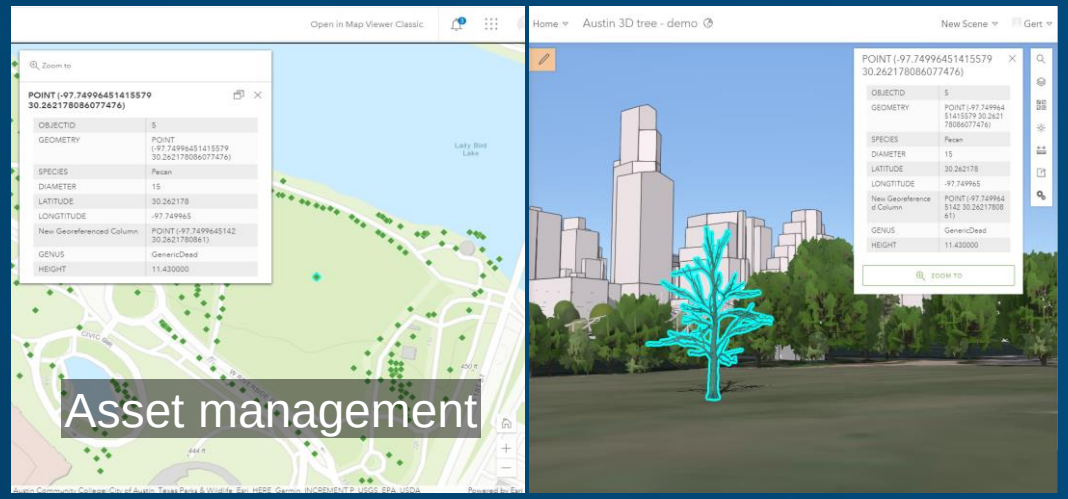




What can you use a 3D basemap for?

Provide context for…



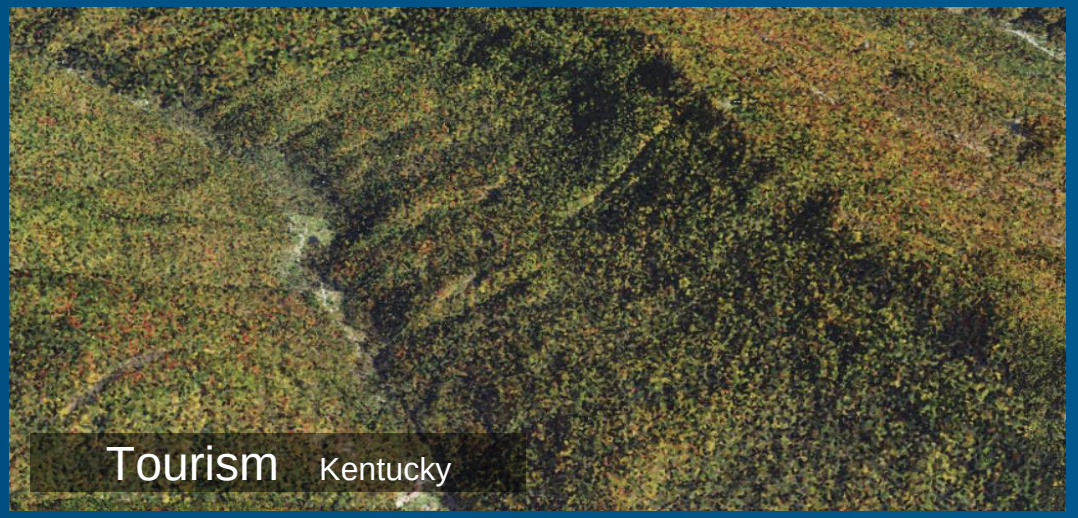


What can you use a 3D basemap for?

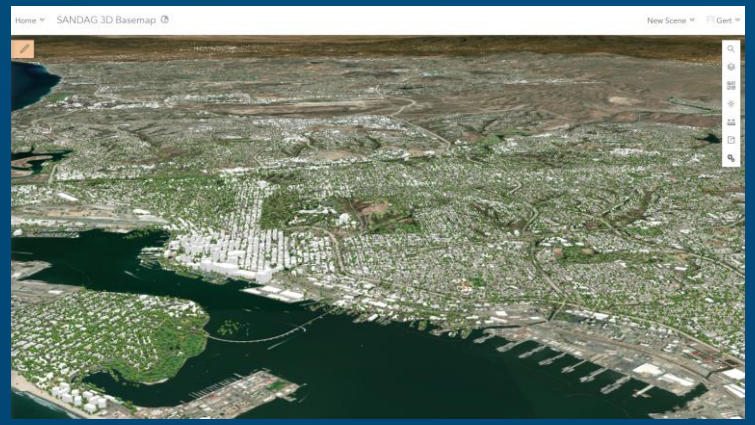
Provide context for…

What can you use a 3D basemap for?

