Mapping Smallholder Forest Plantations in Andhra Pradesh: Machine Learning Using

Multitemporal Harmonized Landsat-Sentinel 2 S10 Data

Randolph H. Wynne, Valerie A. Thomas, Paige T. Williams, Snehal More, Haripriya Gundimeda, V. B. Ramana Murthy, Stella Schons, Gregory S. Amacher, Kelly C. Cobourn

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PROJECT

ANDHRA PRADESH FORESTRY

OVERVIEW | DETAILS | FINANCIALS | PROCUREMENT | RATINGS | RESULTS | MAP | DOCUMENTS | NEWS & MEDIA

ABSTRACT*

The report discusses how this project will finance a 6-year program to support: (a) forestry works on about 355,000 ha. This will consist of regenerating or afforesting degraded forest areas on about 173,000 ha with multi-tier coverage under

India BSE 314.50 NSE 313.95

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No.3A/86-FP
Ministry of Environment and Forests
(Department of Environment, Forests & Wildlife)

Paryavaran Bhavan, CGO Complex,
Lodi Road, New Delhi - 110 003.
Dated the 7th December, 1988.

RESOLUTION

National Forest Policy, 1988

A.P. Forest Development Corporation Ltd.,

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Eucalyptus

Eucalyptus Plantations

THE HINDU

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10 India negotiates release of 30 Indians from two ships in Iranian custody
11 Yogi Adityanat Sonbhadra bla Congress, Sam

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SCI-TECH & AGRI

Yes we can, indeed we must, restore forests

D. Balasubramanian

JULY 21, 2019 00:00 IST
UPDATED: JULY 21, 2019 03:33 IST

Science Contents News Careers Journals

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REPORT

The global tree restoration potential

Jean-Francois Bastin[1,*], Yelena Finegold[2], Claude Garcia[3,4], Danilo Mollicone[2], Marcelo Rezende[2], Devin Routh[1], Constanti…

+ See all authors and affiliations

Science 05 Jul 2019:
Vol. 365, Issue 6448, pp. 76-79
DOI: 10.1126/science.aax0848

Potential of C sequestration in long-lived forest products now also part of the global conversation…

Shobhan Mittal says Greenply is Setting up Asia's Largest Environment Friendly MDF Plant

Nov 14, 2017, 5:40 PM IST Greenply Tweet

Read this story on TOI

Conversion from rice to typical clonal hybrid Casuarina plantation. The Forest Survey of India notes tree cover > 11,100 km² was added during the period 2001 to 2015.

Green cheer: Forest cover increases in Telugu states

U Sudhakar Reddy| TNN | Feb 13, 2018, 05:52 IST

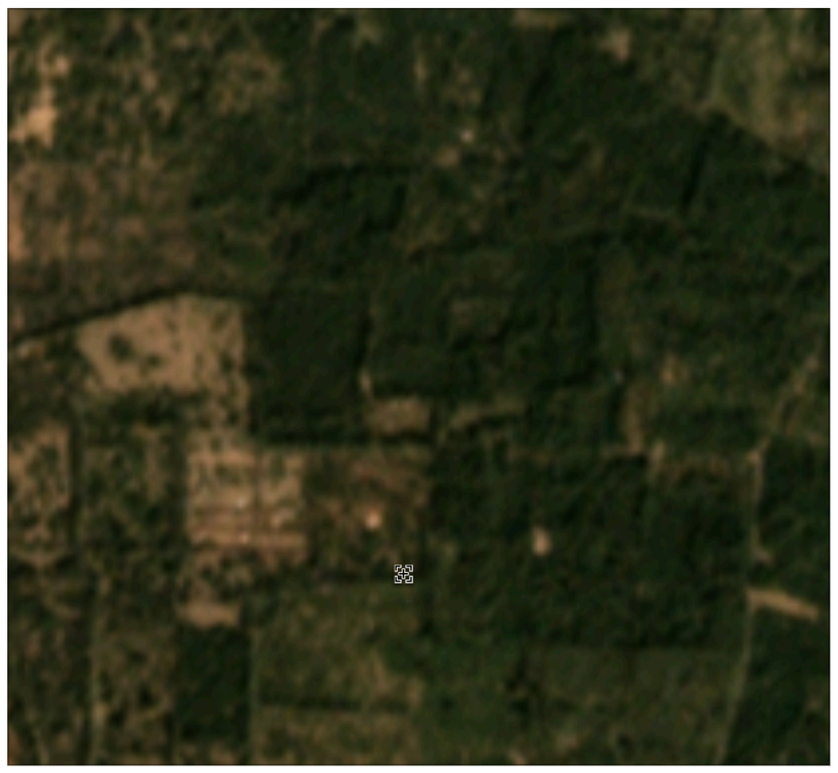
HYDERABAD: In terms of increase of forest and tree cover, Telangana stood fifth in the country by increasing its tree cover by 565 square kilometres. Neighbouring Andhra Pradesh stood first in the country with the maximum increase of forest and tree cover of over 2,141square kilometres.

gaana of the Day

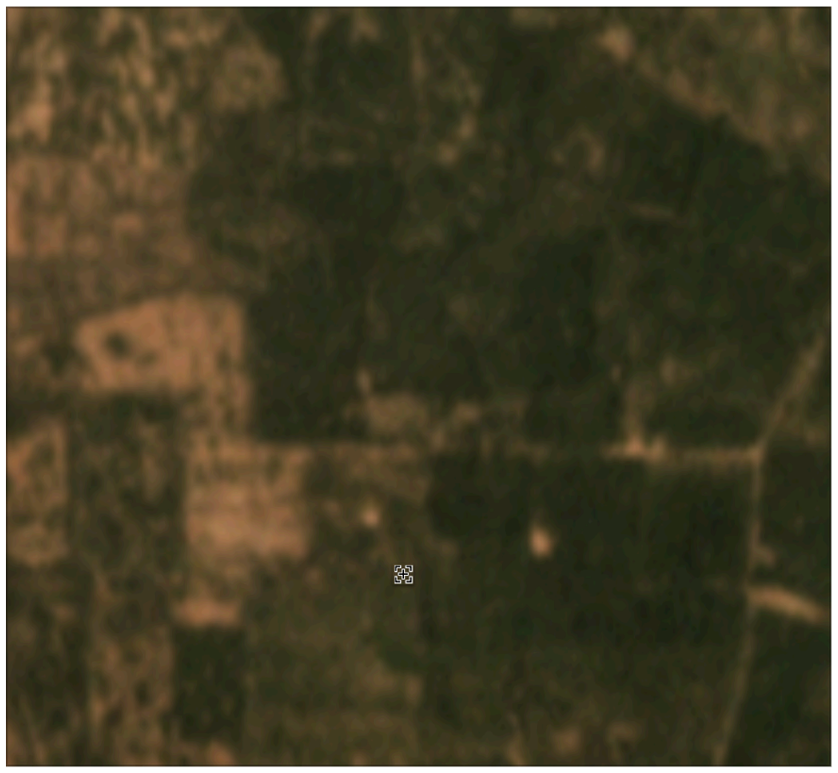
Figure 3. High resolution Google Earth image (from SPOT) on left; Hansen et al. (2013) forest change product for the same area shown on right with blue showing forest gain and green prior forest extent. Note that most small plantations are not identified (2.5 ha plantation within circled area was identified by our in-country cooperators as a plantation established during the period of the Hansen study).

