

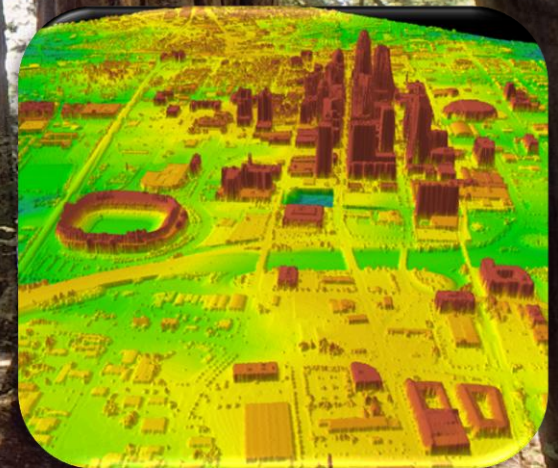
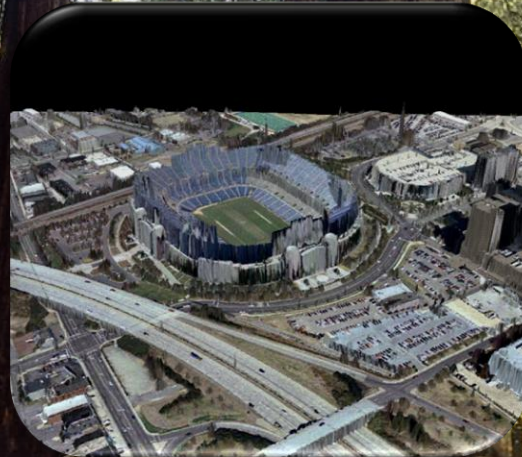
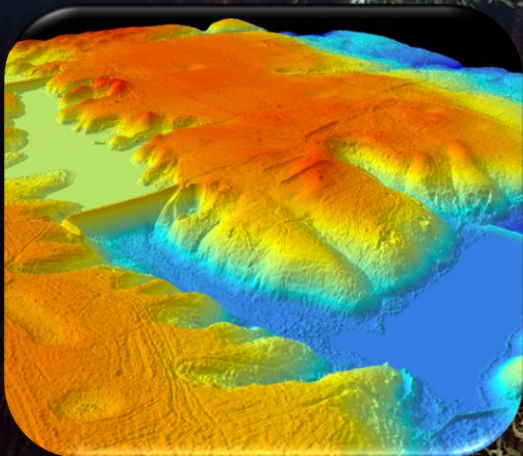