Provide context for…



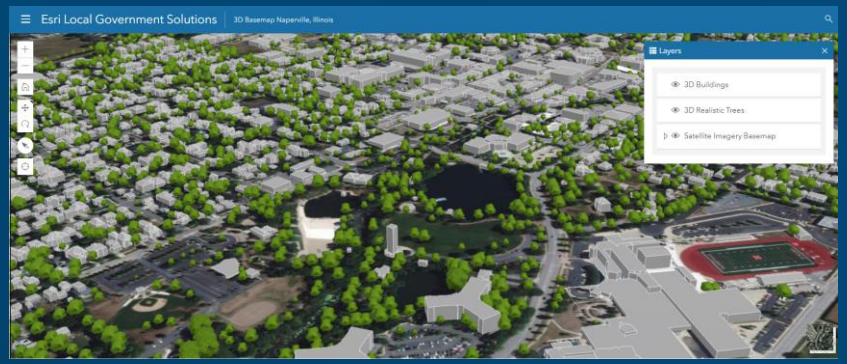
Examples of 3D Basemaps solution users



SANDAG

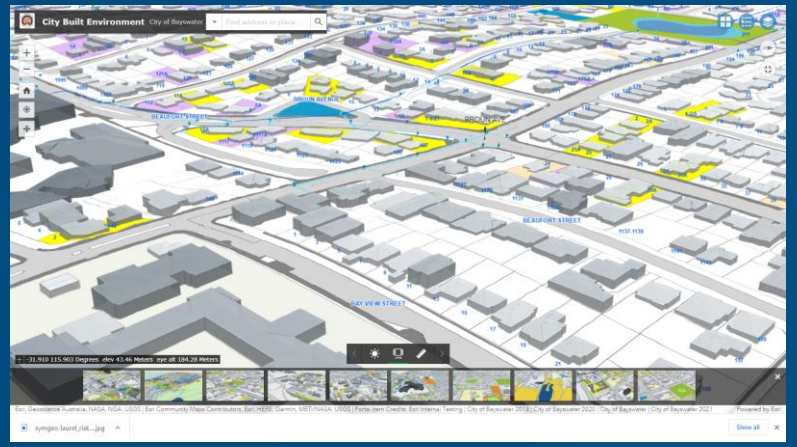
City of Las Vegas

Wolfsville



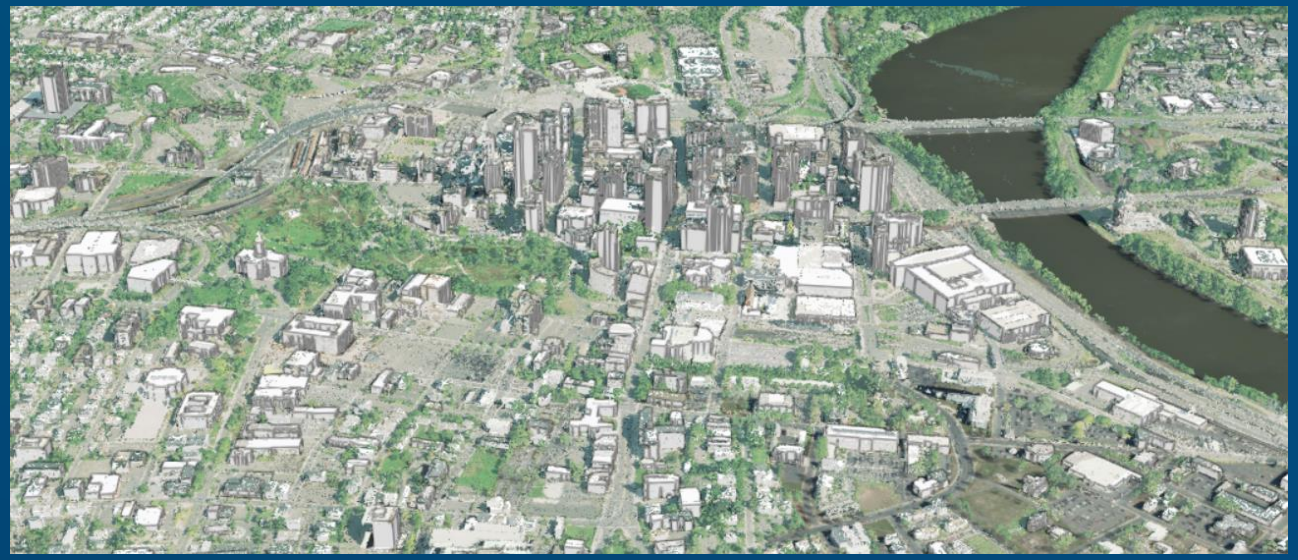
Ryerson University

SymGEO



City of Baywater

Examples of 3D Basemaps solution users



Connecticut CRCOG

Aspen Colorado

Chicago and Cook County

State of Connecticut

State of Delaware

What data do I need?

Leverage existing data

Input data

lidar, imagery

points, lines, polygons

integrated mesh

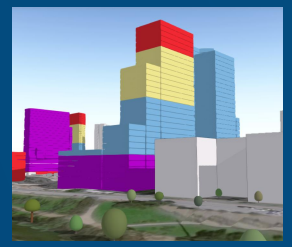
3D Basemap solution

Colorize
Extract
Publish
Modify

Output layers

bridges

buildings



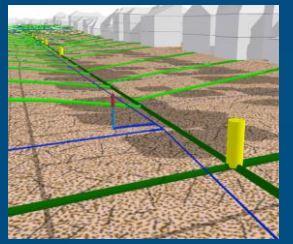
floors

colorized lidar

elevation

power lines

trees



underground pipes

modified mesh

3D Basemap layers

Create 3D layers leveraging existing data within an organization

- Elevation
  - Input: lidar
  - Output: dtm, dsm, ndsm
  - Approach: standard 3D Analyst tools
- Colorized lidar
  - Input lidar, imagery
  - Output: colorized lidar
  - Approach: standard 3D Analyst tools
  - Lidar processing for scale – entire states