Planet Scope Data: Burugupudi, East Godavari, AP

August, 2018



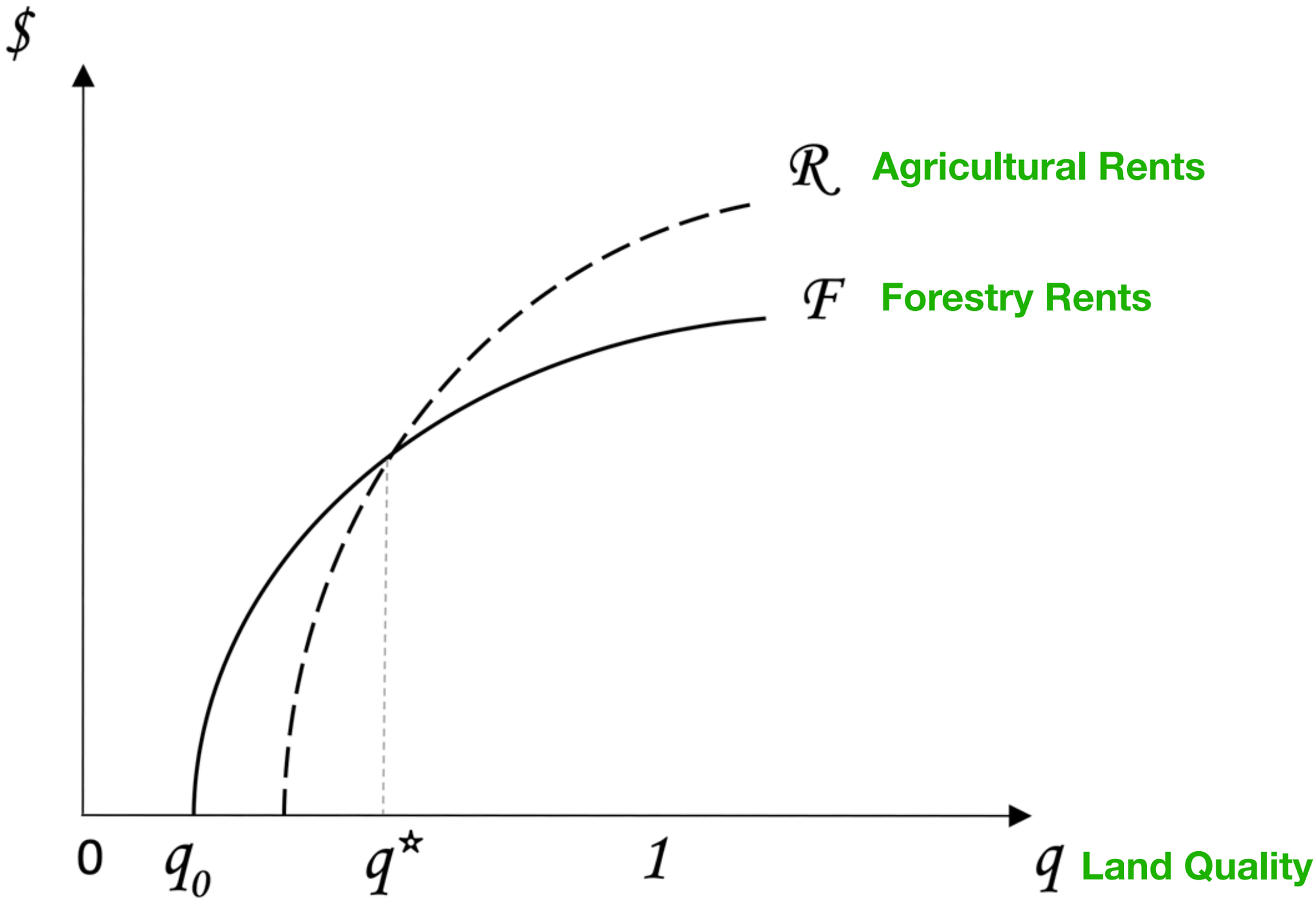
December, 2018



March, 2019

Analytical approach: theory-guided multi-temporal convolutional neural network

Quality Continuum Land Use Model



Preliminary Results: Forest Plantation Adoption Significantly Associated with Higher Incomes, Ownership Area, and Distance to Market

- Probability that a farmer or household will adopt forest plantations
  - Increases with an increase in distance to the market (Timetomkt) and with income
  - Decreases with an increase in area of land owned
- So far, mostly household level data

Probit regression

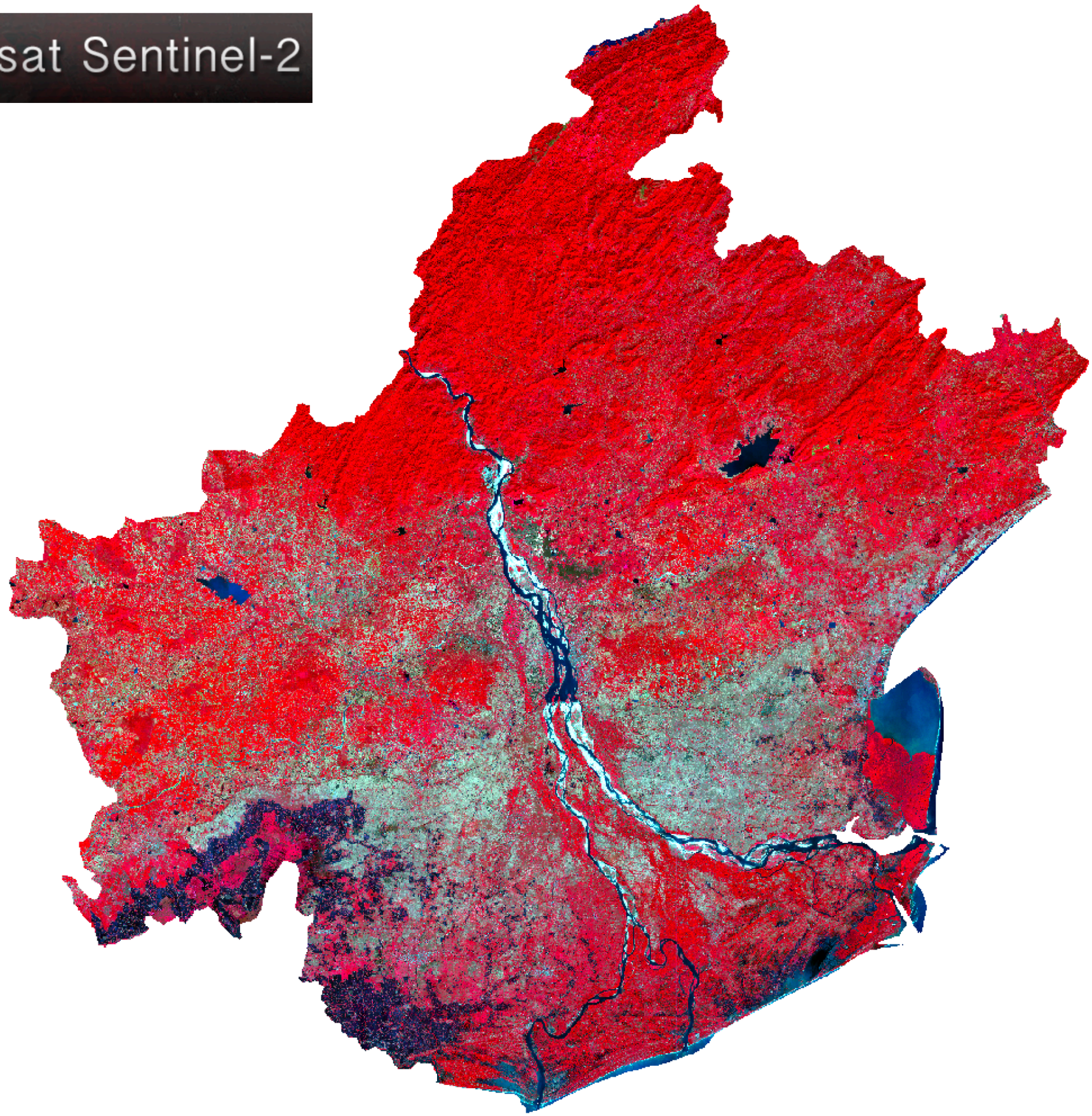
				Wald chi2(12)	=	24.16
				Prob > chi2	=	0.0194
Log pseudolikelihood = -23.921477				Pseudo R2	=	0.3231

PlantFor	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
ageofhhhead	-.0085508	.0294319	-0.29	0.771	-.0662362	.0491346
Edu	-.0197923	.0519485	-0.38	0.703	-.1216095	.082025
LandArea	-.2437047	.0764787	-3.19	0.001	-.3936003	-.0938091
Areleasedout	.1282767	.2224237	0.58	0.564	-.3076657	.5642191
Yrsonland2	-.0347492	.0403296	-0.86	0.389	-.1137937	.0442954
Timetomkt	.0998393	.0381426	2.62	0.009	.0250812	.1745974
Timetofarm	-.0389938	.0236823	-1.65	0.100	-.0854102	.0074227
HHsize	.0055009	.2465736	0.02	0.982	-.4777744	.4887762
Men_work	.8798635	.7269809	1.21	0.226	-.544993	2.30472
Woman_work	-.016978	.4013967	-0.04	0.966	-.8037011	.7697452
N_child	-.4854044	.4569874	-1.06	0.288	-1.381083	.4102744
Income	.0000185	4.63e-06	3.99	0.000	9.39e-06	.0000275
_cons	-1.709691	1.984337	-0.86	0.389	-5.59892	2.179538

Harmonized Landsat Sentinel-2

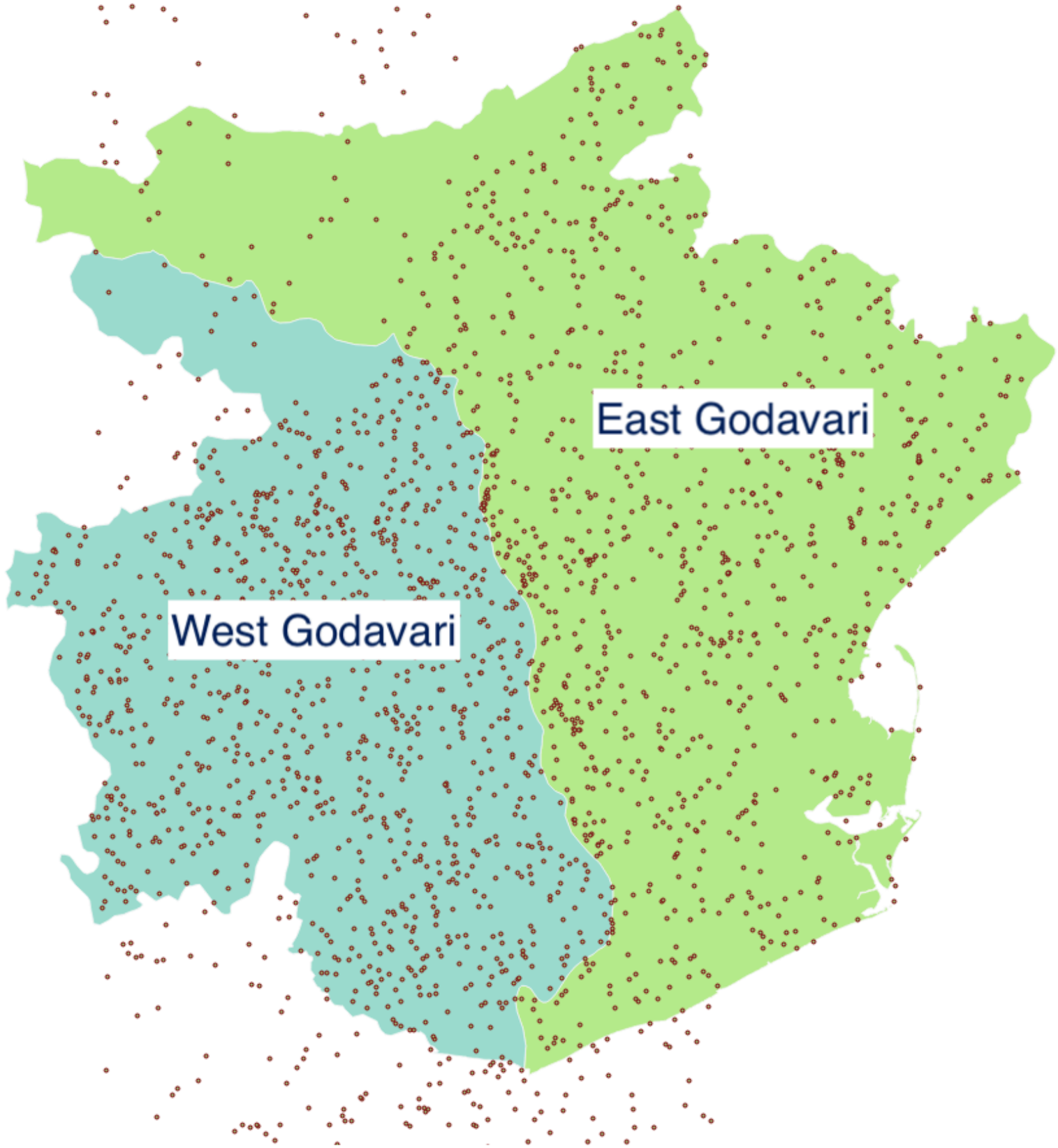
Imagery:

