Managing and Serving Elevation and Lidar Data

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Outline

• Usage Modes
• Data Management
  - Architecture
  - Workflow
• Automation for Repeatability & Scalability
• A few options
Usage Modes of Elevation Data

• Get Data Values
  - Orthorectification
  - Local analysis
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  - Orthorectification
  - Local analysis

• Visual Interpretation
  - Including Metadata
Usage Modes of Elevation Data

- Get Data Values
  - Orthorectification
  - Local analysis

- Visual Interpretation
  - 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
Example – ArcGIS World Elevation – Server Raster Functions

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

Orthometric Height

...many other functions

Hillshade
Contour
Slope
Aspect
Ellipsoidal Height
Example – ArcGIS World Elevation – Update with new data

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
- Include low res datasets in lieu of OVRs
- Vertical adjustments
  - Rescale feet \( \rightarrow \) meters (Lidar state plane data)
  - Convert datum to Derived MD
- **Assign** approximate statistics (do not calculate) **Set Raster Properties**
- Mosaic Method: By Attribute, “Best”
Geodatabase Model
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

• Extensible: additional commands can be added
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

- **Input Data Paths**
- **GP tools necessary for the workflow**
- **Raster Types & Raster Functions**
- **Mosaic Dataset properties**

“BEST PRACTICES”
Configuration XML file

```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>NOMAP</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>
    <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>
  </DefaultProperties>
</AddRasters>
```
Elevation Scripts from Imagery Workflows

• Two downloads: sample scripts and data

• Geoprocessing GUI version for simple introduction

• Command line batch files for programmatic implementation
Imagery Workflows

Best Practice Workflows for Image Management, Analysis, & Use

- Landing page
  - http://esriurl.com/ImageryWorkflows

- Workflow descriptions & rationale

- ArcGIS Online Group
  - Downloadable scripts & sample data
Options/Additional Info
Sharing Geoprocessing Services – Data and Tools in the Cloud

*Move the Processing to the Data, not the Data to the Processing*

- Take advantage of storage and computing power in the cloud or on a private server
- Expose Geoprocessing Tools as services
- Viewshed, Line of sight, Volume calculations, etc.
- Accessible to Desktop, Web, and Mobile clients
Preprocessing

• NOT typically necessary

• Restructure files (optional, but no resampling)
  - Tiled TIFF (5120 x 5120)
  - LZW or LERC compression

• Advanced (Next slide)
  - Copy data to cloud storage
  - MRF Format (optional)
  - OptimizeRasters tool
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
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://esrirurl.com/PublishI3S](http://esrirurl.com/PublishI3S)
Streaming 3D points via *.i3s
LAS / zLAS files exposed for download – ArcGIS for Server

- Server must have local storage for LAS/zLAS files
- Client = ArcGIS Desktop or custom web client
• Simple cloud storage for LAS/zLAS files, linked to AGOL Feature Service
• Client = browser
Resources

• Imagery Workflows: http://esriurl.com/ImageryWorkflows
• Guidebook in ArcGIS Help: http://esriurl.com/6007
• ArcGIS Online Group: http://esriurl.com/6539
• OptimizeRasters: http://esriurl.com/OptimizeRasters
• MRF and LERC: http://esriurl.com/MRF

• Recorded Webinar on lidar data management: http://esriurl.com/LTSLidarMgmt
• Optimized LAS tool: http://esriurl.com/zlas
• Tools from 3D Team: http://links.esri.com/3dSamples (ArcMap 10.x only)

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