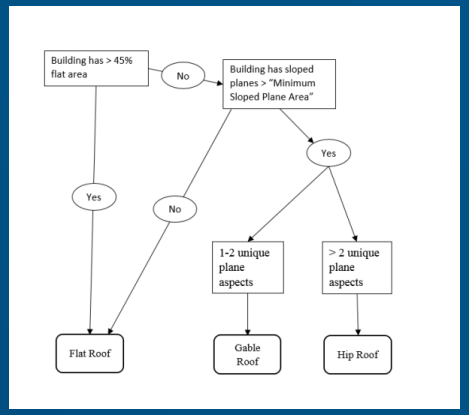
Output layers

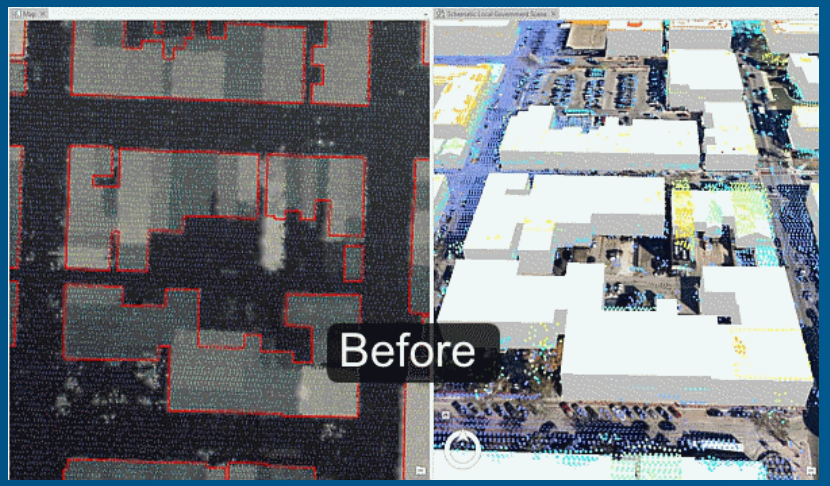
colorized lidar

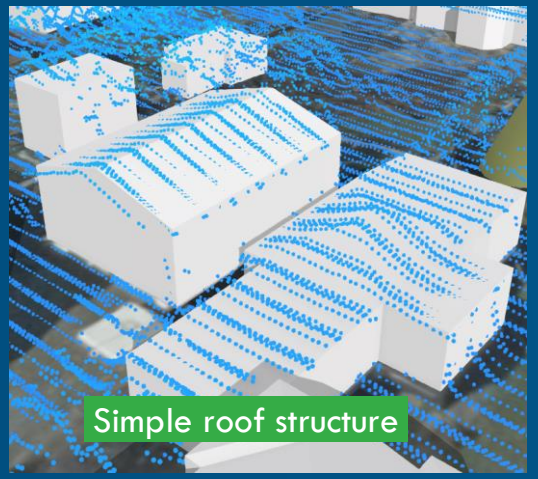
3D Basemap layers

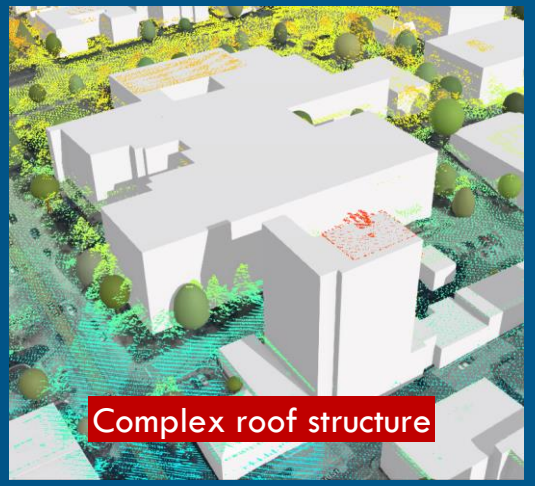
Create 3D layers leveraging existing data within an organization

- Buildings
  - Input lidar
  - Output: footprints, LOD2 buildings
  - Approach:
    - Classify Lidar for Buildings
    - Generate footprints (raster–based)
    - Segment footprints (using segment mean shift on Dsm)
    - Detect roof planes within each segment using nDsm (slope analysis)
    - Attribute footprint segments (base elevation, bldg height, eave height, max height roof form, direction)
    - Procedural generation