All cloud-free HLS S10 data (10 m surface reflectance; VNIR bands & NDVI) from launch to present

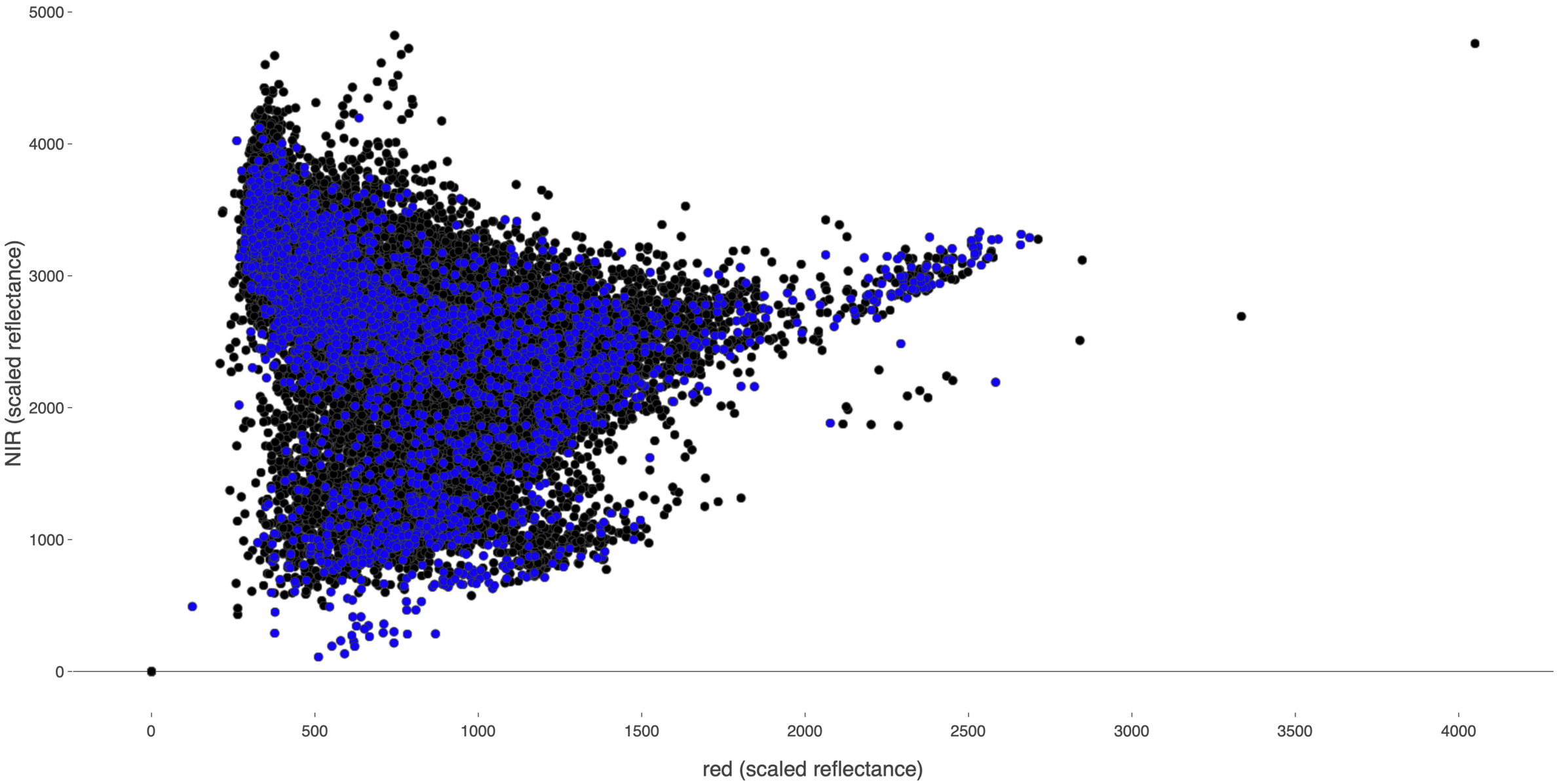


Reference Data:

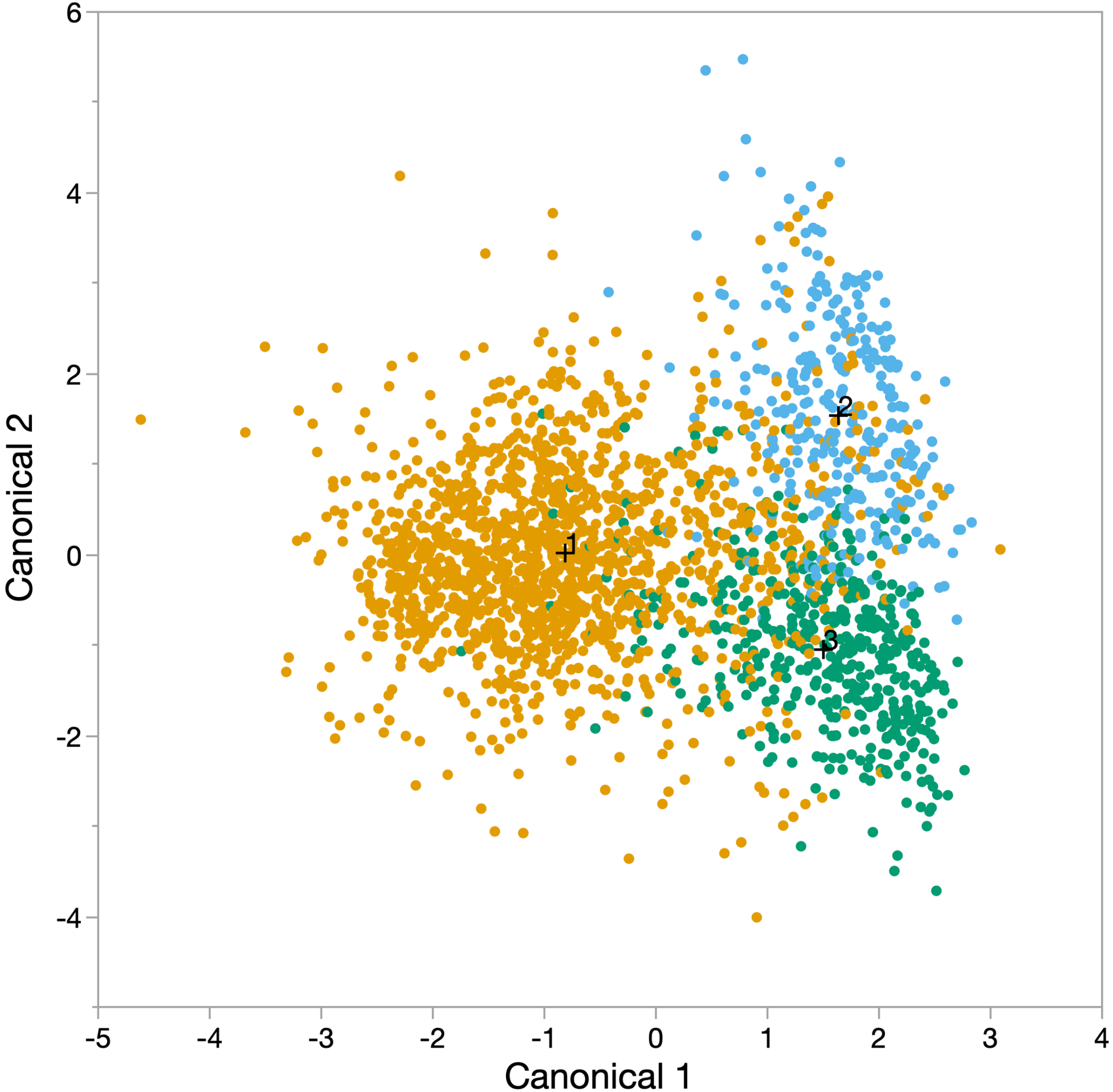
- **2,230 random points**
- **image interpretation with field verification**
- **high-quality sample**

