Managing and Serving Elevation and Lidar Data

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Outline

• Usage Modes
• Elevation Data Management
  - Architecture
  - Workflow
• Lidar
• Automation for Repeatability & Scalability
Usage Modes of Elevation Data

- Get Data Values
  - Orthorectification
  - Local analysis
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• Visual Interpretation
  - Including Metadata
Usage Modes of Elevation Data

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  - Including Metadata

• Server-side Analysis
  - Profile, Viewshed, Contours
ArcGIS Online

World Terrain

Orthometric Height
Derived Products
Visualizations
Server-side GP Tools
Characteristics of Elevation Data

- Typically 32 bit float (sometimes 16)
- Likely to include NoData areas
- Different projections
- Different vertical datums
- May be in different units (XY vs. Z)
Data Management Objectives

- Support User Requirements
- Manage Cost vs. Performance
  - Implement In-house, Public Cloud?
- Avoid resampling
- Scalability
- Maintainability
- Automation
Elevation Data Management
Image Management Workflow Using Mosaic Datasets
Highly Scalable, From Small to Massive Volumes of Imagery

Create Catalog of Imagery
- Reference Sources
- Ingest & Define Metadata
- Define Processing to be Applied

Apply:
- On-the-fly Processing
- Dynamic Mosaicking

Access as Image or Catalog
Mosaic Dataset Design

• Key metadata → Attribute Table
  - Vertical Datum
  - Accuracy (CE90, LE90)
  - Date published
  - Link to detailed metadata

• Source / Derived Model
Source Mosaic Datasets – Elevation & Lidar example

Source Imagery

Source Mosaic Datasets

NED 10m

LiDAR Project #1

LiDAR Project #N
Combine into Derived Mosaic Dataset

Source Imagery → Source Mosaic Datasets → Derived Mosaic Dataset

Multi-source, multi-resolution collection of elevation data

Use *TABLE* Raster Type

Advantage: All data* available in a single location

* All *elevation* data
Example – ArcGIS World Elevation – Server Raster Functions

Source Imagery → Source Mosaic Datasets → Derived Mosaic Dataset → Single image service with multiple server functions

- Orthometric Height
- Hillshade
- Contour
- Slope
- Aspect
- Ellipsoidal Height
- …many other functions
Example – ArcGIS World Elevation – Update with new data

Source Imagery

Source Mosaic Datasets

Derived Mosaic Dataset

Single image service with multiple server functions

Orthometric Height

Hillshade
Contour
Slope
Aspect
Ellipsoidal Height
...many other functions

New data collections added to the central Derived Mosaic appear immediately in all services
Create Source Mosaic Datasets

- Projection = same as source
- Cell Sizes: default
- NoData: define NoData value
- Footprints: calculate approximate footprint, do not clip
- Overviews:
  - Not generally required (use other low resolution datasets in Derived MD)
  - Exception: build OVRs if next available resolution is > 10x difference or larger
- Complete QC of each Source MD
Derived Mosaic Dataset

- DTM (bare earth)
- DSM (first return surface) if applicable
  - Must decide desired behavior at edges – show DTM, or NoData?
- Add Source_MDs using TABLE raster type
- Include low resolution datasets in lieu of OVRs
- Vertical adjustments
  - Rescale feet → meters (e.g. Lidar state plane data)
  - Convert datum to Derived MD
- Assign approximate statistics (do not calculate) Set Raster Properties
- Mosaic Method: By Attribute, “Best”
Options/Additional Info
Sharing / Serving from the Cloud

- NASA Meta-Raster Format (MRF) for S3 storage
  - Optimized for simple cloud storage (S3)
  - Mosaic Dataset accesses local file (e.g. can configure on Desktop, copy all to cloud)

- LERC – Limited Error Raster Compression
  - Truncates 32 bit float values to user specified vertical error tolerance

- MRF and LERC: [http://esriurl.com/MRF](http://esriurl.com/MRF)
Lidar workflow

Creation of Raster Surfaces - DSM & DTM
Publishing points as SLPK (*.i3s format)
Hosting LAS tiles for download
Export raster surfaces from LAS Dataset

“Workflow A”

- Recommended method for best scalability
- Test before export to define best parameters
- Ensure tiles overlap
- Lidar data may be moved to offline storage

Data volume for DTM ~10% of LAS
DSM add another ~10%
Tool: LAS Dataset to *Tiled* Rasters

Download from [http://links.esri.com/3dSamples](http://links.esri.com/3dSamples)
Publishing 3D data as scene services

- **Indexed 3D Scene Layers** (i3s) format accepted as OGC standard
  - [http://esriurl.com/i3sOGC](http://esriurl.com/i3sOGC)

- **Four data types**
  - Textured Mesh (3rd party tools e.g. Drone2Map, Pix4D, Vricon, Bentley Context Capture)
  - 3D objects (multipatch)
  - Point features with attributes
  - Point clouds

- Host scene service on Portal or ArcGIS Online
  - Scene Layer Package (SLPK) may also be read directly into ArcGIS Pro

- [http://esriurl.com/PublishI3S](http://esriurl.com/PublishI3S)
Streaming 3D points via *.i3s