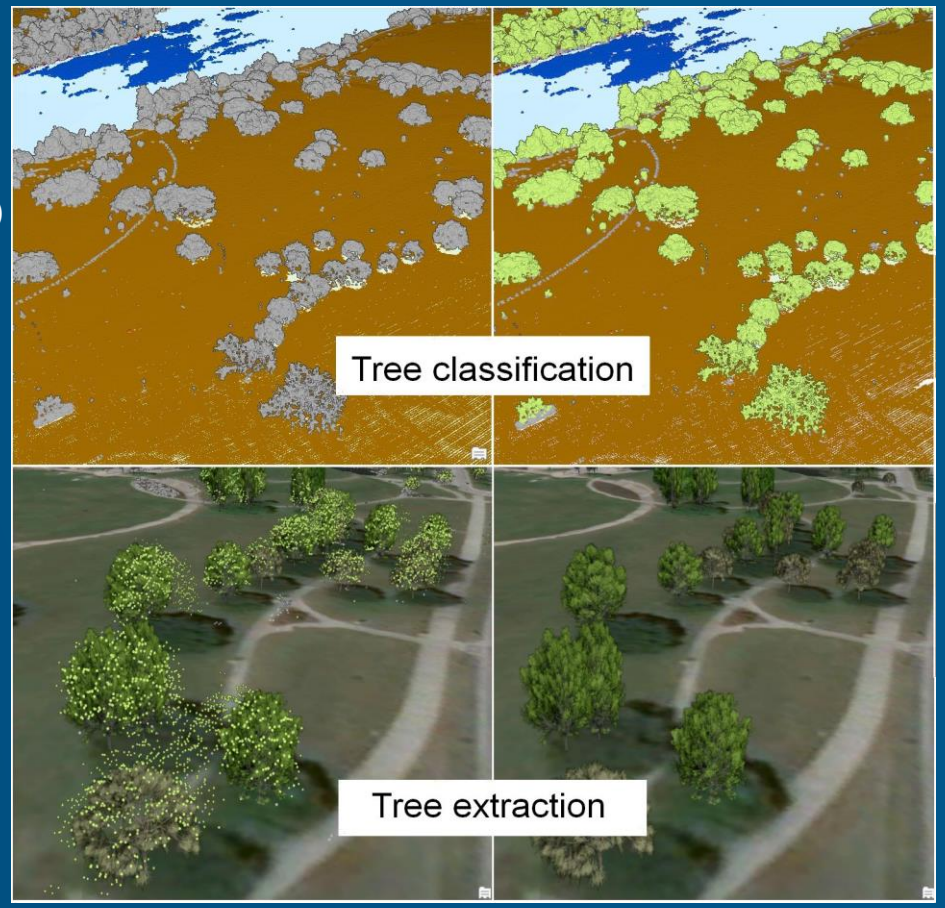




3D Basemap layers

Create 3D layers leveraging existing data within an organization

- Trees
  - Input lidar
  - Output: tree point locations with height / crown diameter, 3D trees
  - Approach:
    - Classify lidar (deep learning for small areas or NAIP NDVI for county sized)
    - Generate tree locations / attributes
      - Flow accumulation (fast but inaccurate for individual trees)
      - Density based clustering (slow but accurate)
    - Procedural generation
    - Leaf off imagery can be used to determine coniferous or decidious



3D Basemap layers

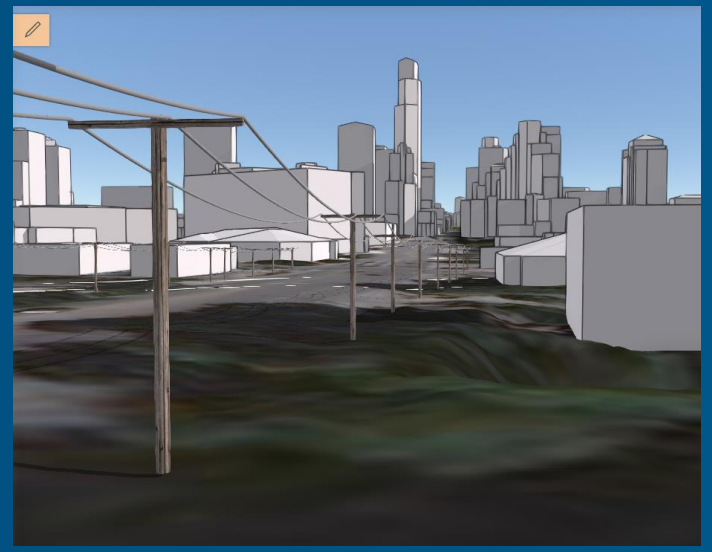
Create 3D layers leveraging existing data within an organization

- Bridges
  - Input lidar
  - Output: 3D bridge surfaces, 3D bridges
  - Approach:
    - Classify lidar (manual)
    - Generate 3D bridges surfaces
    - Procedural generation
  - Inventories of bridges online with 3D party vendors you can import to ArcGIS Pro to move and resize.

3D Basemap layers

Create 3D layers leveraging existing data within an organization

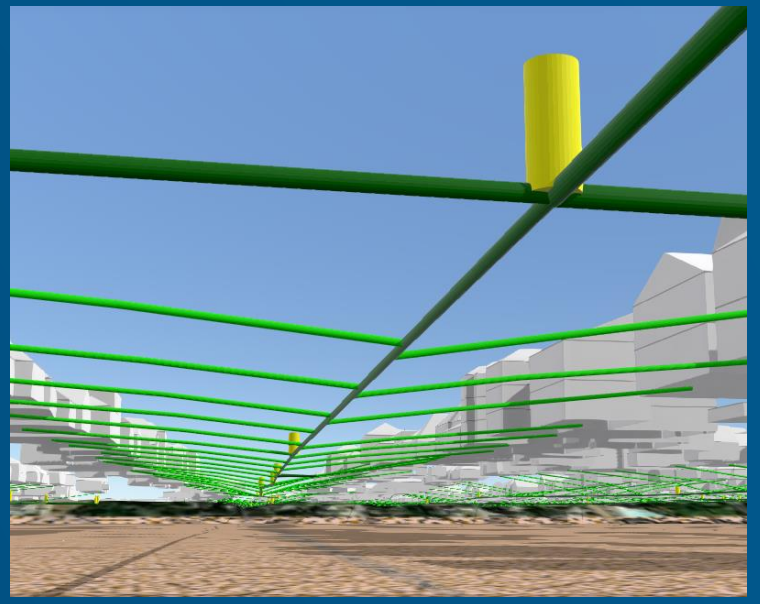
- Powerlines
  - Input: points / lines
  - Output: power line features, 3D powerlines / structures
  - Approach:
    - Classified using Deep Learning
    - Procedural generation



