The role of land cover data in limiting biofuels' GHG emissions

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THE UNIVERSITY OF ILLINOIS AT CHICAGO

UIC

Since the inception of major biofuels policy in the United States, the quality and frequency of land cover data has increased.

- National Agriculture Imagery Program has increased resolution to 1 meter
- Google Earth has become a major platform for open-source land cover analyses
- Private companies such as Planet acquire high-frequency, high-resolution imagery

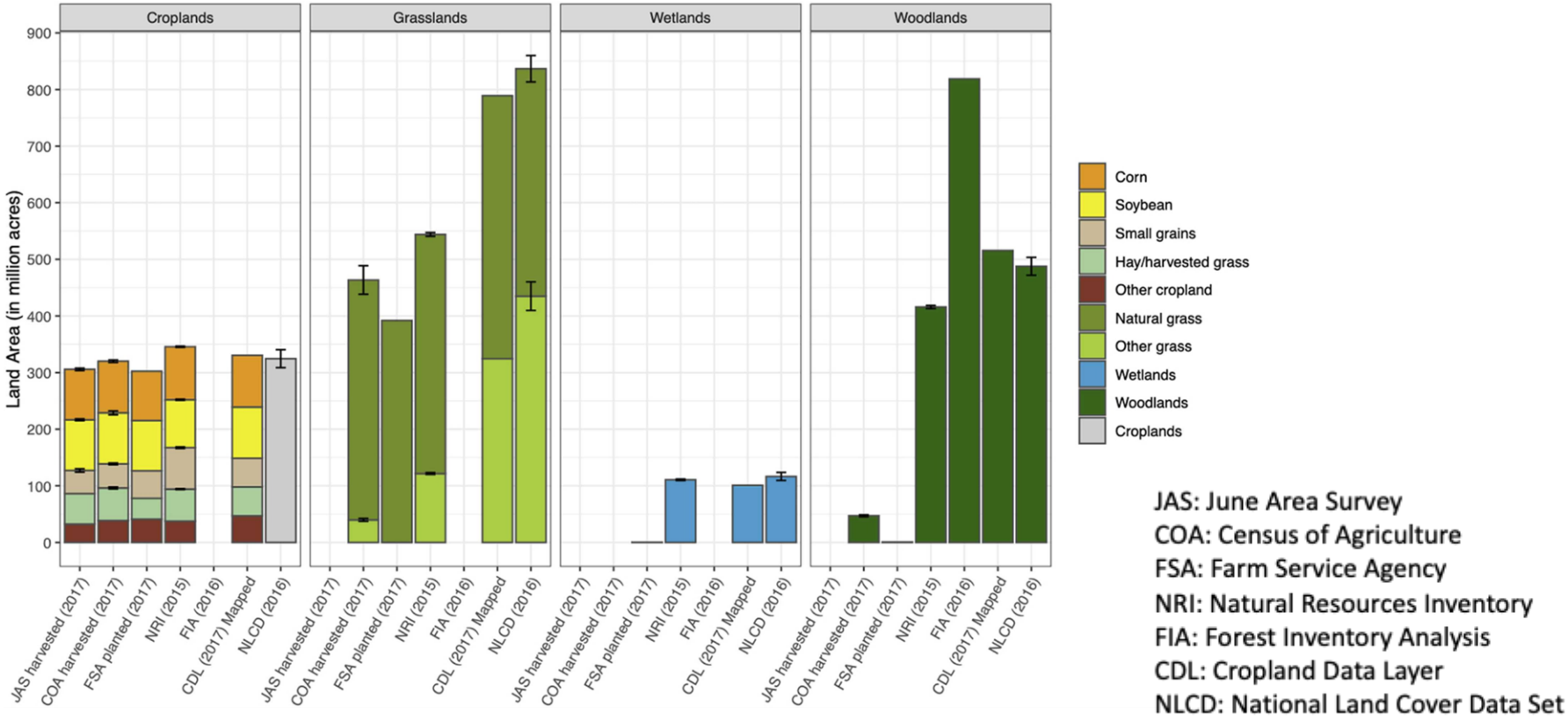
With these data available, what are the complementary roles of LUC GHG modeling and land cover data in understanding land cover changes and whether policies targeting biofuels with low life-cycle GHG emissions are achieving their desired outcomes?

Summarized the methodology, frequency, resolution, and accuracy of

- June Area Survey
- Census of Agriculture
- Farm Service Agency crop acreage data
- National Resources Inventory
- Forest Inventory Analysis
- National Wetland Inventory
- Cropland Data Layer
- National Land Cover Dataset

Data in these models is often used to help parameterize LUC models or evaluate their results.

Wang, Minzi; Wander, Michelle; Mueller, Steffen; Martin, Nico; Dunn, Jennifer. "Evaluation of survey and remote sensing data products used to estimate land use change in the United States: Evolving issues and emerging opportunities." *Environmental Science and Policy*, **2022**, 129: 68-78.



