University of Idaho

BIOFUEL GREENHOUSE GAS MODELING

SESSION 3: FEEDSTOCK SUPPLY AND LAND USE CHANGE

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Feb 28,2022

The premise

- RFS2 Mandate:
  - The ‘‘Energy Independence and Security Act (EISA) of 2007’’ defines the term ‘lifecycle greenhouse gas emissions’ as the aggregate quantity of greenhouse gas emissions (including direct emissions and **significant indirect emissions such as significant emissions from land use changes**)

Earlier model forecasts

1. As fuel demand for corn increases, soybean and wheat lands switch to corn, prices increase by 40%, 20%, and 17% for corn, soybeans, and wheat, respectively.
2. U.S. agricultural exports decline sharply (corn by 62%, wheat by 31%, soybeans by 28%, pork by 18%, and chicken by 12%).
3. **When other countries replace U.S. exports, farmers must generally cultivate more land per ton of crop because of lower yields.**
4. **The US will bring 10.8 million acres of additional land into agriculture.**

Source: T. Searchinger, R. Heimlich, R.A. Houghton, F. Dong, A. Elobeid, J. Fabiosa, S. Tokgoz, D. Hayes, T.H. Yu, Use of U.S. croplands for biofuels increases greenhouse gases through emissions from land-use change, Science 319 (5867) (2008) 1238–1240.