3D Basemap layers

Create 3D layers leveraging existing data within an organization

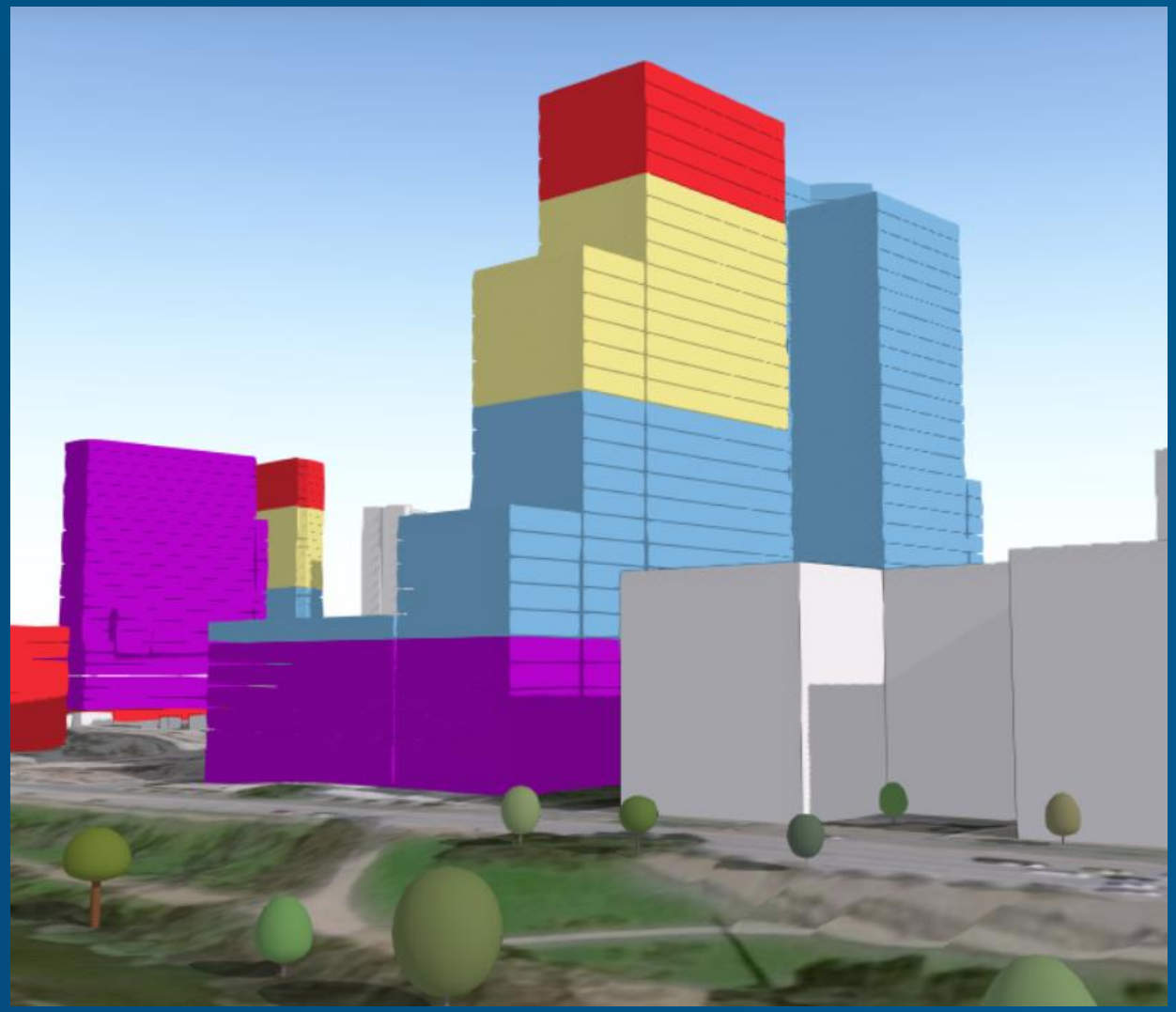
- Underground pipes
  - Input: points / lines
  - Output: pipes features, 3D pipes / manholes
  - Approach:
    - Procedural generation



3D Basemap layers

Create 3D layers leveraging existing data within an organization

- Floors
  - Input: multipatch
  - Output: floor plates, volumes
  - Approach:
    - Procedural generation