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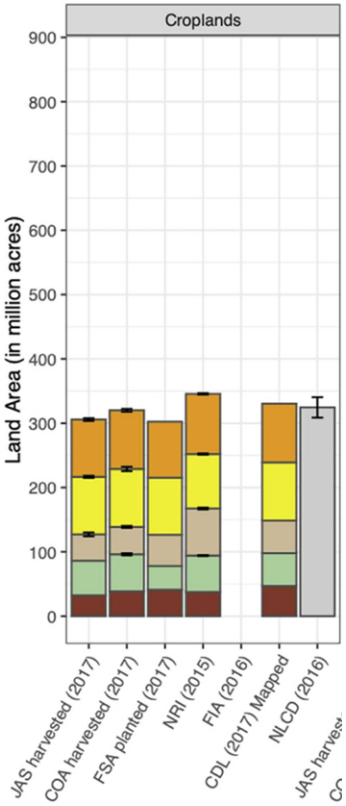
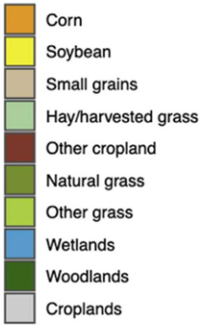


Good agreement regarding total amounts of cropland

Hay, harvested cropland and small grains categories show the most variation



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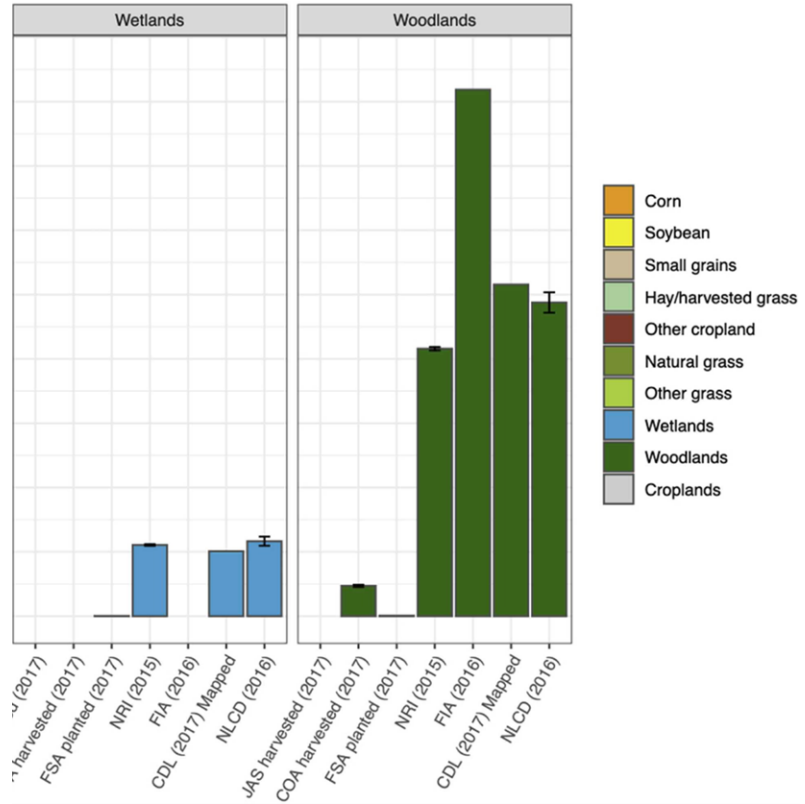
Reasonable agreement on wetland area

Woodlands area shows a surprising amount of variation

Forest Inventory Analysis shows the largest amount of woodlands



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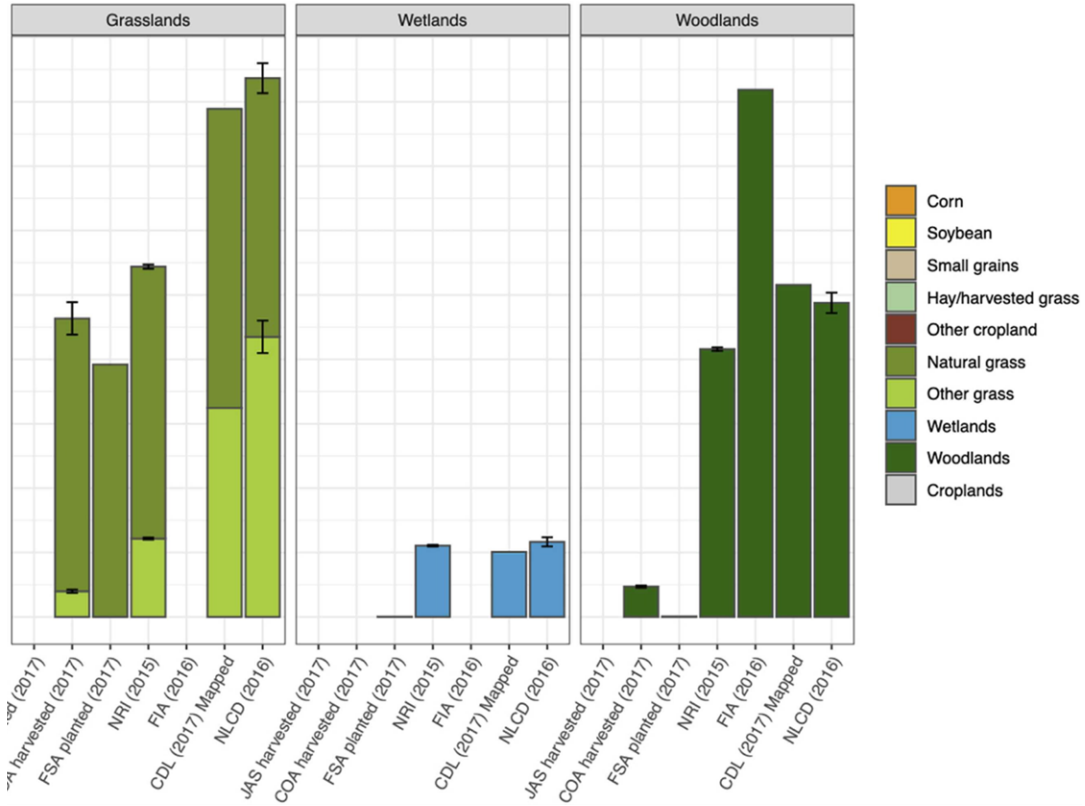
Grassland area varies greatly between survey and remote sensing based methods of estimation