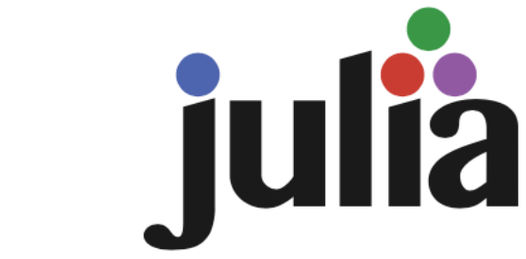


Very well partitioned feature space (2 of 30 bands shown)



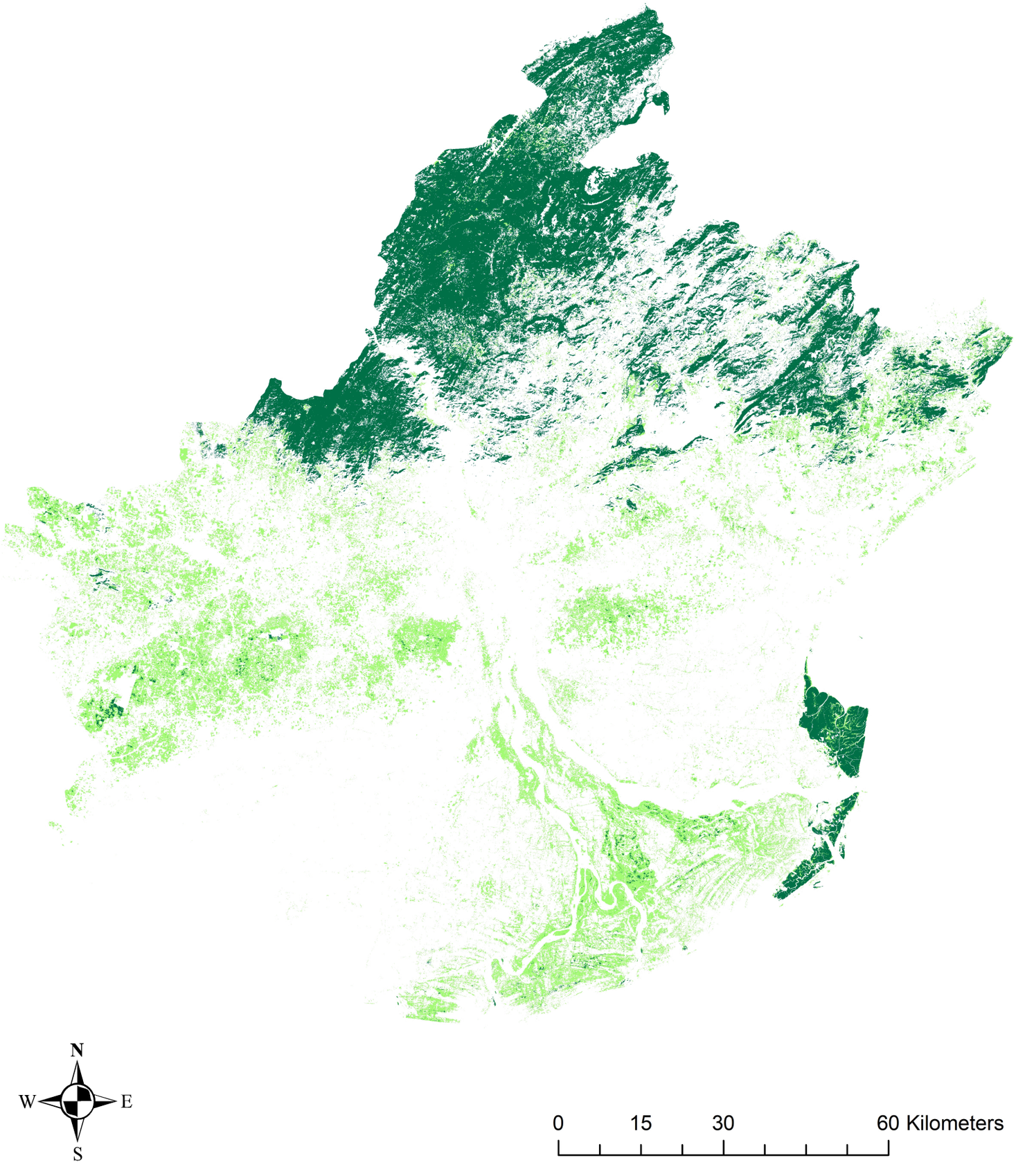
	number of points	aggregate class
agriculture	556	nonforest
aquaculture	153	
ground	81	
sand	110	
urban	119	
scattered forest/shrub	224	
water	225	
natural forest	241	natural forest
mangrove	60	
forest plantation	254	plantation
palm plantation	213	

