FIA Land Use and Land Cover Monitoring Portfolio

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Interior West FIA Program
FIA has non-forest land use and land cover variables. However, the “rolling average” nature of FIA’s annual sample design make it difficult to both:

- Link specific change in LULC with economic or regulatory events
- Identify recent changes

The Farm Bill directs us to enhance FIA’s monitoring of Land Use and Land Cover (LULC) Change.
Landscape Change Monitoring System (LCMS) – highest-quality national disturbance history maps soon to be viewable/query-able/downloadable through an app

Video courtesy of Ray Davis, NFS Region 6
Image-Based Change Estimation (ICE)

- Interpretation of FIA’s Use and Cover variables at two points in time, using NAIP imagery
  - Some simplification of classes needed
  - Now working on 3 points in time
- Workflow is approaching maturity, and has been implemented in states across all FIA regions
Image-Based Change Estimation (ICE)

Net Land Use Change Among All Classes

2005-2014

Forest Land Use Change

- No Change
- Loss
- Gain
- Both Loss and Gain
Image-Based Change Estimation (ICE)

Net Land Cover Change Among All Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Gain</th>
<th>Loss</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree Live</td>
<td>-0.839%</td>
<td>0.201%</td>
<td></td>
</tr>
<tr>
<td>Tree Standing Dead</td>
<td>0.235%</td>
<td>-0.284%</td>
<td></td>
</tr>
<tr>
<td>Shrub</td>
<td></td>
<td>-0.039%</td>
<td></td>
</tr>
<tr>
<td>Other Vegetation</td>
<td>0.391%</td>
<td>0.191%</td>
<td></td>
</tr>
<tr>
<td>Down and Dead Woody</td>
<td>0.292%</td>
<td>-0.237%</td>
<td></td>
</tr>
<tr>
<td>Baren</td>
<td></td>
<td>-0.021%</td>
<td></td>
</tr>
<tr>
<td>Impeccable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Inland Water</td>
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</tbody>
</table>

2005-2014

Tree Land Cover Change

Tree Cover:
- Gray: No Change
- Red: Loss
- Blue: Gain
- Yellow: Both Loss and Gain
TimeSync – Tool for efficiently accessing the entire Landsat archive and recording changes in land use and land cover (Cohen et al., 2010, RSE)

*Can be applied to a sample of points to support statistical estimates
Georgia Pilot Study

- Designed to test FIA options, including ICE, TimeSync and pre-stratification
- GTAC collected TimeSync data on all plots; ICE is already available
General Trends in Georgia LULC via TimeSync

Change in Land Cover Over Time

Change in Land Use Over Time
We do have information about the nature of transitions over time, but the proportions are so small that we don’t get good confidence intervals.

North-Central and Southeast Georgia
Interpreting high-resolution imagery at different points in time allows statistical estimation of LULC at relevant scales.
Integrating photos with Landsat and the most recent plot measurements does several things:

- Gives better temporal perspective
- Increases interpretability
- Improves link between FIA non-forest variables and enhanced estimates
- Opens up efficiencies in pre-field data collection
US government considers charging for popular Earth-observing data

Images from Landsat satellites and agricultural-survey programme are freely available to scientists – but for how long?

Gabriel Popkin

Side note: changing the USG open-data policy would likely increase the cost of any enhancement beyond FIA’s budget
GEDI (Global Ecosystem Dynamics Investigation)

Investigator-led Venture-Class mission, launching 2018/19
(PI: Dubayah)
GEDI observes canopy structure by collecting waveform lidar data over 25-m footprints

- Waveforms describe how dense the canopy is at different heights above the ground
- 20 years experience using similar measurements from LVIS
GEDI will launch in late-2018 or early-2019
Range: 51°S to 51°N

Footprints will be acquired roughly in a lattice pattern (500-m cross track, 60-m along-track spacing), although the forest in many cases will be obscured by clouds.
OBI-WAN
Online Biomass Inference using Waveforms And Inventory
Problem Statement: International reporting of forest carbon stocks requires methods with good statistical properties, including:

1. Clear assumptions
2. Clear uncertainties
3. Strong foundation in theory

But,
We lack ground data that is:

1. Dense enough to allow localized estimates
2. Globally consistent
3. Collected in inaccessible areas

We want: Carbon storage reports that are consistent across scales and space, and that are based upon high-quality measurements and sound statistical theory
1. User inputs shapefile to a Google Earth Engine app (200-hectare minimum)
2. OBI-WAN accesses GEDI’s plot/model/lidar database, supplemented with Landsat archive stored on Google Earth Engine
3. Uncertainty is tracked through hierarchical model-based inference
4. Customized forest biomass report is generated, including estimates of mean biomass, standard error of the mean, and thorough documentation
Potential applications of OBI-WAN include reporting carbon stocks for:

- Forest reserves
- Individual companies
- Municipalities from villages to countries

Estimates of forest carbon will be available through OBI-WAN starting in mid-2020.