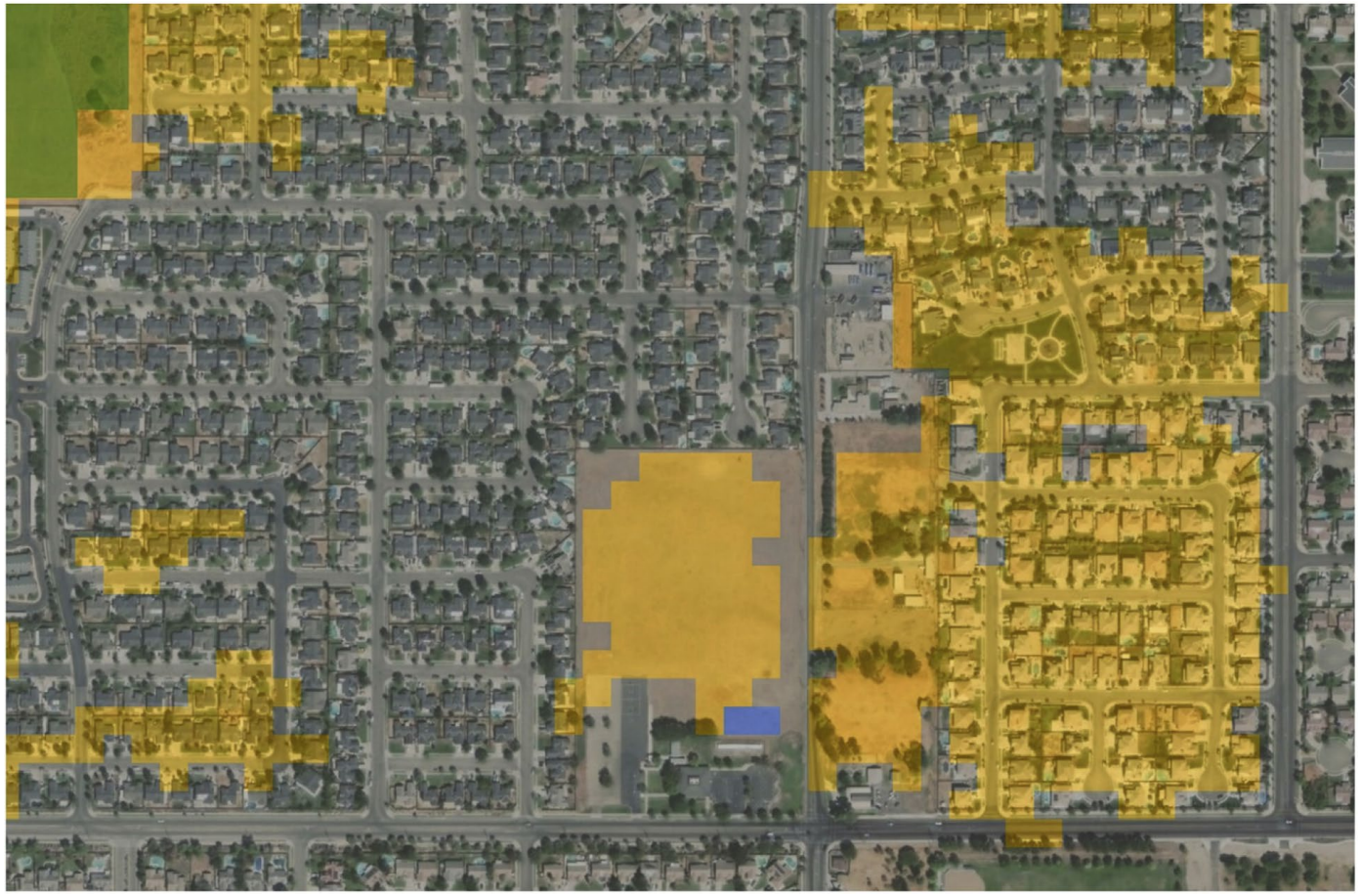
Evaluation method

- Automatically-classified satellite imagery was used by some researchers to estimate the amount of agricultural land use change.
- We[1] evaluated the automated classification error for various crop type and landscape.
- We used NASS CropScape Cropland Data Layer (CDL) and National Land Cover Database (NLCD) data on selected areas for the years 2011 and 2015.
- The locations for manual verification were chosen for their differing climates and proportion of land types

[1]Shrestha, D. S., B. D. Staab and J. A. Duffield (2019). "Biofuel impact on food prices index and land use change." Biomass and Bioenergy **124**: 43-53.

Some Classification errors were Blatant

city of Lemoore, CA



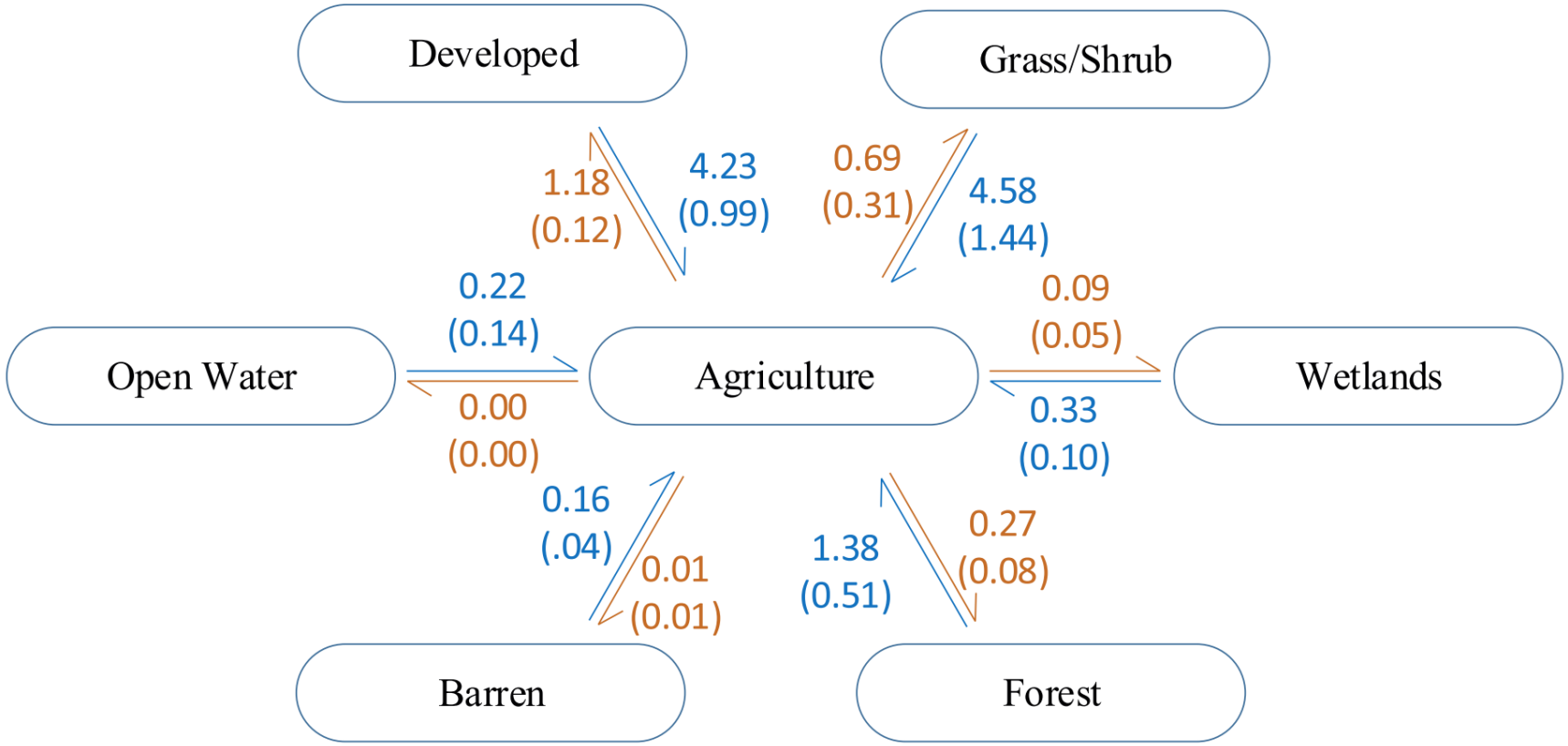
cropland (yellow), open water (blue) and grass/shrub (green)