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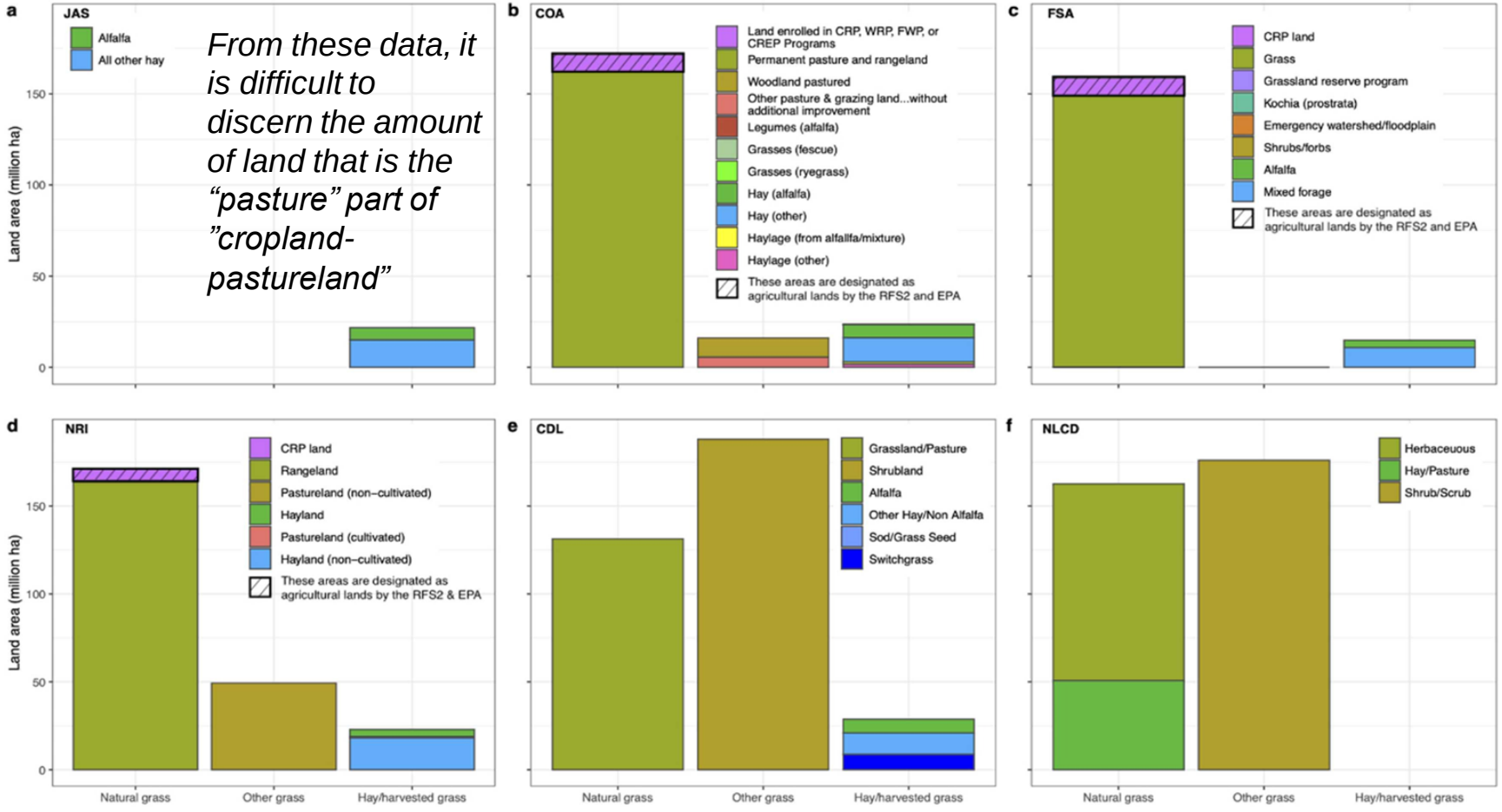
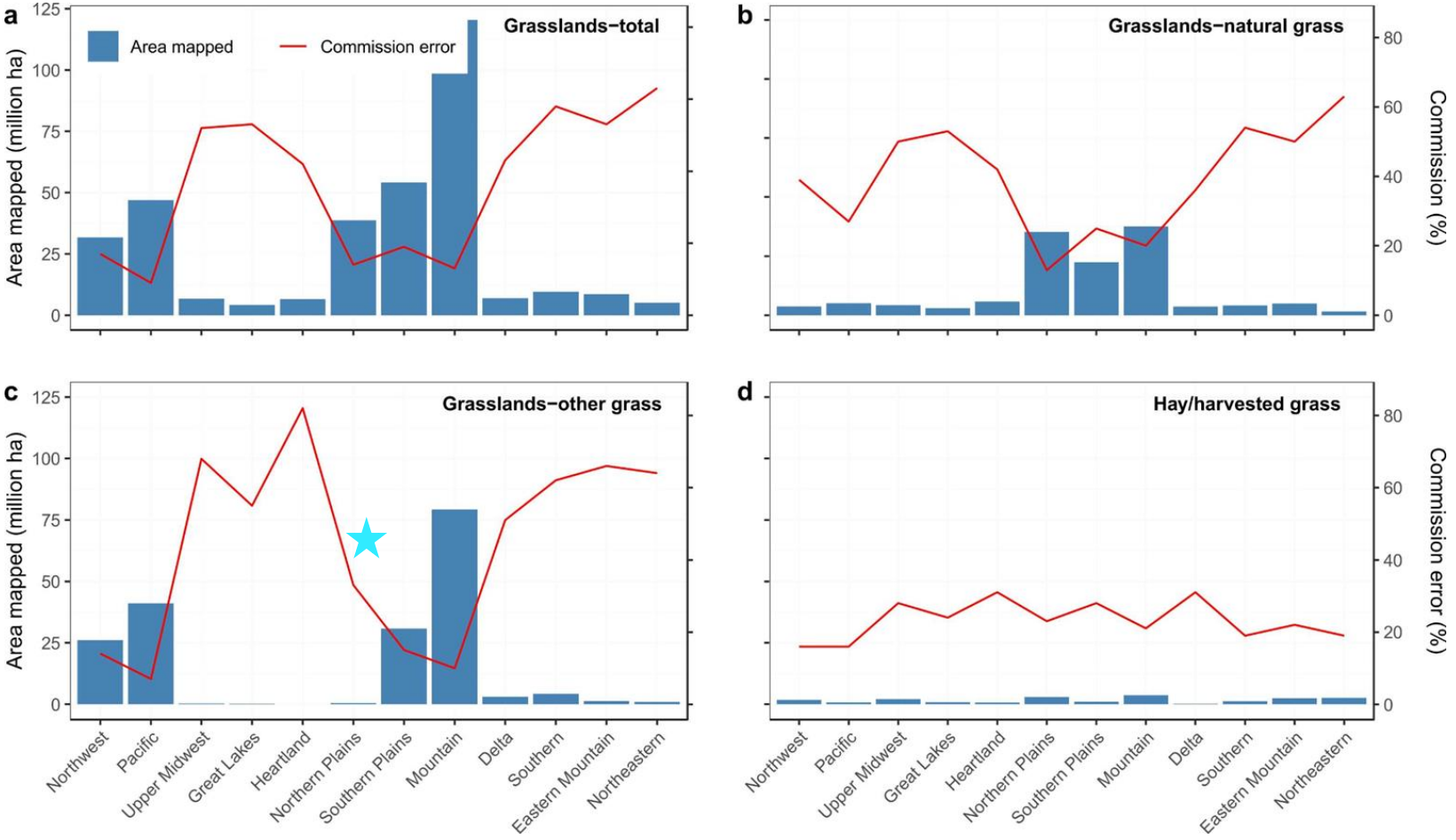