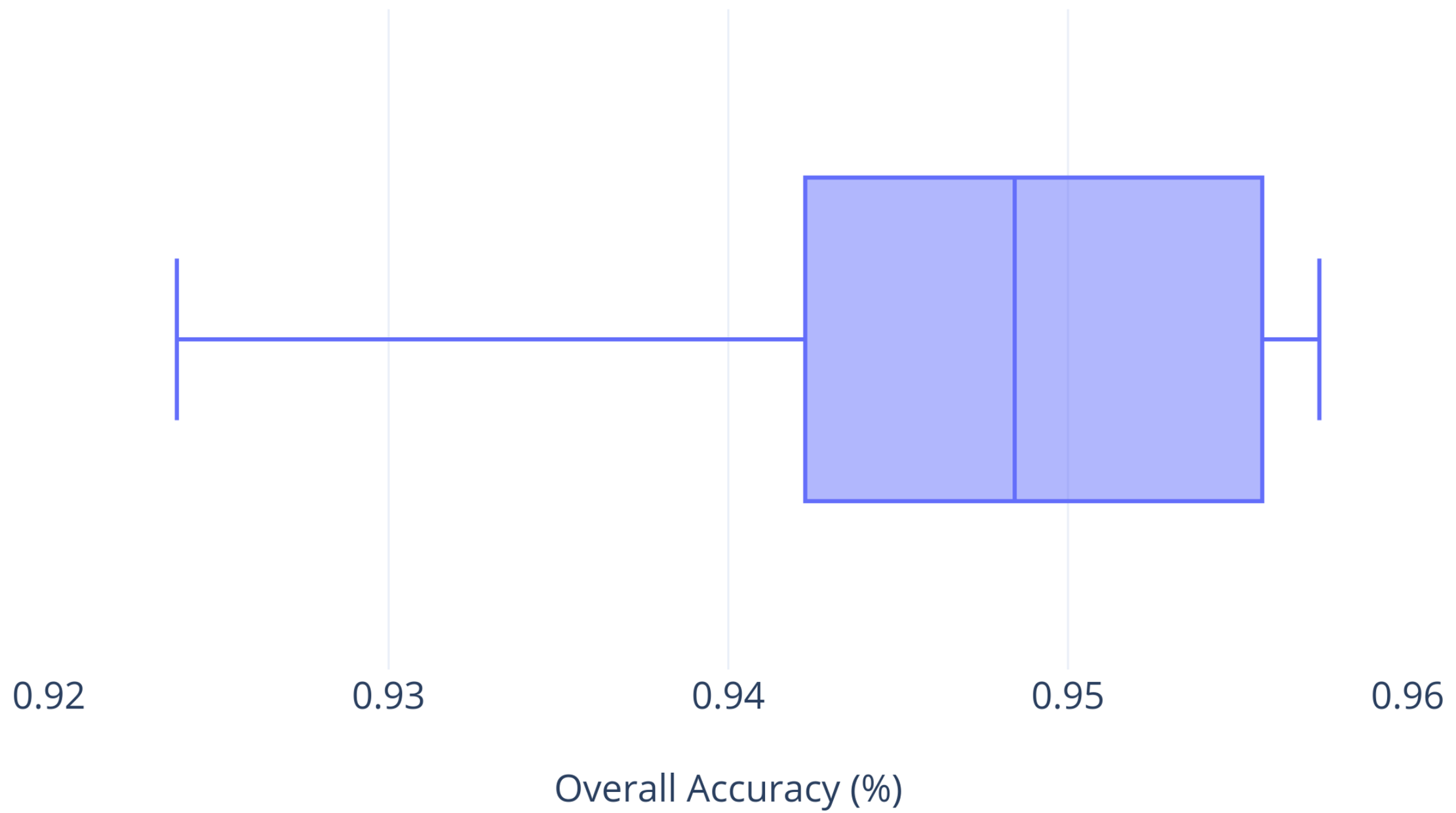

6
4
2
0
-2
-4
Canonical 2
-5
-4
-3
-2
-1
0
1
2
3
4
Canonical 1
1
2
3



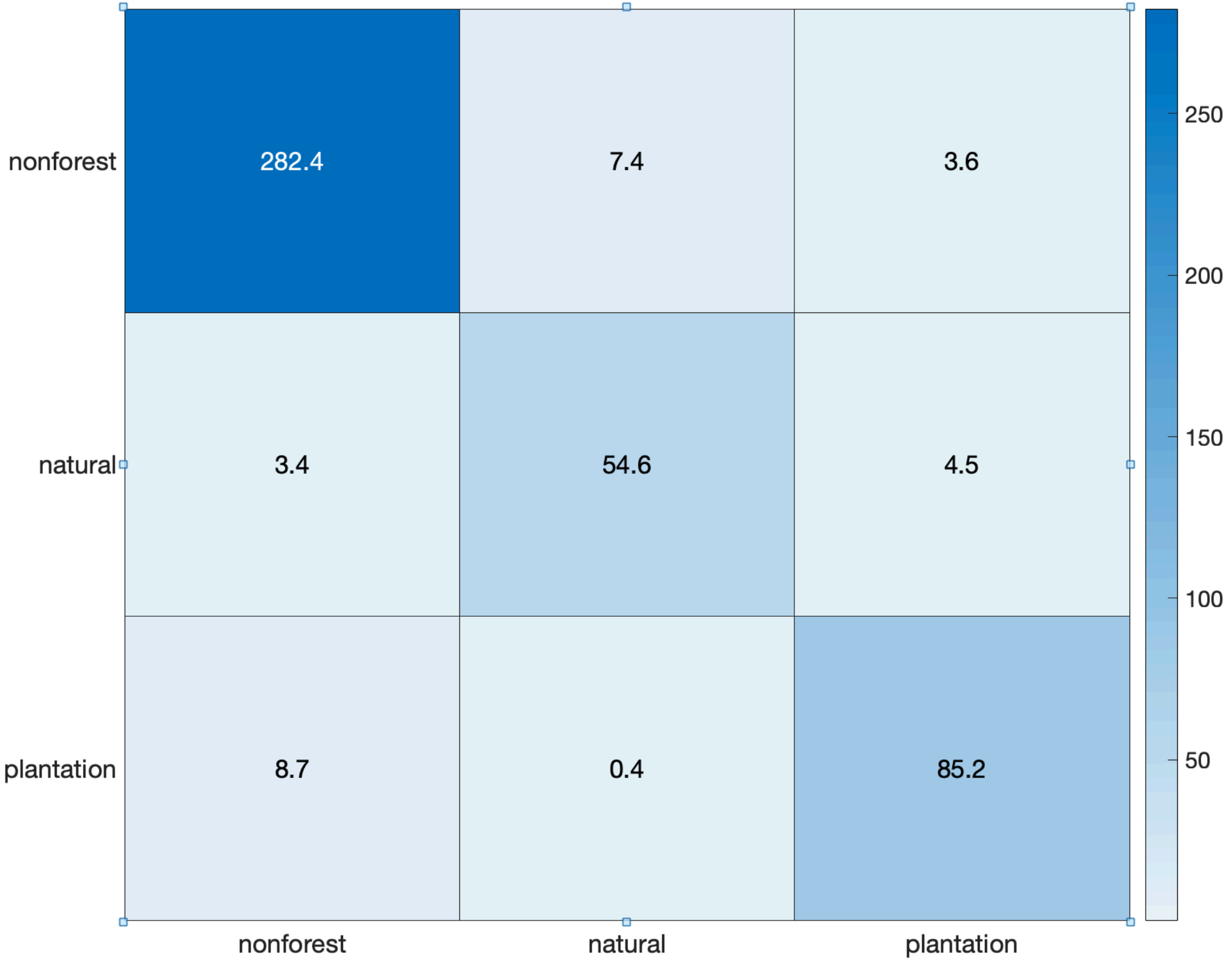
Julia DecisionTree.jl

Parameter	*Value*
num_folds	5
num_subfeatures	-1
num_trees	50
sampling_proportion	.7
max_tree_depth	-1
num_min_leaf_samples	10
num_min_samples_split	5
purity_increase_min	0.0





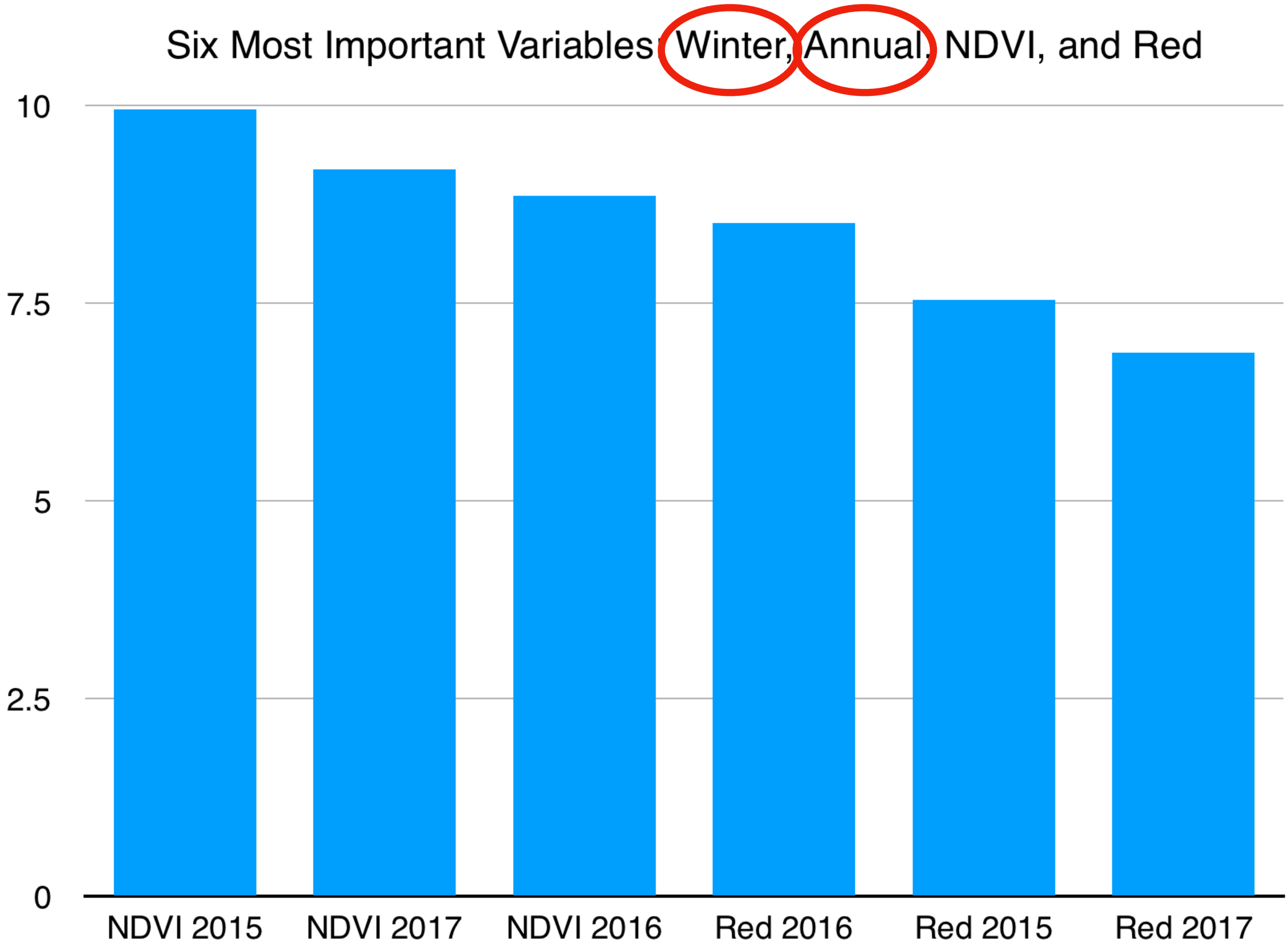
5-fold cross-validation
2,230 samples / 5 folds = 446 samples/fold