Classification Accuracy

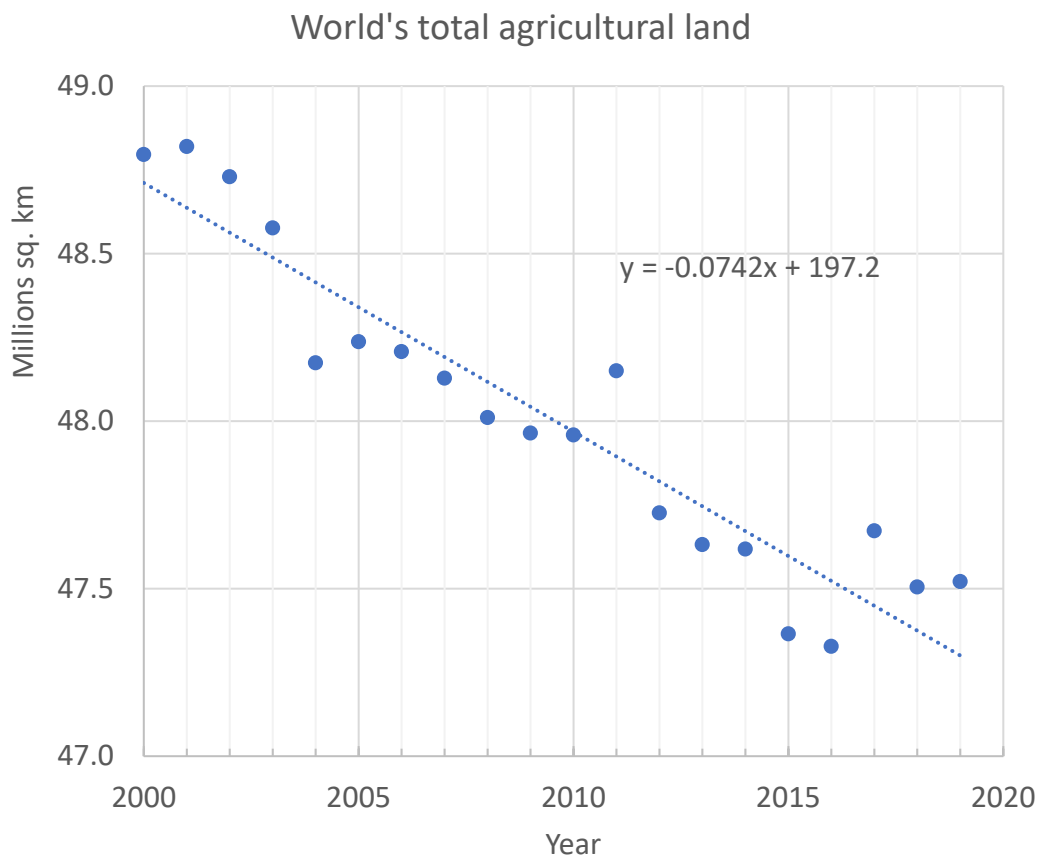
Table 1
Percentage of total land incorrectly classified in CDL and NLCD data for the selected region in the year 2011 and 2015.

