Documenting Damage and Recovery across Bolivar Peninsula, Texas after Hurricane Ike using Object-Based Image Analysis (OBIA)

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Introduction

Global natural disaster costs

2011 Tohoku earthquake and tsunami, Natori City, Japan.
(Credit: AP Photo/Yasushi Kanno, The Yomiuri Shimbun)

Damage from EF5 tornado
Moore, Oklahoma, May 2013.
(Credit: FEMA)

OBIA can support disaster stakeholders

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Object based image analysis (OBIA)
Semi-automated - classify objects - remotely sensed data

- Data: High resolution imagery and elevation.
- Objects: Choice highly flexible = broad applicability.
- Results: Intuitively meaningful = clear communication.

High resolution imagery with OBIA overlay.

- Data: High resolution imagery and elevation.
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OBIA Rule Set

Sequence of algorithms

- Classes based on spectra + size, shape, texture, context (different from pixel-based approaches).
- Semi-automated once ruleset built. Faster, more consistent than manual interpretation.
Case Study

Hurricane Ike (2008) and Bolivar Peninsula, Texas

Location Map

Hurricane track (red) & study area (yellow)
Impacts on Bolivar

Buildings lost: > 65%
Transportation damaged
Eroded coastline/coastal dunes

Good study area
• Major impacts
• Data for 3 time periods (high res.)

Before and after photos, Bolivar Peninsula, TX
(Credit: USGS)
Study Questions

1. Can OBIA classify objects of interest to disaster stakeholders?
   
   Six test objects - Buildings, roads, water, 3 vegetation

2. Can rule sets be re-used (same data; different data)?
   
   Three data sets – Pre-storm, Post storm1, Post storm2

3. Can OBIA clearly document change through time?
Primary Data Sets

Aerial imagery
R, G, B, NIR

Lidar point clouds

Road vectors

2006
Texas Water Development Board
(~2m)

2008
Texas Ortho Imagery (TOP)
(0.5m)

2009
Texas Ortho Imagery (TOP)
(0.5m)

2009 USACE Post Hurricane Gustav / Ike
(~1m)

2010
NAIP (1 m)

Census Tiger/Line shapefile

Pre-storm

Post Storm 1

Post Storm 2

Introduction

Study questions / Methods

OBIA classification

Reuse / Change through time

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Methodology

Data Preprocessing
(ESRI ArcGIS w/ LP360 add-in)

- Lidar Point Clouds
  - Produce digital elevation models
- High res. Imagery (R, G, B, NIR)
  - Mosaic image tiles
- Vector Data sets
  - Digitize / customize

Object Based Image Analysis
(Trimble eCognition Developer)

1. Develop 2008 rule set; assess accuracy.
3. Modify rule set for 2010 data.

Export OBIA classifications.

Merge and review output for disaster applications (ESRI ArcGIS)
Digital Elevation Models

1. Bare earth DEM (ground)

2. First return DSM
   “digital surface model”

3. nDSM (height above ground)
   “normalized digital surface model”

Profile view – 2009 lidar point cloud

Map view – 2009 lidar point cloud

Used in OBIA
Q1: Can OBIA classify objects of interest? Yes.
Thematic Accuracy (2008)

Water

OBIA Water over imagery (Closer view)

With 2016 NHD “best resolution” overlay (yellow)
Buildings and Roads

**Provisional accuracies**

**Buildings:** 96% correctly classified  
5% commission errors

**Roads:** 96% correctly classified  
2% commission errors
Vegetation

- Trees ≥ 16 ft.
- Shrubs
- Low veg. < 2 ft.

Imagery only

Imagery with OBIA vegetation class overlay

Accuracy AOI
Q2: Could rule sets be reused in this study? 
Same data/different areas: Yes   Between time periods: No

2010 natural color imagery


Classified using 2009 rule set
Q3: Can OBIA document change through time? Yes.

Vegetation change
Building change
Water change
Roads least affected
Conclusions

Partly collapsed bridge, 2009 post storm classification, Bolivar Peninsula.

1. **OBIA can accurately classify objects of interest**
   - Concurrent data sets are best; NIR & elevation important.
   - Have specific goals in mind.
   - Subdivide large AOIs for efficient processing.
   - Distinct objects easiest to verify and communicate.

2. **Rule set reuse?** Yes (same time period/adjacent areas)  
   No (between time periods)

3. **OBIA can document change through time.**
Thank you