a
JAS
Alfalfa
All other hay
Land area (million ha)
150
100
50
0
b
COA
Land enrolled in CRP, WRP, FWP, or CREP Programs
Permanent pasture and rangeland
Woodland pastured
Other pasture & grazing land...without additional improvement
Legumes (alfalfa)
Grasses (fescue)
Grasses (ryegrass)
Hay (alfalfa)
Hay (other)
Haylage (from alfalfa/mixture)
Haylage (other)
These areas are designated as agricultural lands by the RFS2 and EPA
c
FSA
CRP land
Grass
Grassland reserve program
Kochia (prostrata)
Emergency watershed/floodplain
Shrubs/forbs
Alfalfa
Mixed forage
These areas are designated as agricultural lands by the RFS2 and EPA
From these data, it is difficult to discern the amount of land that is the "pasture" part of "cropland-pastureland"
d
NRI
CRP land
Rangeland
Pastureland (non–cultivated)
Hayland
Pastureland (cultivated)
Hayland (non–cultivated)
These areas are designated as agricultural lands by the RFS2 & EPA
Land area (million ha)
150
100
50
0
Natural grass
Other grass
Hay/harvested grass
e
CDL
Grassland/Pasture
Shrubland
Alfalfa
Other Hay/Non Alfalfa
Sod/Grass Seed
Switchgrass
Natural grass
Other grass
Hay/harvested grass
f
NLCD
Herbaceuous
Hay/Pasture
Shrub/Scrub
Natural grass
Other grass
Hay/harvested grass

The less grassland in a region, the higher the commission error of the data.



isprs International Journal of Geo-Information

MDPI

Article

Examining the Characteristics of the Cropland Data Layer in the Context of Estimating Land Cover Change

Ken Copenhaver [1,*], Yuki Hamada [2], Steffen Mueller [3], and Jennifer B. Dunn [4]