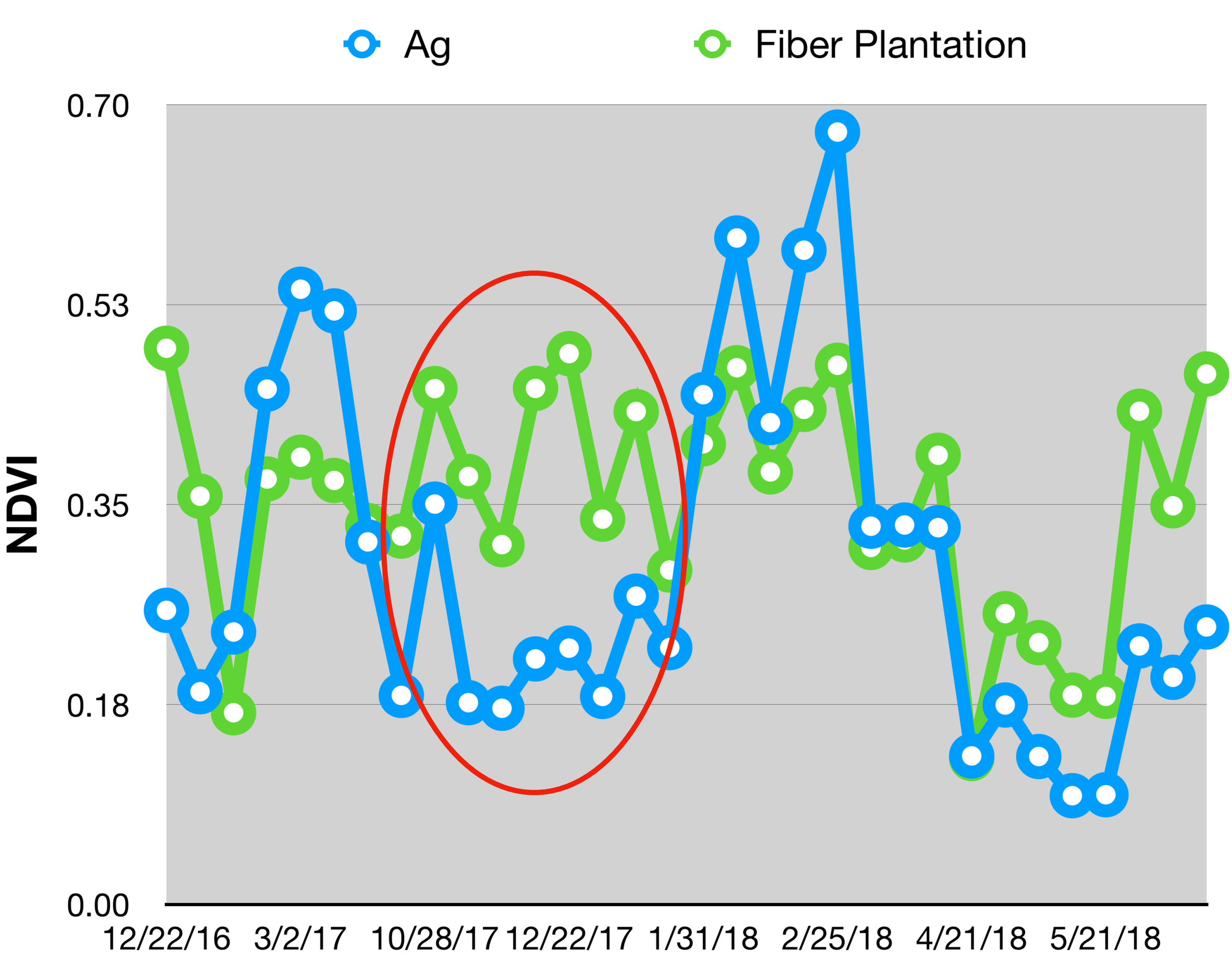

nonforest
natural
plantation
282.4
7.4
3.6
3.4
54.6
4.5
8.7
0.4
85.2
250
200
150
100
50
nonforest
natural
plantation

Results indicate the following:

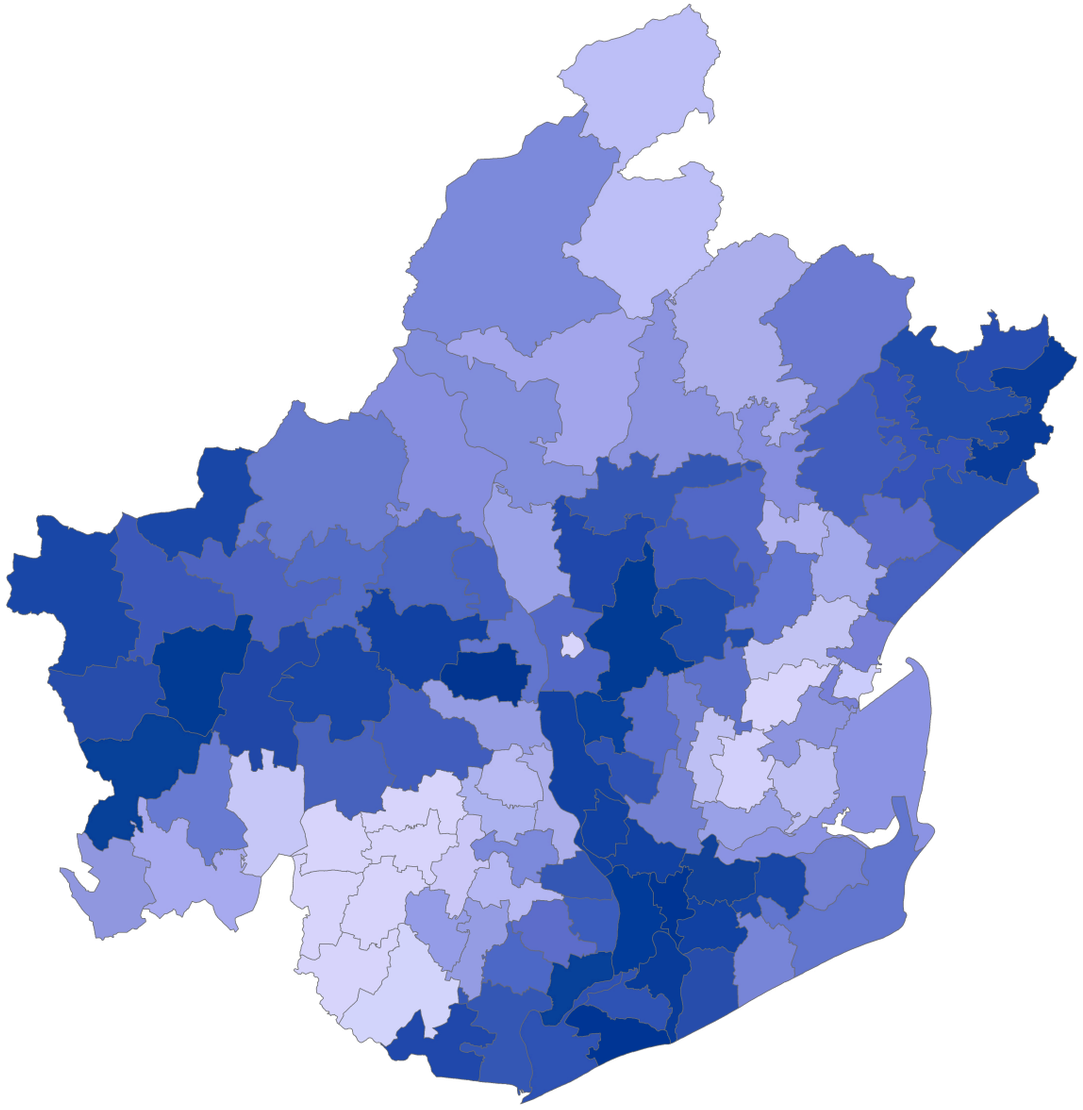
(1)the scale of land cover and land use change can be finer than the effective scale of freely-available imagery,

(2)forests can be separated from other land cover, and plantation forests from natural forests, but plantation types (palm vs. fiber) are more difficult to discriminate from each other using standard machine learning.

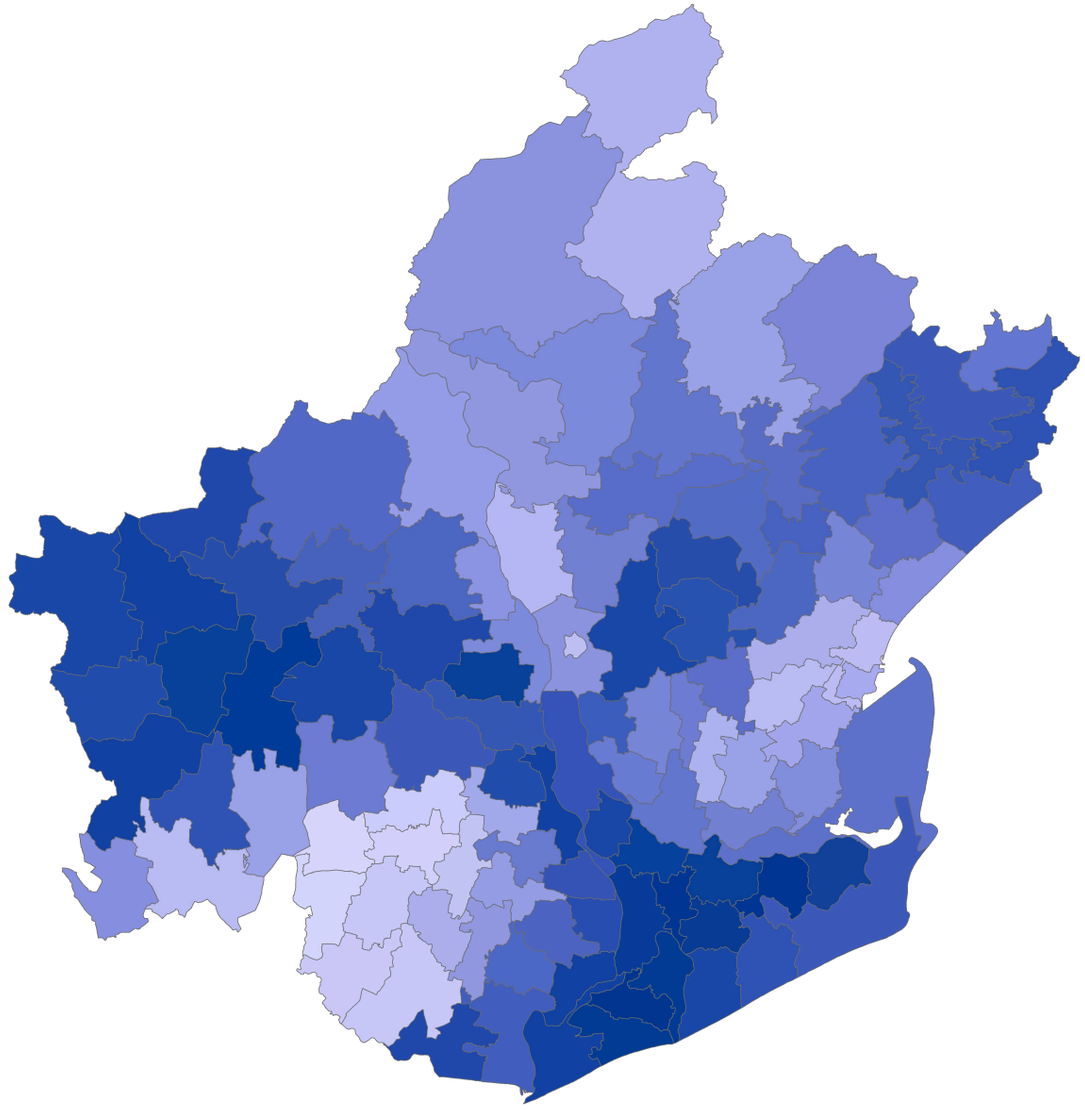

Six Most Important Variables: Winter, Annual, NDVI, and Red
10
7.5
5
2.5
0
NDVI 2015
NDVI 2017
NDVI 2016
Red 2016
Red 2015
Red 2017


