Developing Methodology for Efficient Eelgrass Habitat Mapping Across Lidar Systems

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Some background knowledge…

- Hurricane Sandy
  - Made landfall on October 29, 2012
  - $50 Billion in damages
  - Most of damage focused on coastal zones of New York, New Jersey, and Connecticut, USA
  - Huge data collection efforts in response to the storm
  - Airborne lidar bathymetry (ALB) collected in days immediately before and after storm- provides a unique opportunity to observe storm effects on backshore environments
Where is our study area?

- Barnegat Bay, NJ
  - Shallow, sandy, poorly flushed
  - Bordered by development
  - Two meters of storm surge during Sandy
  - Barrier island breach
  - Overwash
Our questions:

▶ How can we use lidar in conjunction with imagery to detect and classify submerged aquatic vegetation (SAV)?

▶ Is Object-Based Image Analysis (OBIA) an effective and efficient method for SAV classification?
  
  ▶ Object-Based Image Analysis: Identifies objects contained within geospatial data and structures them into a network
  
  ▶ Traditional manual classification from imagery is cumbersome- it is time consuming, and one person must classify all data sets

▶ Can one classification scheme be used across multiple lidar sensors?
Methodology: Manual classification

- Long-term time series for monitoring and possible storm impact assessment
- Many limitations due to imagery quality and variation in collection times
A brief introduction to lidar...

- Light Detection and Ranging
- Uses laser pulses to measure elevation or bathymetry
- Newer topobathymetric sensors allow for benthic mapping of waters too shallow for acoustic data collection methods

Topobathymetric Lidar

- Narrow beam, green laser (532 nm) lidar systems
  - Collects high resolution data (<1m footprint)
  - Suitable for backshore, intertidal and shallow nearshore areas

Benefits:

- The ability to rapidly survey very large areas
- The ability to collect data immediately after storm events, when debris may pose navigational hazards to small vessels for acoustic data collection
- Provides a more robust data set than other frequently used remote sensing techniques (imagery, satellite)
The systems we used

<table>
<thead>
<tr>
<th></th>
<th>Riegl VQ-820-G</th>
<th>AHAB Chiroptera II</th>
<th>USGS EAARL_B</th>
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<tr>
<td>Agency</td>
<td>NOAA NGS (National Geodetic Survey)</td>
<td>NOAA NOS (National Ocean Service)</td>
<td>USGS</td>
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<td>1.5 x secchi depth</td>
<td>2.5 x secchi depth</td>
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Methodology: eCognition, imagery, and lidar

- Benefits of lidar:
  - Can be flown immediately after a storm
  - High resolution data
  - Multiple data types (bathymetry, reflectance, more metrics coming soon)

- Object Based Image Analysis
  - eCognition uses a “holistic” approach to image classification - users can train rule sets based on their knowledge

Here, we compare methodology - is OBIA a faster way to get the same results as the current manual classification methodology?
Data Layers

Imagery

Reflectance

Elevation
Segment and Classify
What did we find?
Comparing methods

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<td>Perimeter to Area Ratio</td>
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What did we find?
Analysis across systems

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Mann-Whitney Test
What does this mean?

- No significant differences in classification between manual methods and OBIA using lidar and manual classification using imagery alone.
  - These methods are comparable for detecting and mapping SAV
  - Still need ground truthing to determine accuracy - this is difficult logistically

- No significant differences in classification for OBIA classification between lidar systems
  - This methodology can easily be applied to multiple data sets collected by multiple sensors
Caveats and considerations

- **Manual classification:**
  - Variation with imagery quality, depth
  - Time consuming
  - What one person sees as “dense” may be another person’s “sparse” - one person needs to classify all years

- **OBIA using lidar and imagery:**
  - More data layers
  - Large areas surveyed quickly
  - Efficient - once a rule set is developed, it can be used to classify large data sets
  - Lidar faces many of the same limitations as imagery - water clarity, wave action can affect data quality
What’s next?

- Is OBIA a more accurate method for SAV classification?
  - Intensive ground truthing in collaboration with Stockton College

- Analysis of EAARL-B lidar data collected pre- and post-Hurricane Sandy to assess the immediate effects of the storm

- Large-scale classification of Barnegate Bay from EAARL-B data, NJ coast from Riegl data

- The addition of several more lidar waveform metrics as a data layer for OBIA to create an even more robust data set
  - Can we differentiate between vegetation types?
What do those wave forms tell us?

Bottom returns: shape based features

- Pearson’s skewness coefficients
- Kurtosis
- Skewness
- Mean
- AUC
- Mode
- Median
- Width
- Amplitude
- Slopes
Gridded AUC
Thanks!

- Funding provided by NOAA
- Thank you to the USGS, Stockton College, and UVM’s Spatial Analysis Laboratory

If anyone is interested in an “OBIA for Marine Mapping” user group, please come see me!