

Geospatial Data to Evaluate and Target Aid

Dan Runfola, Senior Geospatial Scientist, AidData

Geospatial Data is Reaching Adulthood



MacArthur
Foundation

KFW



USAID
FROM THE AMERICAN PEOPLE

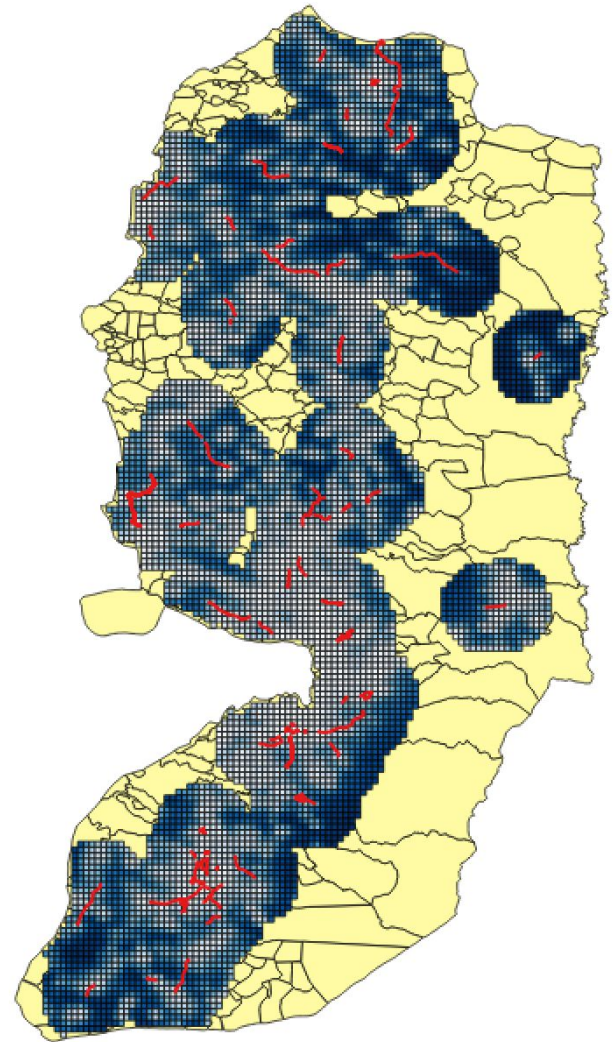
IGC
International
Growth Centre

gef **IEO**

- Dozens of impact evaluations or targeting assessments using geospatial data over the last ~3 years.
- Geographers complaining about causal identification; Economists complaining about spatial spillovers.

No Longer Just Points

- True geometries of aid interventions are now being collected at large scales.
- Integrating this data with a wide variety of spatial data - including satellite and other products.



Examples of causally identified studies from an increasing number of sectors

- Water and Sanitation (USAID Afghanistan)
- Electrification (MCC Tanzania & Ghana)
- Poverty (IGC Liberia)
- Environment (World Bank IEG, MacArthur, GEF IEO)
- Health (Gates Foundation DRC)
- Emergent studies on governance and female empowerment (AfroBarometer)

Solutions to a growing number of methodological concerns in the use of spatial data

- **Spatial Uncertainty** - SIMEX, Bayesian Approaches
- **Spillover in treatment effects** - GeoMatch, distance-restricted control identification, new research into lag-based modeling.
- **Spatial heterogeneity in effects** - Causal matching GWR, Causal Trees
- **Data integration and access** - GeoQuery (more on this very soon!)

Case Study 1: Geospatial Impact Evaluation and Valuation of Land Degradation Projects

Juha Uitto¹, Geeta Batra¹, Anupam Anand¹, Dan Runfola²,
Ariel BenYishay² and Jyothy Nagol³