3D Basemap layers Demo

Create 3D layers leveraging existing data within an organization

LOD1
Simple Extrusion

LOD2
Roof-Form

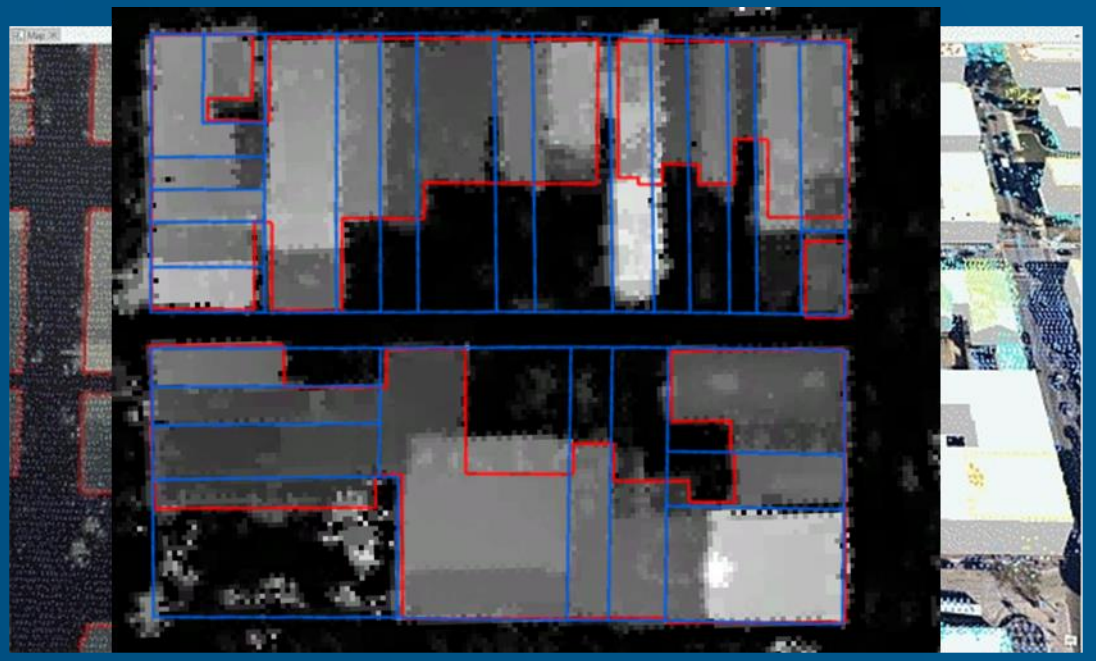
LOD3
Façade Details

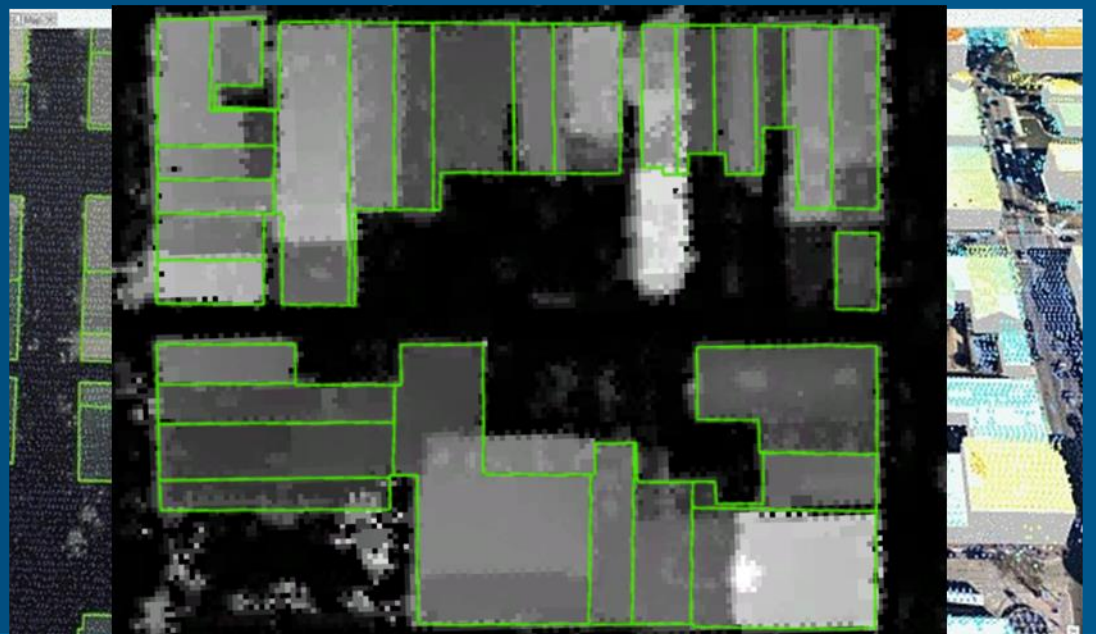
LOD3
Textured

LOD1 exists for Los Angeles County: https://www.arcgis.com/home/webscene/viewer.html?layers=98cc9bf5602c45778fa76c61386f9f5a