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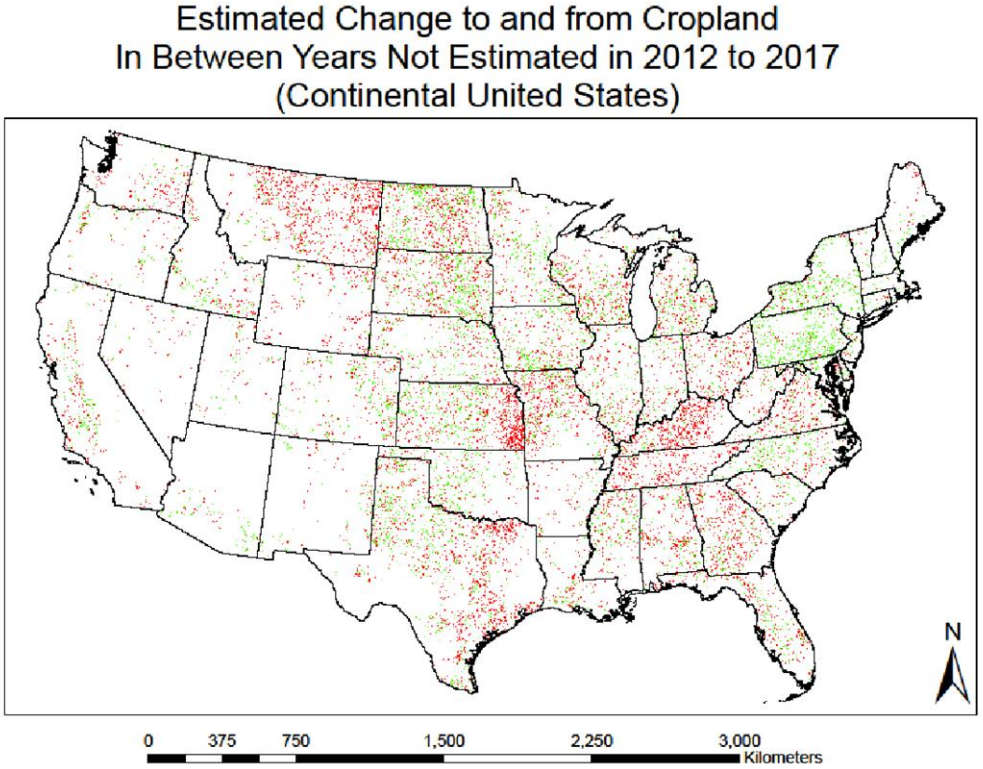
[4] Northwestern University; jennifer.dunn1@northwestern.edu

Issues with Cropland Data Layer And Estimating Land Cover Change

All land in green and red on the map is land that is being estimated as change in years between 2012 and 2017 but is not identified as change from 2012 to 2017.

Much more land moving in and out of crop than consistently indicating change.



Key conclusions from data source summary

Economic modeling relies heavily on cropland-pasture and/or “marginal lands” yet data sources diverge on the amounts of these lands that exist

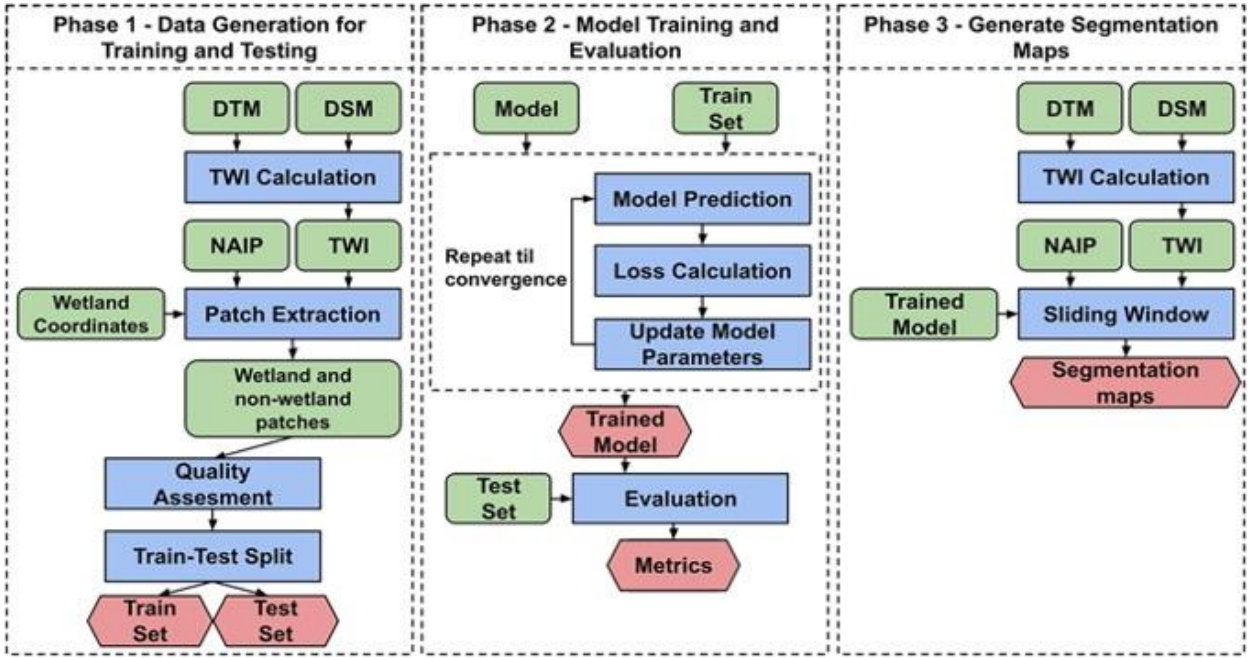
Modeling therefore needs to acknowledge and account for this limited information

Modeling should investigate variation in this land type as an initial condition and a range of results should be reported along with uncertainty estimates.

Caution is merited when we try to apply these data sets to retrospective analyses of LUC GHG emissions.

There is an urgent need for improved accuracy in improving tracking of marginal lands classified as grassland-other, or CRP and wetlands, that are vulnerable to agricultural expansion

Machine-learning as a tool to interpret high-resolution aerial imagery - National Agricultural Imagery Project



López-Tapia S, Ruiz P, Smith M, Matthews J, Zercher B, Sydorenko L, Varia N, Jin Y, Wang M, Dunn JB, Katsaggelos AK. "Machine Learning with High Resolution Aerial Imagery and Data Fusion to Improve and Automate the Detection of Wetlands." International Journal of Applied Earth Observation and Geoinformation. 2021, 105: 102581.