Ag
Fiber Plantation
NDVI
0.70
0.53
0.35
0.18
0.00
12/22/16
3/2/17
10/28/17
12/22/17
1/31/18
2/25/18
4/21/18
5/21/18

Forest Plantation Percent Cover 2015 Mandal Level
APSAC



Forest Plantation Percent Cover Mandal Level
Random Forest Model



Total plantation cover unchanged at 10%, but composition fungible

04:05 PM I 28 SEP CLOSED
MARKET STATS

SENSEX 36,227 ▼ -97.03
NIFTY 50 10,930 ▼ -47.10
GOLD (MCX) (Rs/10g.) 30,510.0 ▲ 186.0
USD/INR 72.48 ▼ -0.12

Coconut cultivation has great potential in coastal Andhra'

"Coconut cultivation is considered to be one of the major livelihoods which support 60 per cent farmers in the state." Naik and Nagaraja 2017 Int. J. Applied Res. 3:(1): 160-168

Progress of Coconut Producers' Society, Federation and Company formation in Andhra Pradesh as on 30-Jun-2018

Sl No.	Districts	Area (ha)	Produ- ction (lakh nuts)	Prodty (Nuts/ ha)	CPS Regd with CDB	CPF Regd with CDB
1	East Godavari	50285	7208.95	14337	653	50
2	West Godavari	21561	4489.03	20821	244	16
3	Srikakulam	14480	2498.59	17256	133	10
4	Vishakapatnam	6796	767.21	11290	48	5
5	Vijayanagaram	2711	435.92	16080	30	1
6	Krishna	2116	340.28	16082		
	Total	**103071**	**16100**	**15620**	**1108**	**82**

image from indiamart.com

ANDHRA PRADESH

State tops in oil palm cultivation, production

G.V.R. Subba Rao

VIJAYAWADA, DECEMBER 10, 2018 00:32 IST
UPDATED: DECEMBER 10, 2018 00:32 IST

Andhra Pradesh stands first in the country in oil palm cultivation and production covering an area of 1.62 lakh hectare with a yield of 14.09 lakh metric tons (MTs) of fresh fruit bunches (FFBs). The average productivity stands at 19.81 tons per hectare from the bearing plantations. Apart from attractive returns and the government's oil palm development programme etc., '**absentee landlordism**' is also said to be one of the reasons behind farmers taking up cultivation of oil palm.

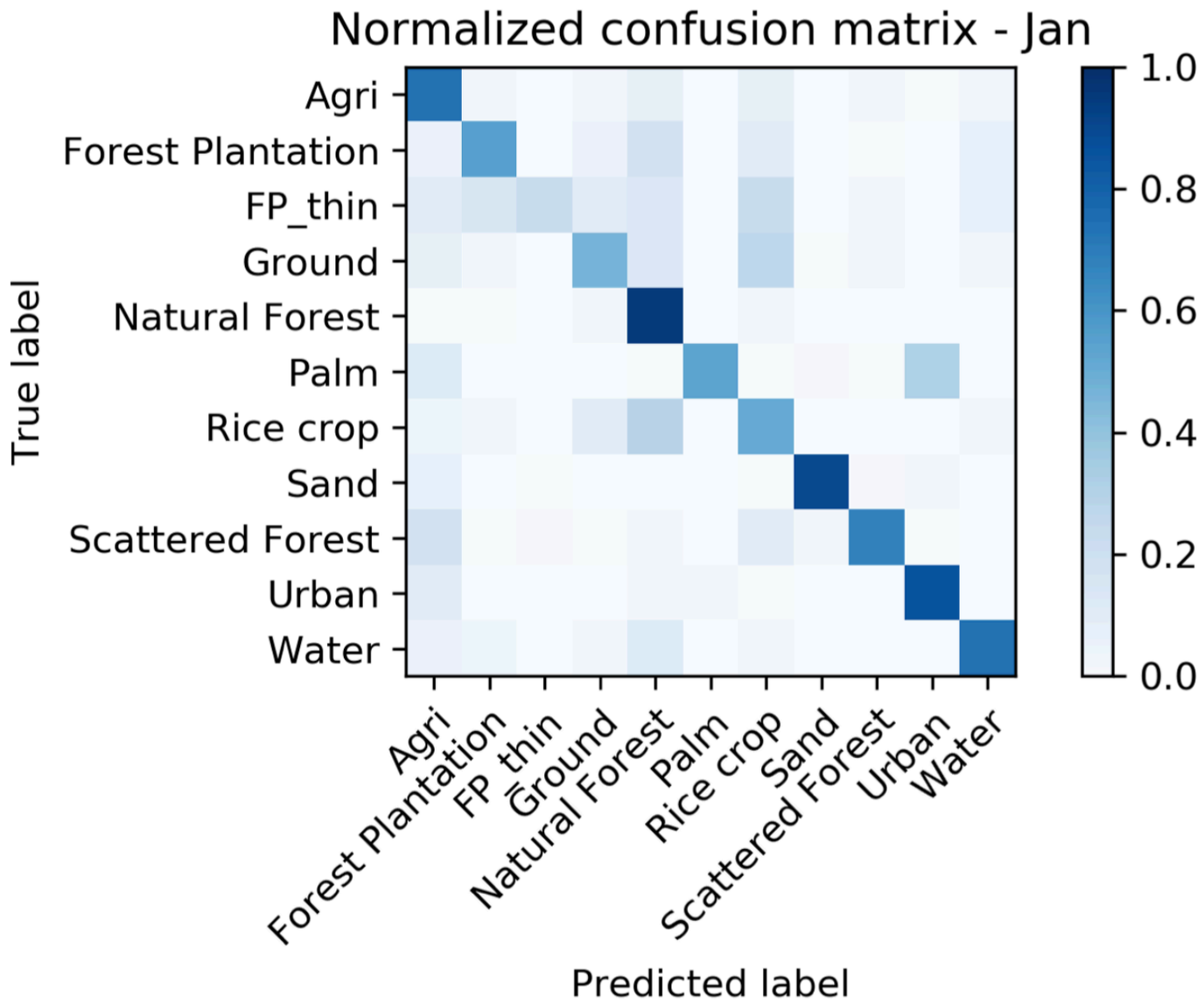
According to information, thousands of farmers in the State are cultivating oil palm for various reasons including returns per acre and very less incidence of pest and disease compared to other crops. In addition, inter-crops like cocoa, pepper and vegetables can also be taken up. **About 1.14 lakh farmers are into oil palm cultivation**. On an average, the farmers are getting a net income of ₹40,000 to ₹50,000 per acre from oil palm crop, horticulture officials say.

1/8/2015
Image © 2018 DigitalGlobe
2011
Imagery Date: 1/8/2015 44 Q 642986.72 m E 1914061.76 m N

1/14/2018
2007
2018
Image © 2018 DigitalGlobe
2007
Imagery Date: 12/8/2017 44 Q 593975.60 m E 1881646.84 m

Deep Learning for Forest Plantation Mapping in Godavari Districts of Andhra Pradesh, India

Snehal More[1]*, Anuj Karpatne[2], Randolph H. Wynne[1], Valerie A. Thomas[1]



Association for Computing Machinery's (ACM) Special Interest Group (SIG) on Knowledge Discovery and Data Mining (SIGKDD) 25th Annual Conference

Conclusions

- HLS S10 data, across years, were vital.

- High-quality, field-verified, classification training data were, as always, essential.

- Smallholders have fine-scale, temporally-variable, and complex combinations of crops and forests in many parts of the world, and the lessons learned from AP have regional to global applicability.

ISSN: 2666-0172

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•Land cover and land...

