DIGITAL MAPPING TECHNIQUES 2018

The following was presented at DMT‘18
(May 20-23, 2018 - University of Kentucky,
Lexington, KY)

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http://ngmdb.usgs.gov/info/dmt/
Topographic Maps and LiDAR in Field Mapping and Research at the Geological Survey of Alabama

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While limitations and inaccuracies of 7.5’ topographic maps can bring challenges to geologic mapping, LiDAR, high resolution elevation data, can help clarify some of these issues. With greater detail and accuracy, LiDAR allows clarification of elevation and surface (especially in areas of dense tree cover), identification of anthropogenic features, characterization of surficial geologic units, location of geologic hazards, generation of new contour base maps, and more. In this presentation, we combine examples of challenges in mapping and research projects at the Geological Survey of Alabama, and give examples of the LiDAR derivatives and methods we use to help address some of those challenges. Examples presented include techniques from geologic mapping (STATEMAP), geologic hazards, coastal, and environmental divisions.

REFERENCES

Geological Survey of Alabama, main website at http://www.gsa.state.al.us


U.S. Geological Survey, 3D Elevation Program (3DEP), https://nationalmap.gov/3DEP/
Topographic Maps and LiDAR in Field Mapping and Research at the Geological Survey of Alabama

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Included in this Presentation

• Challenges with topo maps in the field

• LiDAR and how it is applied in our work

• Future use/application of LiDAR at GSA
Mapping and Research at GSA

• Geological Survey of Alabama: Four programs
  • Geologic Investigation Program
  • Water Assessment Program
  • Ecosystems Investigation Program
  • Energy Investigation Program

• Each uses elevation data for mapping and research
  • Topographic maps (or NED)
  • SRTM
  • GPS
  • LiDAR
Intro to Topo Map Limitations

• Topographic Map Construction
  • Aerial imagery, not feasible to ground check

• Spatial limitation
  • Lateral, not ground checked everywhere
  • Vertical (e.g. contour intervals)

• Temporal limitation

• Land cover limitation
  • Densely forested areas
Example from field

- Initially noticed mismatch between GPS location and actual topography
- Contour lines do not match the actual ridgeline as observed
- Possible solution?
LiDAR Intro

• LiDAR: **Light Detection And Ranging**

• Laser acquired elevation data

• Collected as either
  • Ground (tripod or handheld)
  • Aerial (plane, helicopter, or drone)
Aerial LiDAR

- GPS collects xy location of plane
- Laser shot from plane, bounces off ground, and returns to plane
- Sensor/software calculates time of return = distance from plane (z)

(Credit: Betsy Boynton. USGS.)
Points are Classified

- Bare ground
- Water
- Urban areas, tall building
- Bridge deck
- High vegetation
- Low vegetation
- High noise
- Low noise
- Processed, but unclassified
LiDAR points

QL2 LiDAR points covering a 1-mile wide area, NW AL
Zoomed in, point-spacing varies

1 – 7 feet point spacing in places
Point cloud – All Points

Canopy and ground as a 2D profile
Ground only
3D ground only with exaggeration

3D profile
Derivative: 10-m contours
Derivative: 2-m contours
Derivative: 1-m contours
Derivative: 20ft contours compared w topo

Same measurement, different places
Derivative: Digital Elevation Model (DEM)
Derivative: Slope
Derivative: Slope shade
Derivative: Hillshade
Derivative: DEM as 3D in ArcScene
Applications in projects: Challenges and ways LiDAR helps
Challenges:

- GPS showed different xyz on topo map with respect to ridgeline
- What other features can be observed?
STATEMAP - Ellisville Geologic Quadrangle

- Identifying exact location
- Identifying elevation with improved accuracy
STATEMAP - Ellisville Geologic Quadrangle
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STATEMAP - Ellisville Geologic Quadrangle

- Trails/abandoned roads – good for hiking into remote areas
- Possible outcrops in cut banks
STATEMAP - Ellisville Geologic Quadrangle

- Identifying anthropogenic features
STATEMAP - Ellisville Geologic Quadrangle

• Identifying paleokarst features
• Challenges:
  • What is the broadest extent of the alluvium?
  • How/where to separate alluvium from terrace deposits?
Spatial statistics – histogram of elevation distribution (relative to river/stream elevation)

Peaks in elevation distribution can indicate terrace deposits vs alluvium
Elevation separation of surficial geology

Further explore those populations using surface profiles tools.
Next steps: Separate peaks to shapefiles for Qal and Qt – then cross check with field

Difficulties in areas changed by development
Environmental Karst Hydrology

• Challenges:
  • Locating sinkholes in large basins
  • Hydrology/drainage analyses
Details help identify surface to groundwater

7.5’ Topographic map

LiDAR

Topo map profile

LiDAR profile

1.2 km length
Impact to Coast from Hurricane

• Challenges:
  • Identifying shoreline change
  • Calculating sand volume change
  • If needing to rebuild beaches
Effects of Hurricane Ivan on West Perdido Key, Alabama

DEM of pre-hurricane with post-hurricane LiDAR allows change detection and volume calculation of erosion: how much sand needed for beach restoration
LiDAR Summary

Pros

• XYZ accuracy and detail
• Allows flexibility of final derivatives:
  • DEM resolution and contour interval
• Growing in availability and quality
• Temporally current so it captures:
  • Hazards, roads, anthropogenic features, etc.
• Detailed modeling capabilities
  • Hydrology, geomorphologic characterization, etc.

Cons

• Cost
• Large file size
• Processing
• Knowledge of LiDAR data
• Quality variation across study areas
• Does not come with placenames, roads, etc.
Topographic Map Summary

**Pros**

- Familiarity
- Anthropogenic features
  - Building footprints
  - Quarries/mines
  - Major roads
- Physical geography
  - Geographic features
- Elegant arrangement of labels/placenames
- Township/Range/Section

**Cons**

- XYZ errors due to limitations on:
  - Low contour interval
  - Dense forest
- Temporal limitations
  - Although new GeoPDFs have new roads, contours are still the same old lines
- Digital spatial limitations
  (zoom equal more detail – just larger pixels)
- Densely forested areas may obscure topo features
Future: Topo and LiDAR in Geo Mapping

• Tandem approach for geologic mapping
  • Using strengths of each, esp. for pre-field planning

• LiDAR: Generate new contours as a basemap for future quads
  • Many details still to work out...
  • When LiDAR coverage of all STATEMAP areas is available, GSA will begin using LiDAR for generating basemap products for geologic quadrangles
Future LiDAR Plans, Other Projects

• Many GSA projects and activities
  • Hazards
  • Coastal applications
  • Groundwater
  • Ecology
  • Oil/gas

• And as more LiDAR becomes available – more mapping and research use
  • Now 85% of AL counties have LiDAR
  • Thanks in part to USGS 3DEP
USGS 3D Elevation Program (3DEP)
Thank you

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References of Interest

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• LiDAR publications, USGS
  • https://www.usgs.gov/science-explorer-results?es=LiDAR

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• Geological Survey of Alabama
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