Coming soon: Clip/Zip/Ship *.i3s to LAS
LAS / zLAS files exposed for download – ArcGIS for Server

- Server must have local storage for LAS/zLAS files
- Client = ArcGIS Pro, ArcMap, or custom web client
LAS / zLAS files exposed for download – Simple download (S3 / FTP)

- Simple cloud storage for LAS/zLAS files, linked to AGOL Feature Service
- Client = browser

More lightweight
Download Lidar tiles Demo

Data from Sonoma County, CA
Automated Build

MDCS
(Mosaic Dataset Configuration Script)
Automated Workflows – for Repeatability & Scalability

• Simplicity

• Improve Productivity
  - Repeatability, Maintainability, Scalability
  - Documentation → Facilitate QA & QC, Design Review

• Training/Examples
  - Encapsulate best practices
  - Reusable templates
Python implementation - *Mosaic Dataset Configuration Script (MDCS)*

- Calling standard Geoprocessing tools from a single script
- Input configuration file contains complete information to:
  - Create,
  - Populate, and
  - Configure one mosaic dataset

- Also generates detailed log files
Advantages of MDCS

• Configuration file encapsulates “Best practices” (mosaic dataset properties) based on image type

• “Self Documenting” –
  - Template is reusable for different image types, or multiple mosaic datasets within a more complex system
  - Compare versions (difficult with ModelBuilder)

• Automated Log files – Simple Review
Other features to note within MDCS

- Can run subsets of full configuration via command line options
- Built in version compatibility checks
- Extensible: additional commands can be added
Configuration file contents

“BEST PRACTICES”

- Input Data Paths
- GP tools necessary for the workflow
- Raster Types & Raster Functions
- Mosaic Dataset properties
```xml
<AddRasters>
  <DefaultProperties>
    <RasterPerMosaic>50</RasterPerMosaic>
    <MaxRequestSizeX>4000</MaxRequestSizeX>
    <MaxRequestSizeY>4000</MaxRequestSizeY>
    <allowed_compressions>LZ77;NONE;LERC</allowed_compressions>
    <default_compression_type>LERC</default_compression_type>
    <CompressionQuality>75</CompressionQuality>
    <resampling_type>BILINEAR</resampling_type>
    <LERC_Tolerance>0.01</LERC_Tolerance>
    <clip_to_footprints>CLIP</clip_to_footprints>
    <clip_to_boundary>CLIP</clip_to_boundary>
    <color_correction>NOT APPLY</color_correction>
    <footprints_may_contain_nodata>FOOTPRINTS_MAY_CONTAIN_NODATA</footprints_may_contain_nodata>
    <allowed_mensuration_capabilities>BASIC</allowed_mensuration_capabilities>
    <default_mensuration_capabilities>BASIC</default_mensuration_capabilities>
  </DefaultProperties>
  <allowed_mosaic_methods>LockRaster;ByAttribute;Seamline;None</allowed_mosaic_methods>
  <default_mosaic_method>ByAttribute</default_mosaic_method>
  <Order_field>BEST</Order_field>
  <order_base>0</order_base>
  <sorting_order>Ascending</sorting_order>
  <mosaic_operator>FIRST</mosaic_operator>
  <blend_width>10</blend_width>
  <view_point_x>300</view_point_x>
  <view_point_y>300</view_point_y>
  <max_num_per_mosaic>50</max_num_per_mosaic>
  <cell_size_tolerance>999</cell_size_tolerance>
  <cell_size>##</cell_size>
  <metadata_level>BASIC</metadata_level>
  <transmission_fields>Name;MinPS;MaxPS;LowPS;HighPS;ProductName;BEST;Source;LE90;CE90;D
  <use_time>DISABLED</use_time>
</AddRasters>
```
Elevation Scripts from Imagery Workflows

- Two downloads: sample scripts and data
- Command line batch files for programmatic implementation
- Geoprocessing GUI version for single mosaic datasets
Imagery Workflows

Best Practice Workflows for Image Management, Analysis, & Use

- Landing page
  - http://esriurl.com/ImageryWorkflows
- Workflow descriptions & best practices
- ArcGIS Online Group
  - Downloadable scripts & sample data
Resources

- Imagery Workflows: [http://esriurl.com/ImageryWorkflows](http://esriurl.com/ImageryWorkflows)
- Elevation script: [http://www.esriurl.com/ElevationScript](http://www.esriurl.com/ElevationScript)
- Lidar workflow: [http://esriurl.com/LidarMgmt](http://esriurl.com/LidarMgmt)
- ArcGIS Online Group: [http://esriurl.com/6539](http://esriurl.com/6539)
- OptimizeRasters: [http://esriurl.com/OptimizeRasters](http://esriurl.com/OptimizeRasters)
- MRF and LERC: [http://esriurl.com/MRF](http://esriurl.com/MRF)
- Optimized LAS tool: [http://esriurl.com/zlas](http://esriurl.com/zlas)
- Tools from 3D Team: [http://links.esri.com/3dSamples](http://links.esri.com/3dSamples)

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