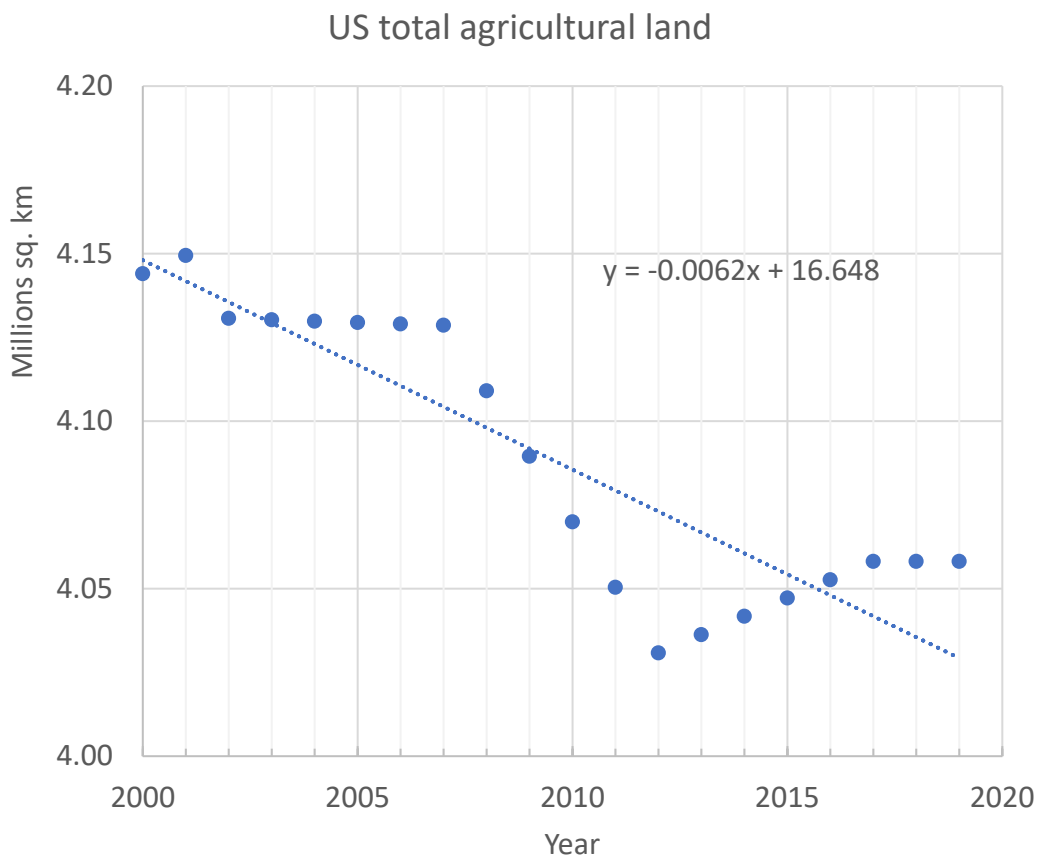
Data Source[a]	Percent of total land incorrectly classified as								
	Developed	GLS	AG	GLP	Wetland	Forest	Barren	Water	Total
CDL ID 2015	2.13	5.38	7.45	2.79	0.00	0.07	0.00	1.38	19.19
CDL CA 2015	2.49	0.01	19.19	0.16	0.65	0.08	0.12	0.00	22.71
CDL NY 2015	2.43	1.39	6.15	9.87	0.08	7.98	0.43	3.15	31.48
CDL ID 2011	2.45	3.36	3.08	21.75	0.00	0.02	0.00	1.83	32.50
CDL NY 2011	2.32	2.98	8.81	4.80	0.07	3.93	0.50	14.02	37.41
NLCD ID 2011	1.85	2.05	15.94	N/A	0.00	0.11	0.00	1.91	21.87
NLCD NY 2011	2.48	1.67	15.66	N/A	0.03	8.37	0.00	1.68	29.90
Average Error	2.31	2.41	10.90	7.87	0.12	2.94	0.15	3.43	27.86
Standard Error	0.09	0.65	2.27	3.23	0.09	1.45	0.08	1.80	2.52

Error specific to agricultural land



Agricultural land is declining





Source: www.fao.org/faostat/en/#data/RL

Be careful with satellite image interpretation

- Limitations of statistical image classifier
- Similarity in grassland and cropland pixels
- Change in land type definition over time
- Image pixelation and image timing
- Temporary land use change

Cause of land use change

- Economic (legal and illegal mining and other activities unrelated to commodity prices)
- Biophysical (fire, pests)
- Cultural (communal decision making)
- Technical (slash and burn to boost fertility)
- Demographic (rapid growth of populations and the rural poor)
- Political (Policy change, Programs to help the landless poor)

Using satellite data for biofuel land use change

- As a verification tools for economic model predictions in a regional basis
- To capture general trend of land use change
- Provides opportunity for data mining
- Complement farm surveys in land use.

Take-home messages

- RFS2 mandates stipulates inclusion of significant land use change in biofuel life cycle analysis.
- Automated satellite image classifiers has been used in the past to quantify land use change.
- Automated image classifier has average error rate of 28% compared to human classification when tested over various geographical area.
- Agricultural land is steady declining in US and in the World.
- Ground truthing is important to evaluate classification error.
- Quantifying land use change cause by biofuel is not easy.