¹Independent Evaluation office, Global Environment Facility

²College of William and Mary

³ Global Land Cover Facility, University of Maryland

Objectives

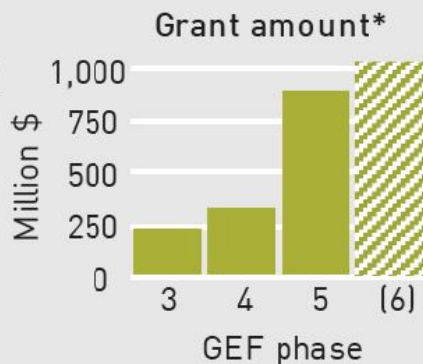
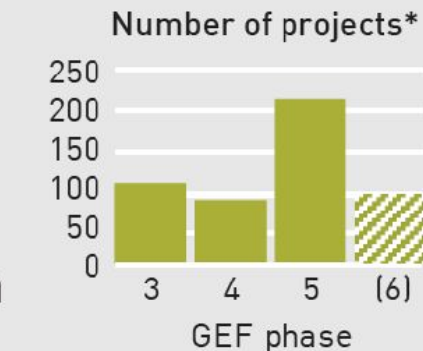
- (1) Portfolio-wide impact evaluation (top-down)
- (2) Identification of factors frequently associated with positive outcomes
- (3) Valuation in terms of Carbon Sequestration

PORTFOLIO HIGHLIGHTS

237
projects

\$630 million
in grant funding

\$2.97 billion
in cofinancing



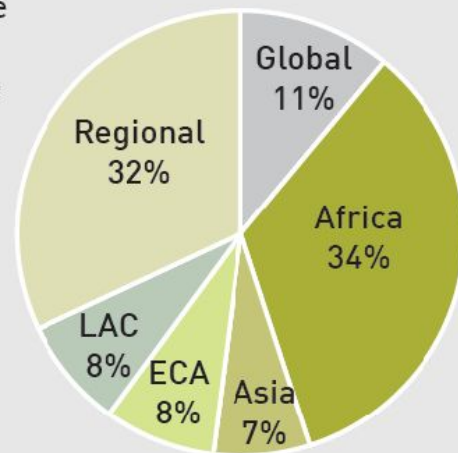
Top 3 agencies*

43% UN Development Programme
17% World Bank Group
17% UN Environment Programme

Regional distribution*

34% Africa
24% Asia
20% Latin America & Caribbean
13% Europe and Central Asia
7% Global
2% Regional

Total GEF funding per region*



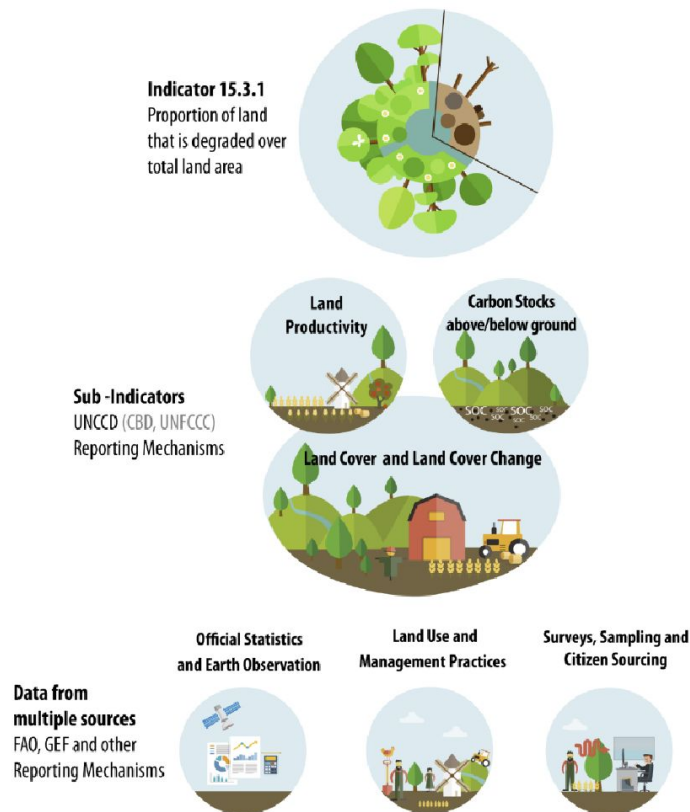
*Includes LDFA and multifocal projects.