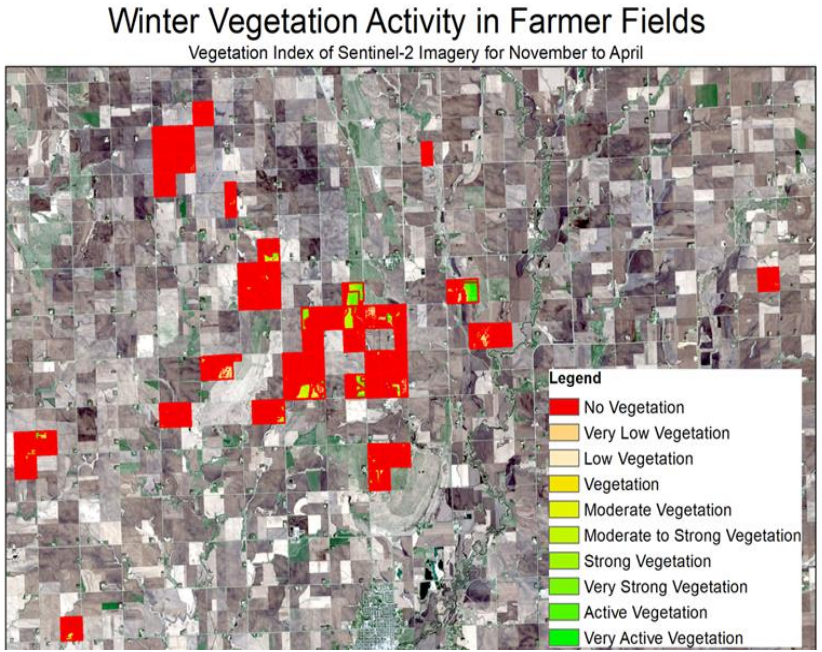
Red: Ground truth
Blue: Area segmented by model as wetland

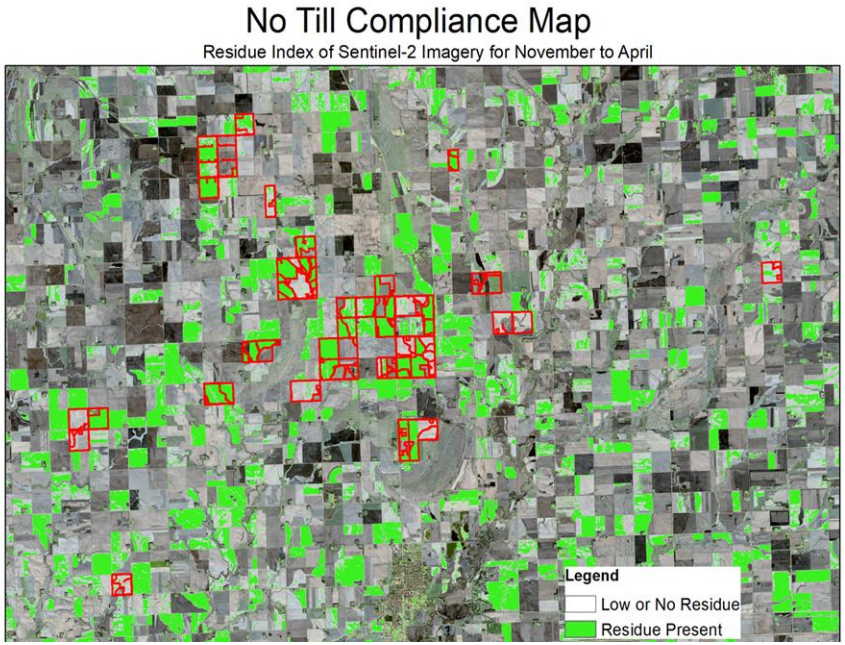
López-Tapia S, Ruiz P, Smith M, Matthews J, Zercher B, Sydorenko L, Varia N, Jin Y, Wang M, Dunn JB, Katsaggelos AK. "Machine Learning with High Resolution Aerial Imagery and Data Fusion to Improve and Automate the Detection of Wetlands." International Journal of Applied Earth Observation and Geoinformation. 2021, 105: 102581.

Satellite Data to Reduce Uncertainty Associated with Land Use Management and Low iLUC Land Identification

Use of Remote Sensing to Determine Land Management

Remote Sensing can inform cover crop, double cropping, soil carbon management, residue removal for potential consideration in LCA modeling

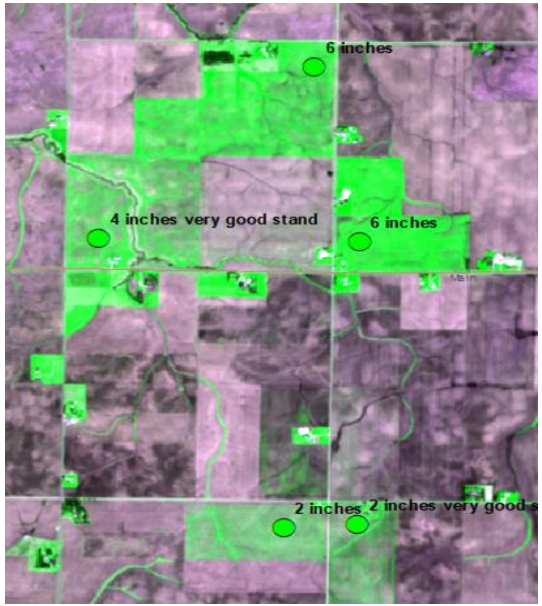




Remote Sensing Source: Ken Copenhaver, CropGrower LLC

Identification of Cover Crop, Residue Removal, and Double Cropping

- Fall and Spring Imagery from Sentinel-2 is used to identify vegetation
- Further geospatial analysis focused on polygon shape separates cover crop from weeds and buffers.
- After analysis to remove other vegetation types accuracy is 89%.