3D Basemap layers Demo
Roof Segmentation

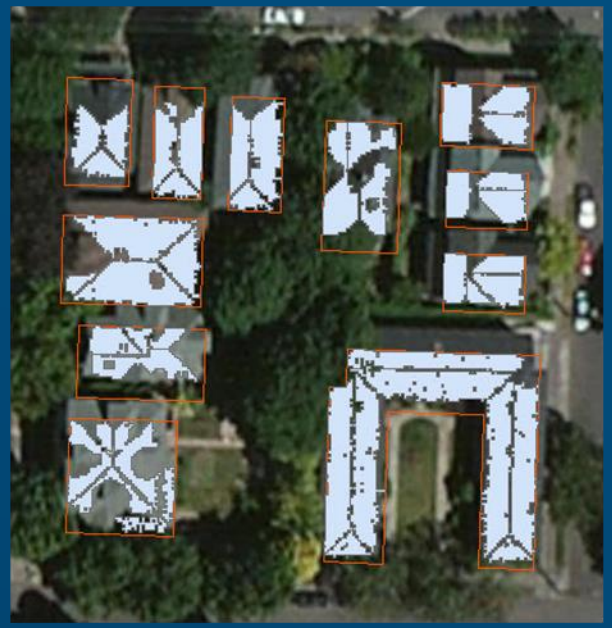
- Using elevation
  - Uses Image segmentation on DSM to determine breaks in roof tiers
  - Regularize Adjacent Building Footprint
- Using features
  - Features such as parcels can delineate roof boundaries in dense urban areas
  - Incorporates boundary lines into existing footprints
- Often both are used