Outcomes

- Forest Cover
- Vegetative Density
- Forest Fragmentation

Framework for Monitoring and Reporting on SDG Target 15.3

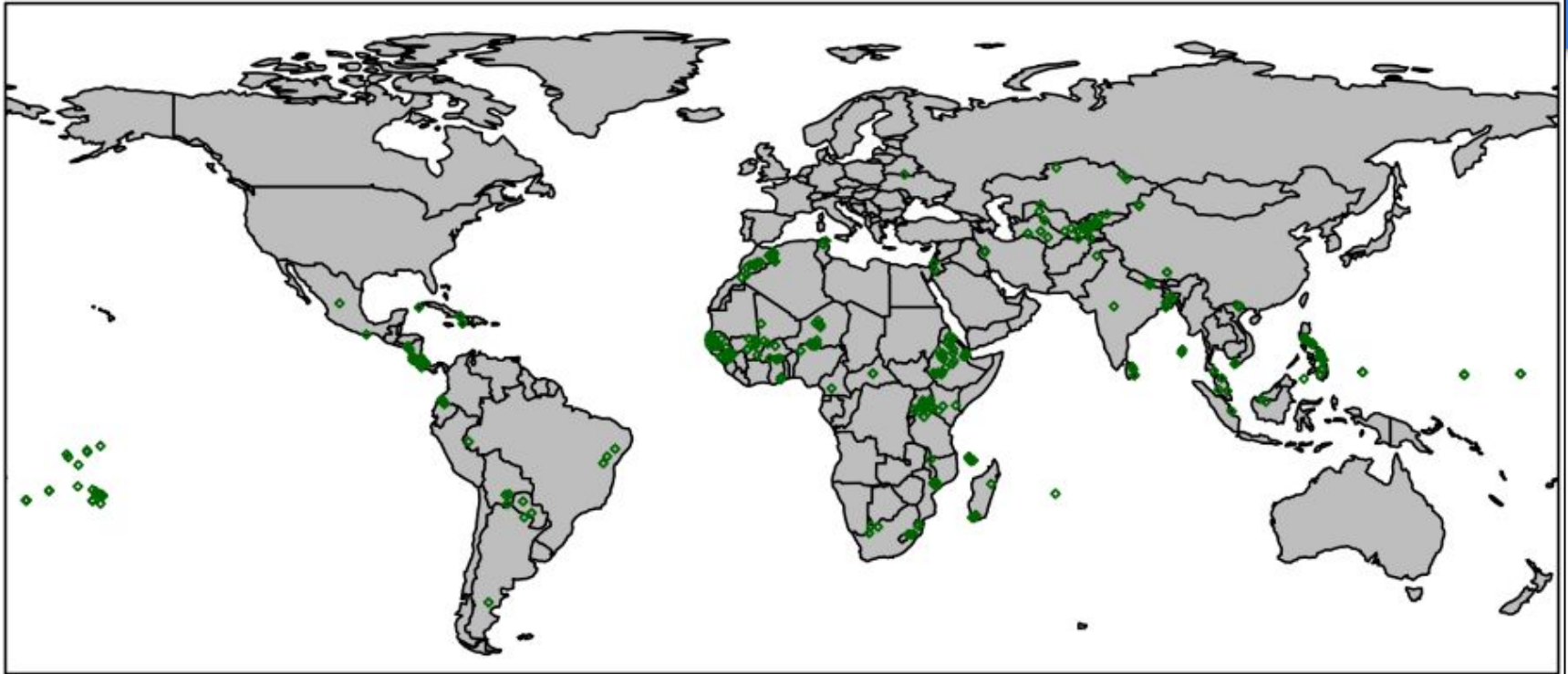


Methodological Approach

1. Geoparsing and coding GEF project locations
2. Integrating Satellite, Fragmentation, Survey, and Other Data Sources
3. Causal Inference through Cross-sectional Matching
4. Valuation of Impacts

1. Geoparsing and Coding

Location of GEF Land Degradation Projects Known with a High Degree of Geographic Precision