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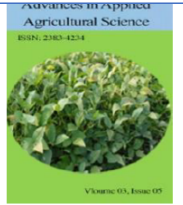

Research Article

Handling of co-products in life cycle analysis in an evolving co-product market: A case study with corn stover removal

Steffen Mueller[1], Stefan Unnasch[2], Wallace E. Tyner*[3], Jennifer Pont[2] and Jane M-F Johnson[4]

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[3] *James and Lois Ackerman Professor, Purdue University, Department of Agricultural Economics, 403 West State Street, West Lafayette, IN 47907-2056.*

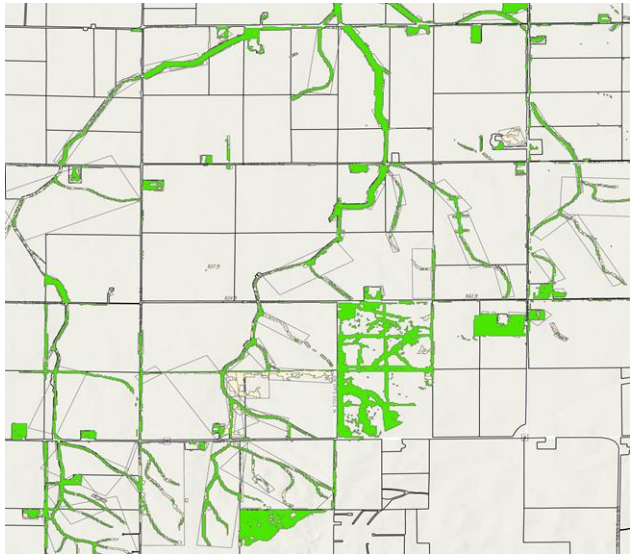
[4] *USDA-Agricultural Research Service, North Central Soil Conservation Research Laboratory, 803 Iowa Ave. Morris, MN 56267. E-mail: Jane.Johnson@ars.usda.gov*

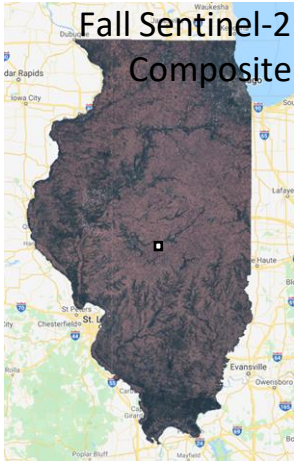
Remote Sensing Source: Ken Copenhaver, CropGrower LLC

Identification of In-field Buffers in Illinois

Project Sponsors: The Nature Conservancy & Illinois Corn Growers

- Fall and Spring Imagery from Sentinel-2 is used to identify vegetation
- Further geospatial analysis focused on polygon shape separates buffers from weeds and cover crop.
- After analysis to remove other vegetation types accuracy is 84%



