Large-Scale Land Transactions as Drivers of Land-Cover Change in Sub-Saharan Africa
Global data sets on land transactions underestimate the total number of transactions (e.g. LMI=92, Ethiopia=833)

Not all transacted land is implemented as intensive agriculture

Non-representative samples confound conclusions about effects of geography, socioeconomic differences, and contractual arrangements

**Insufficient Research on Land Grabs**

Extant Narratives

“Land Grabs”


“Agricultural Intensification”

Project Objectives

Large Land Deals

- Obj 1: Collect spatial data on large deals

Q1: Variation in Patterns of Deals

- Obj 2: Assess variation in deal profiles across sub-national spatial units

Q2: Socio-ecological impacts

- Obj 3: Analyze forest and land-cover impacts
- Obj 4: Analyze economic and livelihood impacts

Synthesis

- Obj 5: Incorporate large-scale land tenure changes into conceptual frameworks on synergies and tradeoffs in LCLUC outcomes.
Q1: Detecting Transactions

- Boundary data for tenure changes difficult to acquire
  - often either over or under-estimate implementation area
- Joint workshop with Land Matrix Initiative (LMI) Oct 2018
  - Collaborations initiated with LMI, JRC

Yan & Roy (2014); Graesser & Ramankutty (2017); Yin et al. (2018); Kennedy et al. (2010); Kennedy et al. (2018)

Goal is to identify area and timing of implementation
Compared to Smallholder Systems in Ethiopia

- Control sites from outside the transaction vs sites from inside the transaction
- Located in the Rift Valley

Trajectory 1 – Smallholder Agriculture to Intensified

Analysis: Carly Muir, UFl
Compared to Woody Savanna/Forest in Ethiopia

Trajectory 2 - Woody Savanna/Forest to Intensified

[Graph showing data over time]

[Map images with labels: Control, Transaction]
Distinguishing Forest and Palm Oil in Liberia

Analysis: Sadie Trush, UW
Vegetation Indices (VI):
- NDVI
- EVI
- SAVI

Phenology Profiles

Monthly Composite of each VI

Normalized Difference Vegetation Index
Enhanced Vegetation Index
Soil Adjusted Vegetation Index
Phenology Profiles

April

EVI Plantation

September

EVI Forest

Q1 Q2 Mean Q3
Machine Learning

Threshold VI Q3’s

Monthly Masks

Urban Mask

Classification

randomForest

Plantation Identification

Training Accuracy ≈ 93%

Validation

Digital Globe and Known Boundaries

e.g. Greenville, Liberia

with VI’s

with Q3 threshold
Q2: Site-Based Analysis

Identify Treatment and Control Areas
   Acquire CAD4NASA imagery
   Eight sites in Ethiopia, and four each in Tanzania and Liberia

LULC Classification
   Segmentation-based manual classification
   Manually mapping house of rooftops
   Testing *inter-rater variability* measure

Social Surveys
   Collection of ~1200 household surveys in each country
Propensity Score Matching

Before matching

- Transacted area (treatment)
- Buffered area (control)
  - Systematic points in control area
  - Systematic points in treatment area

After matching

- Transacted area (treatment)
- Buffered area (control)
  - Non-matched points in control area
  - Systematic points in treatment area
  - Matched points in control area
Polygon-based Matching

Grow 20 polygons as candidates

Purple points are those within all 20 candidate polygons

Black points (n=92) are those within polygon 15

Liao et al. In Prep
Image Processing Workflow

1. Raw NGA Images
2. Images Sorted by Transaction Sites
3. Imagery orthorectified and segmented
4. Sites Broken Into Samples
5. LULCC Analysis
6. Storage of Results
7. Digitization By Analysts
8. Validation Measure: Inter-Rater Variability
Inter-Rater Variability

Classification by each analyst

Selection of polygons: GM1, OR2, and BG3

Confusion Matrix, Contingency Tables and Comparative agreement statistic

Inter-rater agreement:
72% from multi-spectral imagery, lower for pan

(11) Small-holder Ag  80.5%
(13) Intensive Agriculture  70.2%
(21) Forest  58.4%
(23) Woodland/Sav.  78.7%
(32) Bare/Exposed Soil  34.3%
(41) Rural Settlement  14.0%
(42) Development  78.9%
(51) Water  10.6%

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One of Eight Ethiopian Sites

Control

Treatment
Smallholder Ag persisted in **68% of Treatment sites** and **52% of Control sites**.
Prevalence of Transitions

- Treatments had more conversion to intensive ag
  - Controls had very little
- Also more abandonment of smallholder
  - Slightly less extensification

Preliminary Results
Household Surveys

Status:

Liberia, complete

Ethiopia, stalled by civil unrest

Tanzania, underway
Effects on Livelihoods in Liberia

• More than 45% of total land area is under some type of concessions

• Forestry concessions
  • 7 Forest Management Contracts (FMCs)
    • larger and have not been fully implemented
  • 39 Private Use Permits (PUPs)
    • smaller and have been fully implemented

• We evaluated livelihood impacts
  • DHS asset-based wealth index (electricity, tv, table, water source, floor, roof, etc)
• Treatment group
  • Household clusters within 2km of concession boundaries

• Control group
  • Household clusters between 2km and 10km from concession boundaries
  • Sensitivity check: up to 12, 14km

Results show:

- **Higher** wealth for households living closer to *active* forest concessions
- Driven by demand for goods and services and increased employment in all-year and non-subistence jobs.
- Could be short-lived
Q3: Synthesis Activities to Date

- Invited workshop on Land Transactions, Ann Arbor, April 2016
  - Focus on bridging qualitative-quantitative approaches, and case studies to generalized patterns.
- Organized session at AAG, Boston, April 2017
  - Focus on Coupled Human-Natural Systems
- Workshop on Remote Sensing of Land Transactions with Land Matrix Initiative, Bern, Switzerland, Oct 2018
- Organized session at AAG, Washington DC, April 2019
- Organized session at GLP, Bern, Switzerland, April 2019
- Planned Special Issue, manuscripts due Sept 2019.
- High-profile synthesis publications.
Thank You