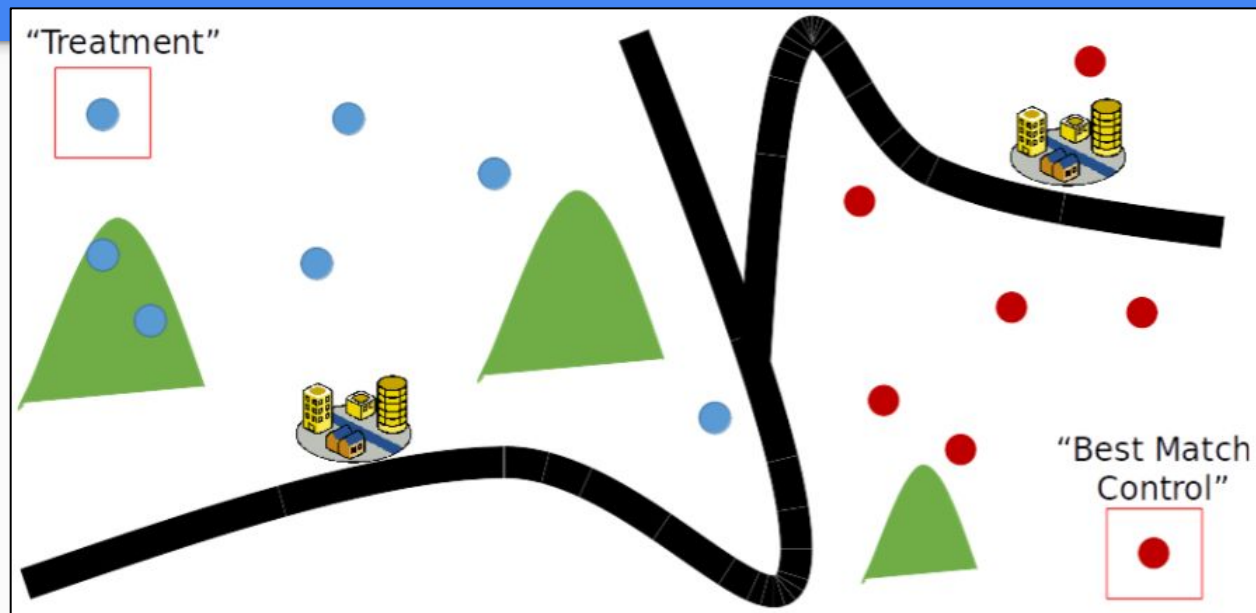


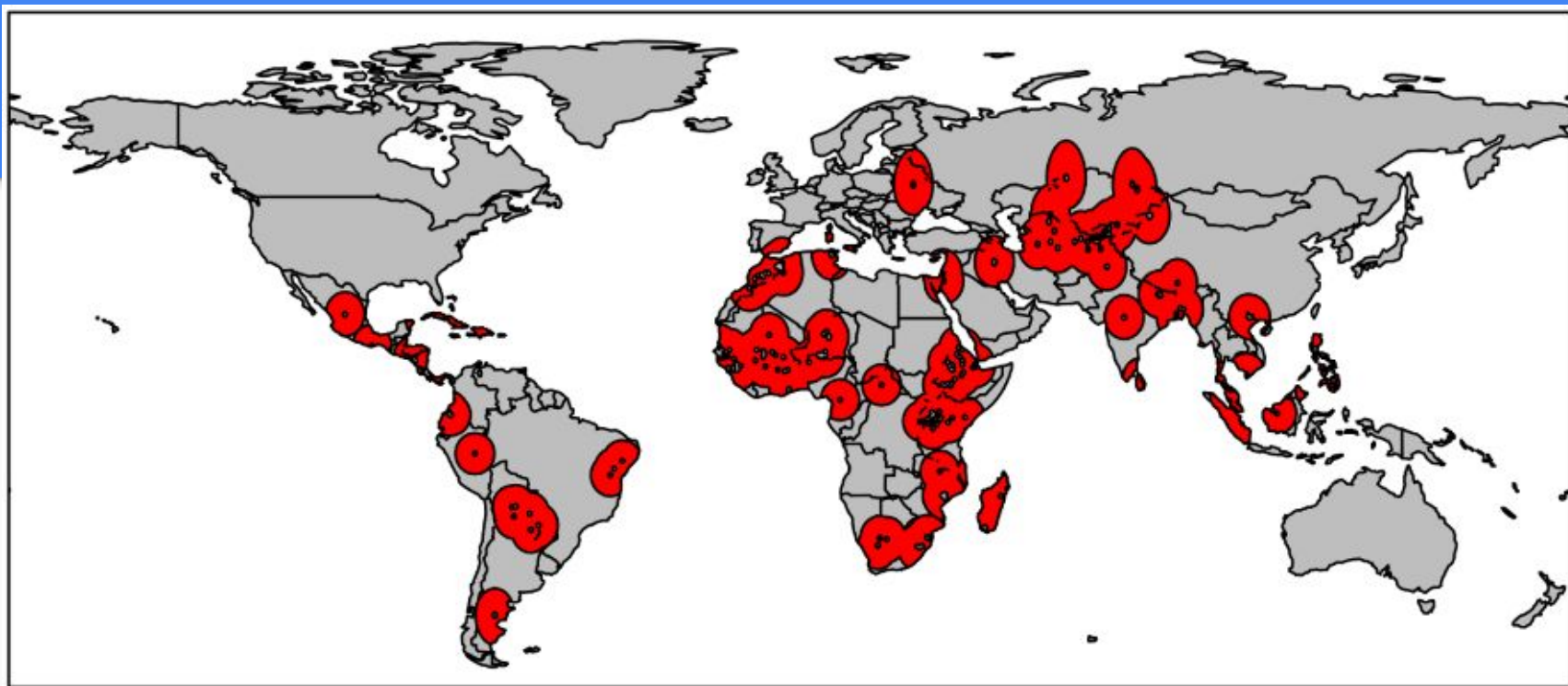
2. Data Integration

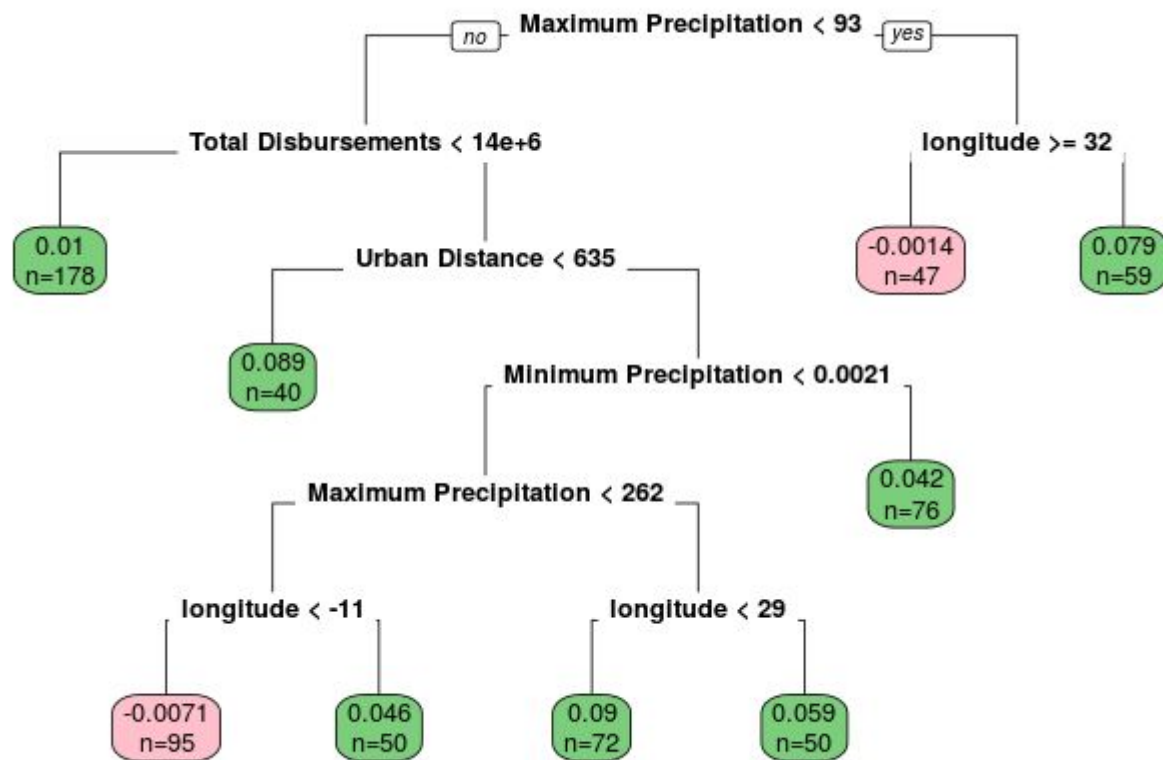
- Multi-sourced (including data from NASA, NOAA, a wide number of academic research groups, GEF project characteristics, and more.
- Multi-resolution (Monte Carlo simulation to capture uncertainties)
- Ancillary data included:
 - Distances to roads, rivers, cities, a variety of economic sites (i.e., on-shore petroleum resources, diamond mines), rainfall, precipitation, nighttime lights, GEF characteristics such as dollar value of project and year, and more.

3. Causal Model

- Cross-sectional matching (with temporal components on some dimensions).
- Propensity Score-based
- Causal Tree to capture spatial heterogeneity.