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LiDAR Solutions in ArcGIS

Tim Clark



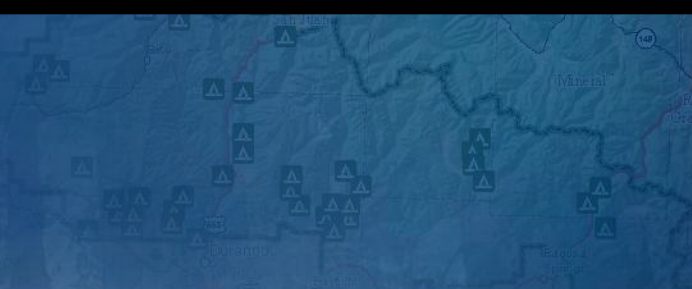


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Topics

- Importing LiDAR
- Terrain datasets
- Analysis
- QA/QC
- Demo





Different Types of LiDAR Users

- **Data collection**

- Fly
- Process
- Deliver

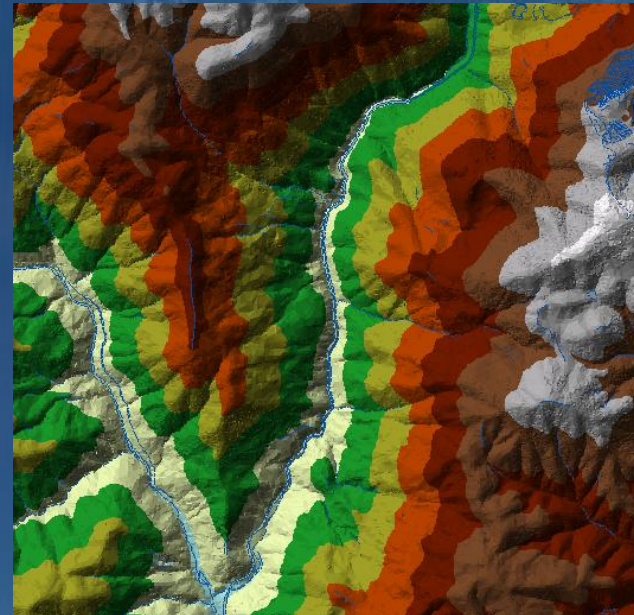
- **Management**

- Store
- Distribute
- Update

- **Use**

- Display
- Query
- Analyze

ArcGIS





LiDAR Input Data Formats – ASCII & Binary

- **XYZ, XYZI, GENERATE Format**
 - 3-D points, lines, polygons
 - Loaded using ASCII 3D To Feature Class geoprocessing tool
- **LAS Format**
 - LAS files are industry standard binary format for LiDAR
 - Loaded using LAS To Multipoint geoprocessing tool



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Geodatabase Solution

- **Import source LiDAR measurements into geodatabase**
 - Do not work directly on LAS lidar files
- **Leverage geodatabase capabilities for efficient storage and management of lidar point clouds**
- **Benefits:**
 - Multipoint technology
 - Pyramids
 - Multiuser capabilities at enterprise level databases
 - Fast retrieval and display of point clouds



Handling LiDAR (LAS) Attributes

- Per point attributes (e.g. return number, class code) optionally stored in BLOBs
- A separate BLOB field is used for each attribute
- Array of values with one-to-one correspondence with a set of grouped points is stored with points in same database row

OID *	Shape *	Intensity	PointCount
1	Multipoint Z	Blob	30000
2	Multipoint Z	Blob	30000
3	Multipoint Z	Blob	30000
4	Multipoint Z	Blob	30000
5	Multipoint Z	Blob	8518
6	Multipoint Z	Blob	16502
7	Multipoint Z	Blob	11466
8	Multipoint Z	Blob	25779

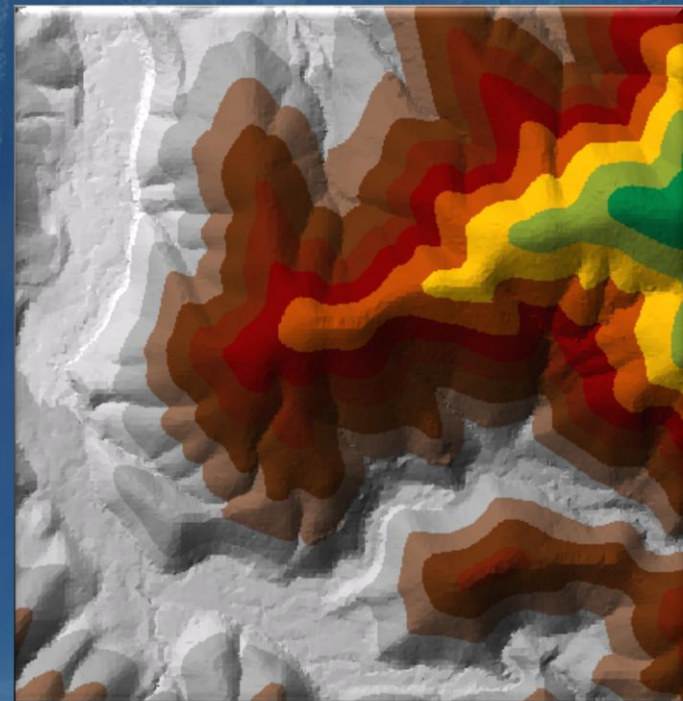


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Terrain Dataset

- A Terrain is a multi-resolution surface created from measurements stored in feature classes and managed in the geodatabase.
- Typical applications:
 - Topographic mapping
 - Bathymetric mapping
- Typical data sources:
 - Photogrammetric data
 - LIDAR
 - SONAR





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Terrain Wizard

The screenshot shows the 'Terrain Wizard' software interface with several overlapping dialog boxes. The background is a topographic map with blue triangles indicating terrain points.

Dialog Box 1 (Leftmost): 'New Terrain' dialog box. It contains the following text: 'Choose terrain characteristics.', 'Enter a name for your terrain:', 'napa_Terrain', 'Select the feature class characteristic:', a list of feature classes with checkboxes (napa_mass, napa_break, california_co, california_st, napa_clip), 'Approximate point size:', '12', and a 'Preserve Embedded Fields...' button.