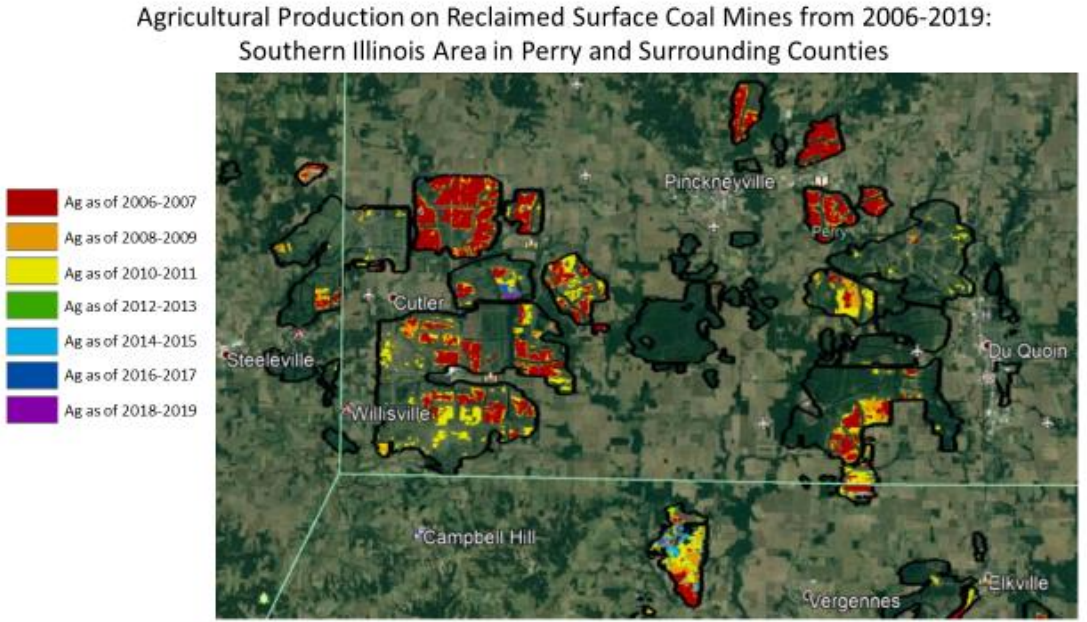


Remote Sensing Source: Ken Copenhaver, CropGrower LLC

Use of Remote Sensing for Low iLUC Risk Lands under CORSIA/EU RED

Ag Land Reclaimed from Coal Mining

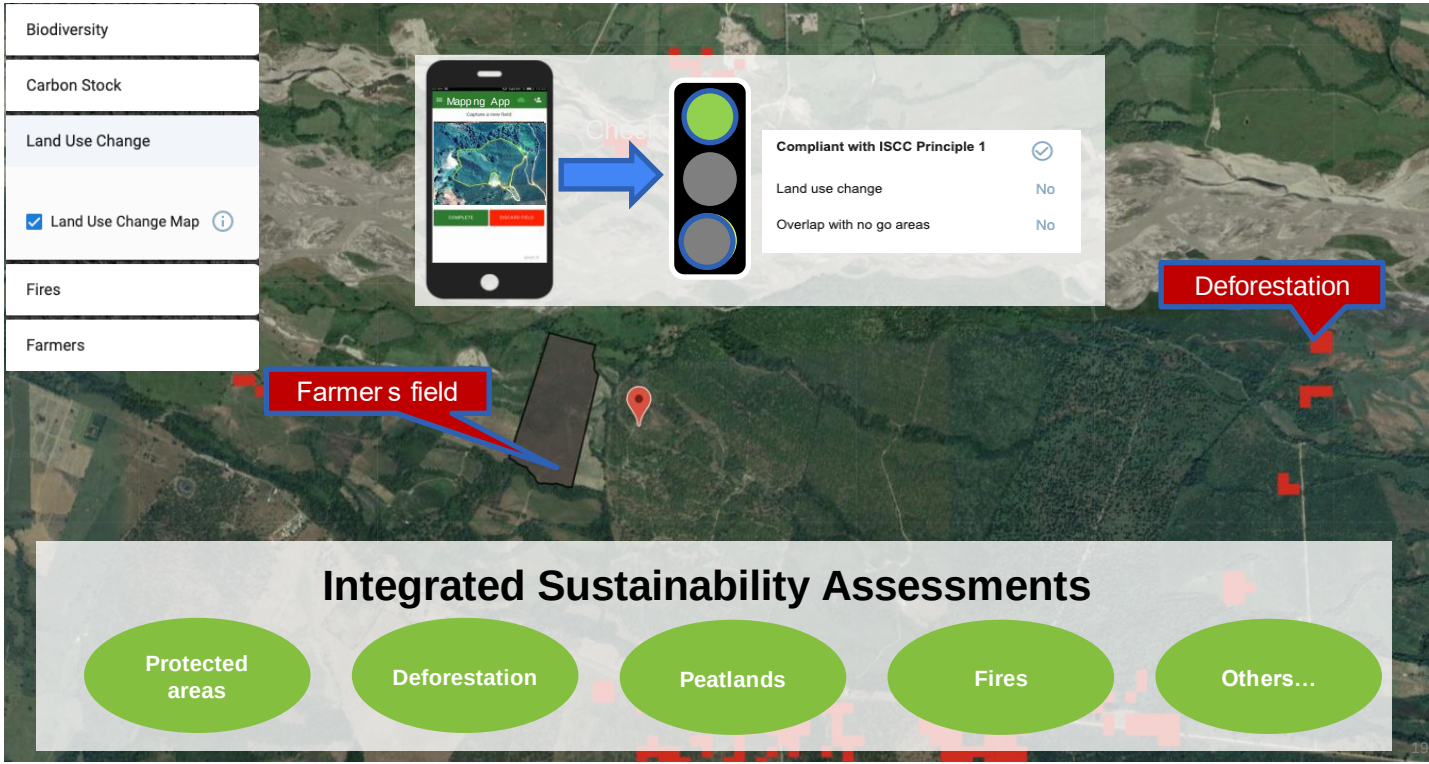
- Performed for International Sustainability and Carbon Certification (ISCC)
- Technical pilot for SAF certification



Source: Southern Illinois University Edwardsville, LASA, Pearson, Pritsolas; Randy Pearson, Joshua Pritsolas, Steffen Mueller

EU Approach

- iLUC not included in ethanol plant-level GHG calculations
- But certification requirements at field level scale by EU recognized protocol
- Individual Protocols support digital tools for farm-level land use and land management verification
- LUC verification is risk based, checks for encroachment into protected areas, deforestation, peatlands, etc.



Conclusions

- Land use change modeling should **explore sensitivity to choice of data source for initial conditions** (e.g., amount of land in grassland, cropland-pastureland)
- Land use change modeling should **report uncertainty**
- Use of remote sensing data to assess lands for low iLUC risk is possible
  - Double cropping, cover crops, residue removal, marginal lands
- Use of remote sensing to determine land management practices (reduced till, field buffers) has increased in accuracy over the last decade and can be incorporated into modeling
- Given the advances in spatial and temporal resolution of remote sensing and aerial imagery data, EPA should invest in and monitor improvements in AI-based methods for interpreting these data sets
- The agency should continue to evaluate the possibility of replacing a single LUC GHG estimate for an individual biofuel with economic modeling to identify high LUC-risk areas and monitoring of those areas with high-resolution satellite data