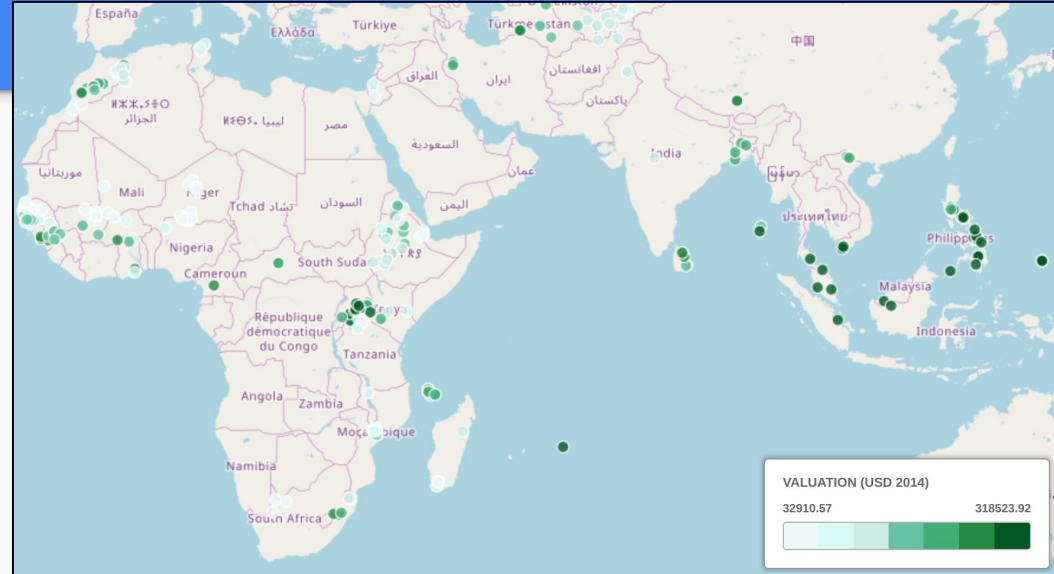






4. Valuation

- Literature meta-review transfer approach.
- No assumptions on modeling made; tool produced to enable end-users to choose valuations.
- Mean valuation in literature used to report findings.