Feedback

SAFE has a feasible mission concept

Mission:

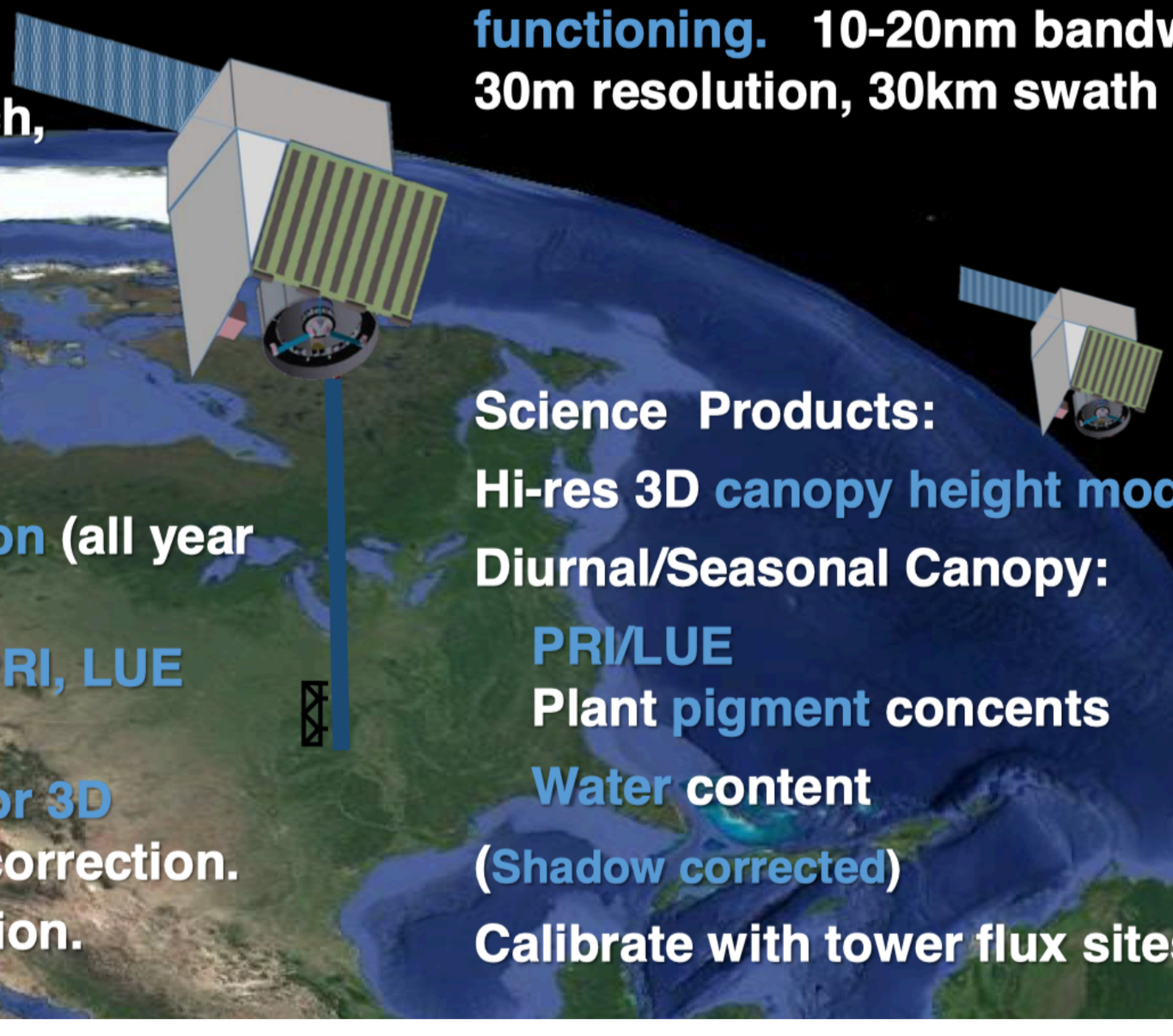
Three SAFE SmallSat buses for diurnal sampling of forest structure and function 3 hour on-orbit temporal separation of SmallSats

Orbit: ~700 km, sun synch, equator crossing time at 1300, 1630 hours

Instruments:

Stereo camera (Visible Pan) for structure, 1m res, 30 km swath

VSWIR (400-1700nm) for forest functioning. 10-20nm bandwidth, 30m resolution, 30km swath



Data:

Daytime, growing season (all year in tropics).

Spectral radiance for PRI, LUE and pigments.

Stereo triplet images for 3D structure and shadow correction.

Flux towers for calibration.

Science Products:

Hi-res 3D canopy height models

Diurnal/Seasonal Canopy:

PRI/LUE

Plant pigment concents

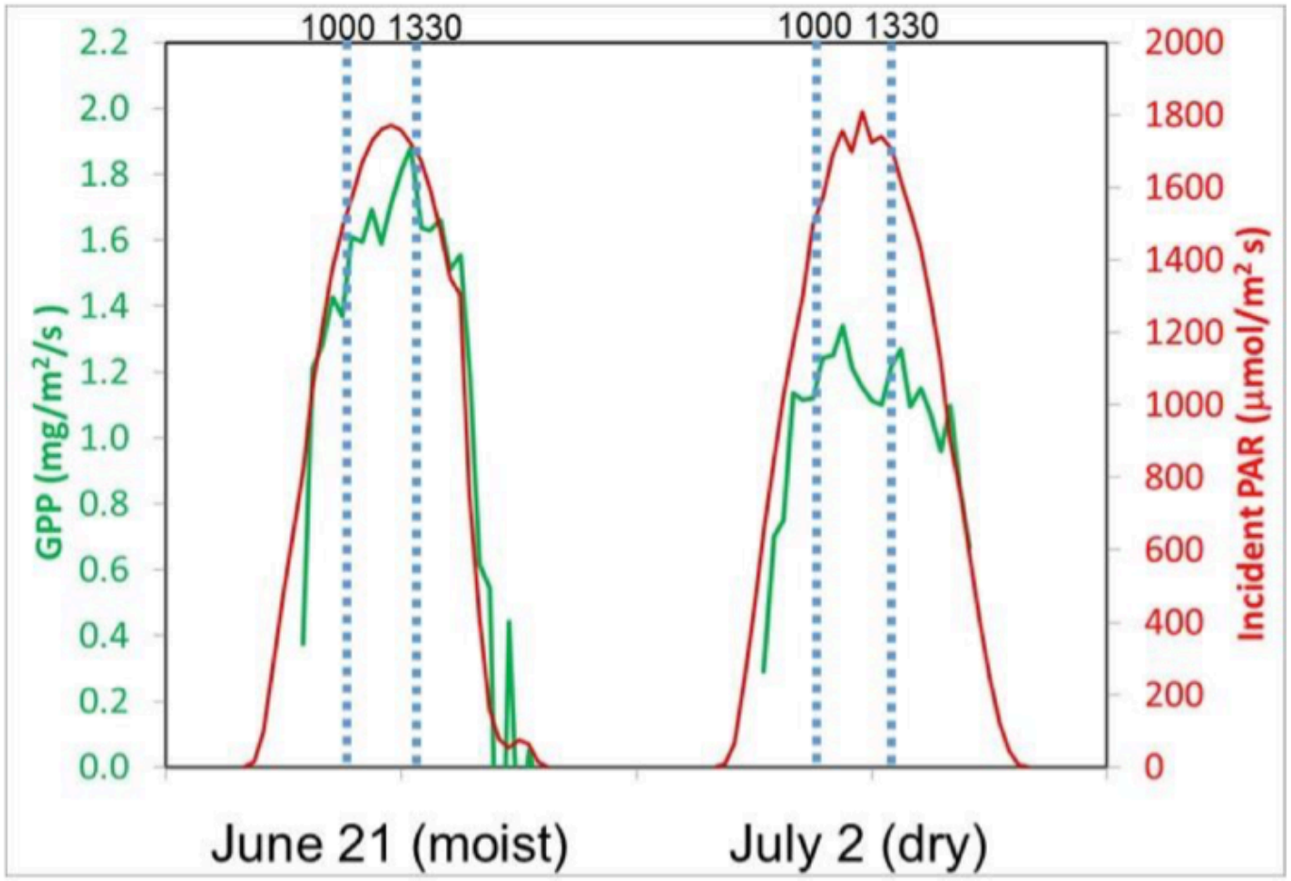
Water content

(Shadow corrected)

Calibrate with tower flux sites

Time of Day and Shadows Impact Forest Productivity Measurements

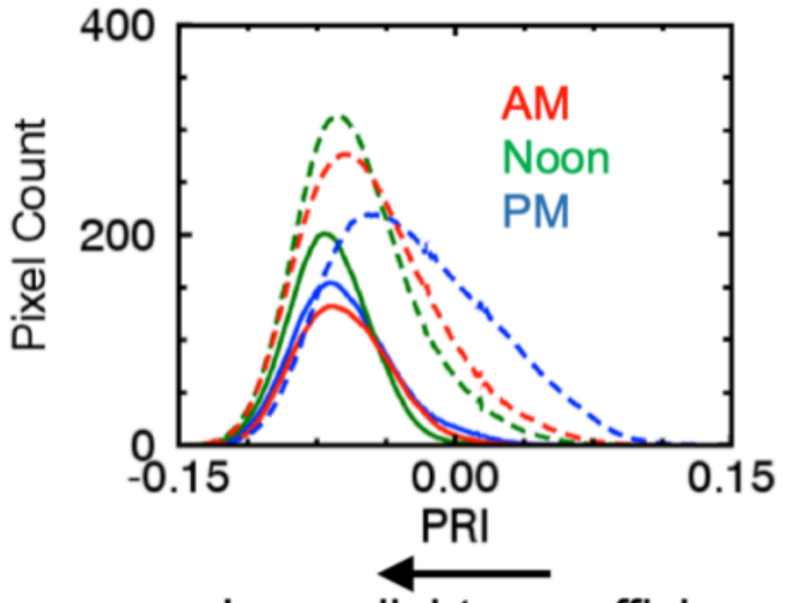
Productivity Dynamics



Photochemical Reflectance Index (PRI) provides a remotely sensed estimate of LUE and is sensitive to plant pigment contents

$$PRI = \frac{\rho531-\rho570}{\rho531+\rho570}$$

Senescing Deciduous Forest Stand



Lower light use efficiency

Dashed = all pixels
Solid = illuminated