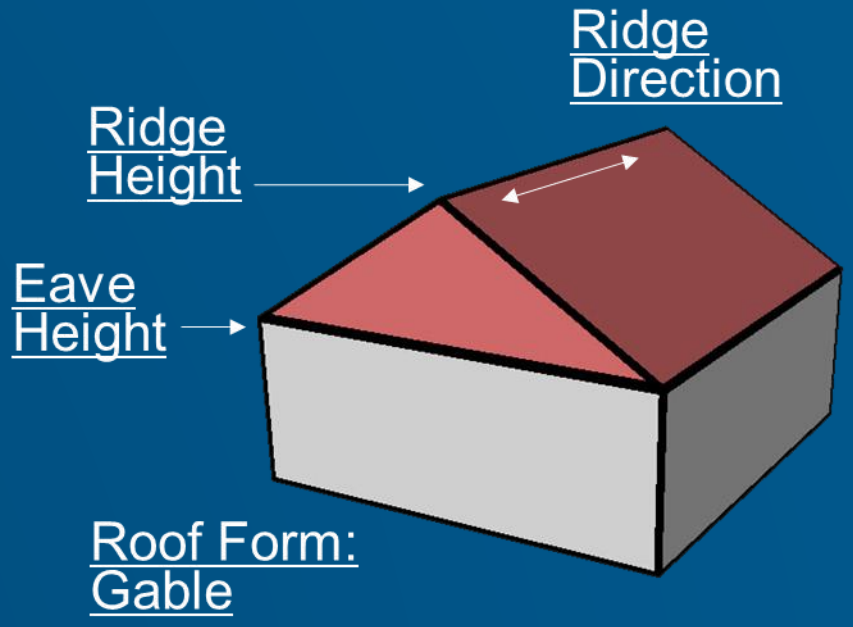




3D Basemap layers Demo

- Using feature extraction techniques to inform procedural geometries



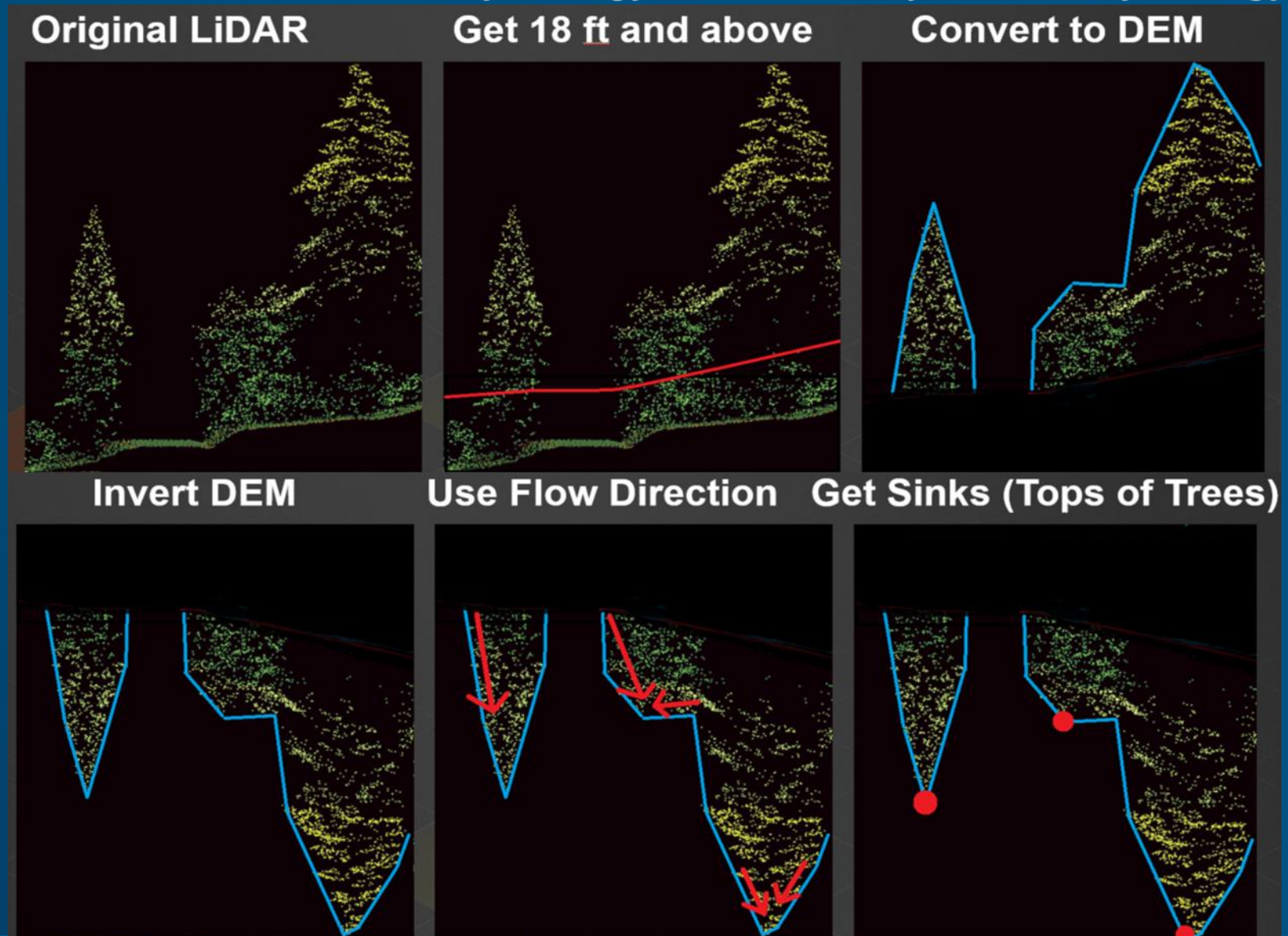


- **Extract roof-plane features**
- **Derive attributes**

Apply procedural rule

3D Basemap layers Demo – Three tools for Tree Extraction

Trees from Lidar – uses hydrology tools currently, can use hydrology raster functions



- Trees from Lidar
  - Gets millions of points
  - Slope, NDVI, Height, and Crown Diameter used to determine if likely a tree
  - Trees removed that are too close to a building
  - All points retained for refinement of selection to display

Community Maps Program

Living Atlas of the World

Join the Community

Your input makes a difference! Join the community by providing feedback, creating large scale features, or sharing data layers and services. Your contributed data will be added to Esri basemaps, which are freely available to ArcGIS users as part of the ArcGIS Living Atlas of the World. Watch this video for a tour of what you can do!

Provide Feedback

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ArcGIS Online

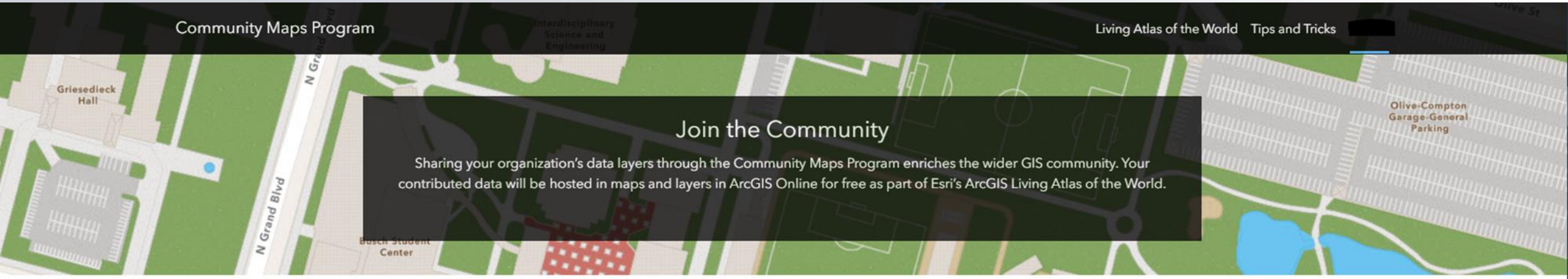
Connect people, locations, and data using interactive maps. Work with smart, data-driven styles and intuitive analysis tools. Share your insights with the world or specific groups.

Thank you!

- **Arthur Crawford –acrawford@esri.com**
- **Khalid Duri – kduri@esri.com**

Community Maps Program

Living Atlas of the World | Tips and Tricks | [redacted]



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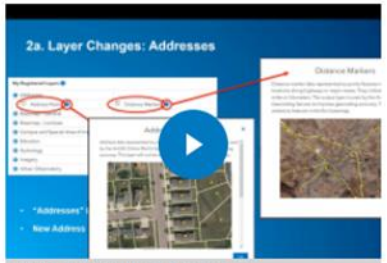
Ready to contribute? Provide your data layers as a prepared Zipped Geodatabase or directly from online map services.

We've updated the Contributor App! Read the **Tips and Tricks** to see what's new.

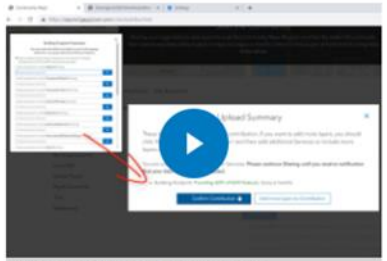


Video: 8 Minutes 3 Seconds

What's New (Nov 2020)

Video: 5 Minutes 45 Seconds

Using the App (Nov 2020)



Video: 3 Minutes 59 Seconds

Service Tips and Tricks (June 2019)