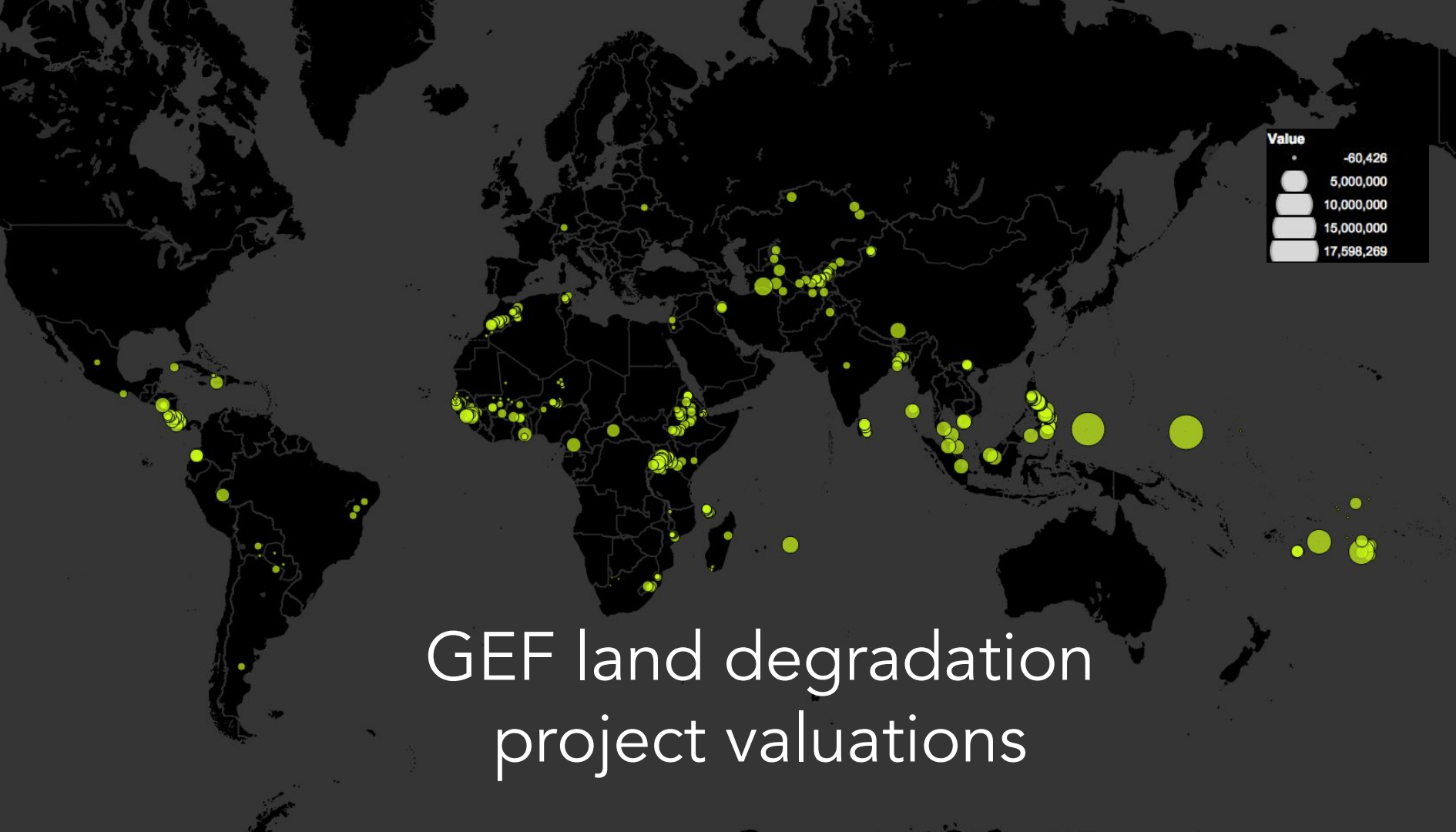


Key Findings

- Approximately 40 tonnes of carbon sequestration was attributable to GEF projects, on average per hectare.
- This resulted in approximately 100,000 tonnes of carbon per project.
- The mean valuation from the literature resulted in an estimated 7.5 million USD value of this sequestration.

Key Findings - Heterogeneity

- ~5 years was a robust breakpoint across many analyses of when impacts became most apparent.
- Projects tended to be more effective in urban or higher population density areas, though more often located in lower population areas.
- Significant heterogeneity in valuation for carbon sequestration over geographic space.
- Clear and compelling evidence for positive GEF impacts on NDVI and forest cover; limited evidence for forest fragmentation (for the Land Degradation Portfolio).



Learning from Project Success / Next Steps

- Heterogeneity in project outcomes along geographic dimensions allows for estimates of characteristics that might drive project success.
- While globally the 5 year threshold was found, many local characteristics were also positive drivers.
- For example, in some geographic contexts MFA projects outperformed SFA. While distance to roads was generally important, the distance thresholds themselves changed over different regions.

Case Study 2:

Indigenous Land Rights in the Amazon

Ariel BenYishay¹, Silke Heuser², Rachel Trichler¹, Dan Runfola¹

¹ AidData, William and Mary

² KFW

Objective

Does demarcating indigenous lands reduce deforestation?

- Land tenure security not widely shown to reduce deforestation
- Indigenous control / stewardship shown in several recent studies to be associated with lower deforestation rates (Nelson et al 2001, Nelson and Chomitz 2012, Nolte et al 2013, Vergara-Aseno and Potvin 2014)
- Given low rates of deforestation observed on indigenous lands, is demarcation likely to influence deforestation?

Project Details

- In 1988 constitution, Gov of Brazil committed to demarcating indigenous people's territories
- Between 1995-2008, with funding and tech support from KfW and the World Bank, the PPTAL project identified, recognized, and studied 181 community lands.
- By 2008, 106 community lands demarcated, covering 38 million hectares (~35% of all indigenous lands in Amazon)

Project Details

- ***Demarcation***: recognition by the Min of Justice
- Followed by regularization (entry into municipal, state and federal registries)
- Varied by community between 1995 and 2008
 - Median year is 2001
- Support for Boundary Enforcement

Data

- Treatment status
 - Boundaries of community lands
 - Administrative data on demarcation dates
- Merged with satellite-based greenness measure
 - NASA Land Long Term Data Record (LTDR), 1982-2010
 - Processed to Normalized Difference Vegetation Index (NDVI)
 - Range is [0, 1] (0 = rocky, barren; 1 = dense forest)
 - Annual NDVI max and mean measures
- Covariates
 - Climate (precip., temp.); topology (elevation, slope); distance to rivers; gridded, interpolated population