Dialog Box 2 (Middle): 'New Terrain' dialog box. It contains the following text: 'Select Feature Class characteristic:', 'Each data source has some settings in the drop-down menus in the table below:', 'Choose the options for a feature class:', a list of feature classes with checkboxes (napa_mass, napa_breaks, napa_clip), and a 'Preserve Embedded Fields...' button.

Dialog Box 3 (Right): 'New Terrain' dialog box. It contains the following text: 'Select pyramid type.', 'Determine the pyramid type used:', radio buttons for 'Z Tolerance' and 'Window Size', 'Point selection method:', 'Secondary thinning method:', 'Secondary thinning threshold:', and a 'Resolution Bounds Setting...' button.

Dialog Box 4 (Rightmost): 'New Terrain' dialog box. It contains the following text: 'Create terrain pyramid properties.', 'Generate the properties for each pyramid level within your terrain.', 'Terrain Pyramid Levels' section with a 'Calculate Pyramid Properties' button, a table with 3 columns (No., Window Size, Maximum Scale), and buttons for 'Add', 'Remove', and 'Remove All'. At the bottom, there are '< Back', 'Next >', and 'Cancel' buttons.

No.	Window Size	Maximum Scale
1	24	20000
2	48	50000
3	96	100000
4	192	250000
5	384	500000



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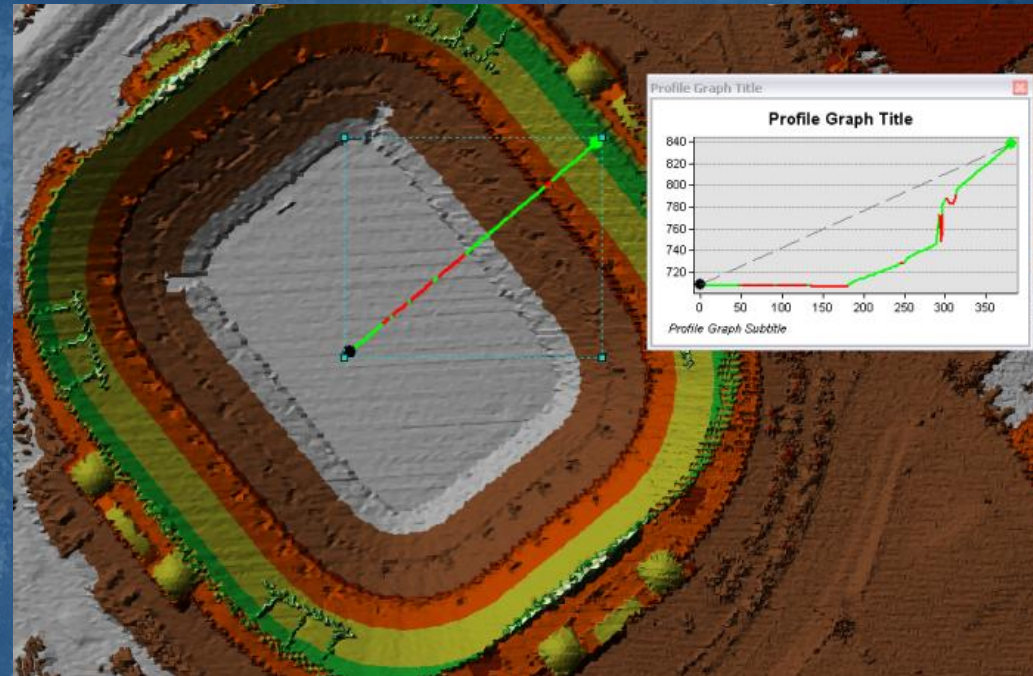
Terrain Editing

- Updates accomplished through edits to source measurements
 - Coarse grained area operators to append, remove, replace mass points
 - Standard/custom edit tools (e.g. ArcEditor) used to modify polylines, polygons, spot heights
 - Terrain rebuild based on dirty-areas
- Support for versioning in SDE



Analysis Tools on LiDAR

- QA/QC lidar data
- DEM / DSM creation
- Slope
- Aspect
- Contours
- Surface differencing
- Intensity image generation
- Estimating Forest Canopy
- Data area delineation
- Thinning / reducing noise
- Spot interpolation
- Profiling



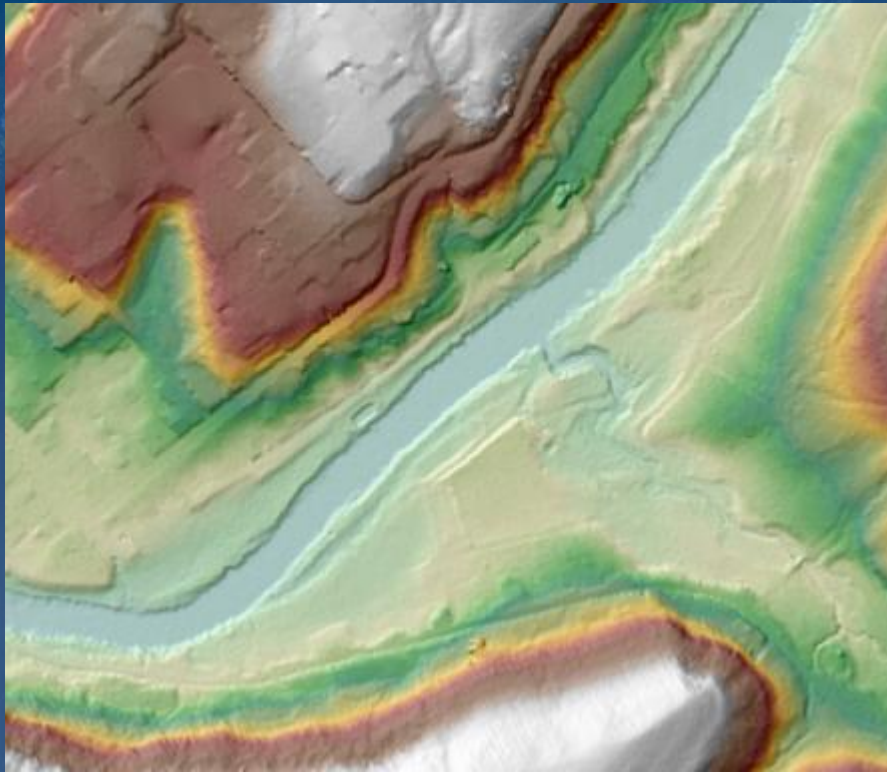


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Common Analysis: Creating Raster DEMs and DSMs

Digital Elevation Model



Bare earth surface made using only ground hits.

Digital Surface Model



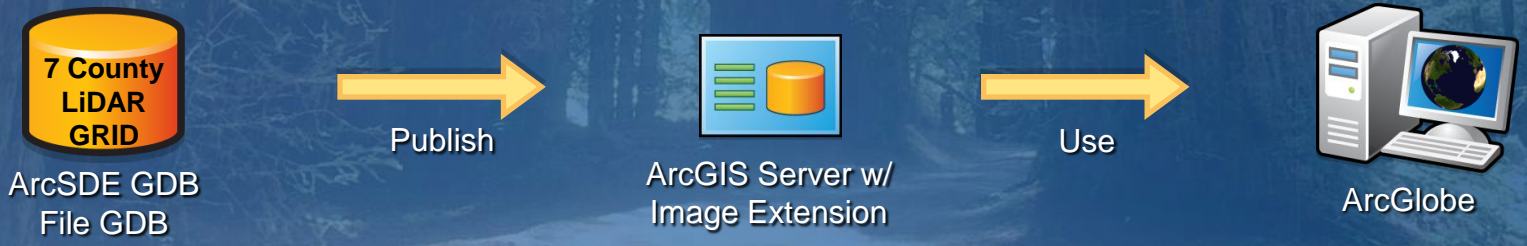
Includes ground, trees, and buildings made using first returns.



Best Practices

- LAS Over ASCII
- Use File or SDE GDB (Personal - 2GB Limit)
- Consider SDE for large datasets (> 1-2 billion points)
- Terrain must be stored in a feature dataset
- No Geographic Coordinate Systems
- Use Consistent Units (x, y, and z)
- Use Contiguous Datasets
- Breakline Enforcement
- Use ArcGlobe for LiDAR derived GRIDs

Workflow for large GRIDs:





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Performance/Size Estimates (ArcGIS 9.3)

- **Import:**
 - 800 million LAS points per hour
- **Terrain pyramid build:**
 - 80 million points per hour using z-tolerance filter
 - 400 million points per hour using window size filter
- **Storage:**
 - 150 million points (geometry only) = 1GB
 - Terrain pyramid will be roughly same size as source multipoint feature class

Timed using Dell Precision M6300
Intel Core2 Duo 2.60 GHz CPU
4GB RAM
Reads/writes using same drive
File Geodatabase



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Demo