Methods

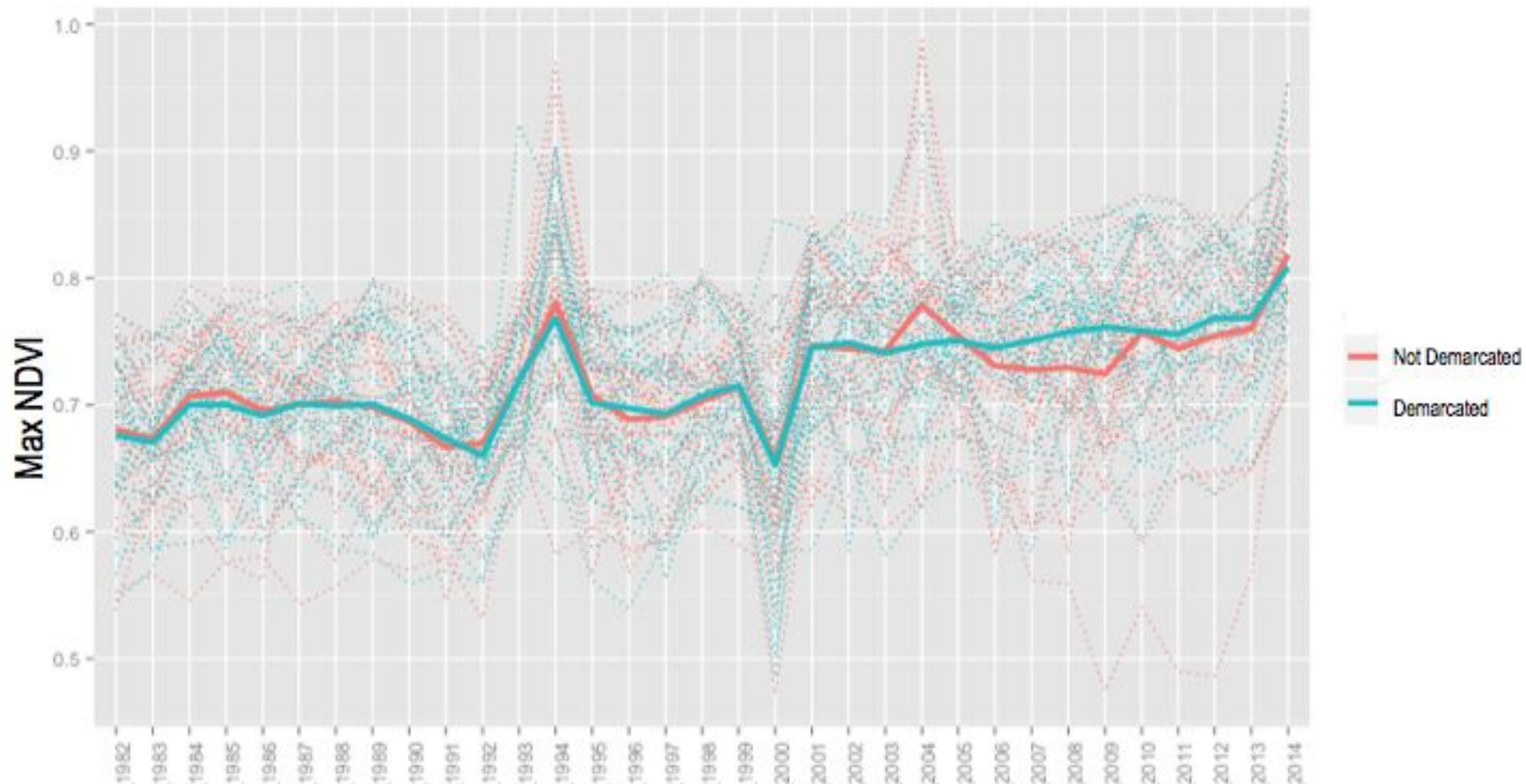
- Propensity Score Matching
 - Differences over time across matched treated/comparison communities
 - Match on baseline levels, pre-trends, & covariates
 - Demarcated vs. not; “Early” (‘95-’01) vs “Late” (‘01-’08)
- Fixed effects
 - Control for time-invariant community unobservables
 - Treatment status at finer time intervals



1997

2008

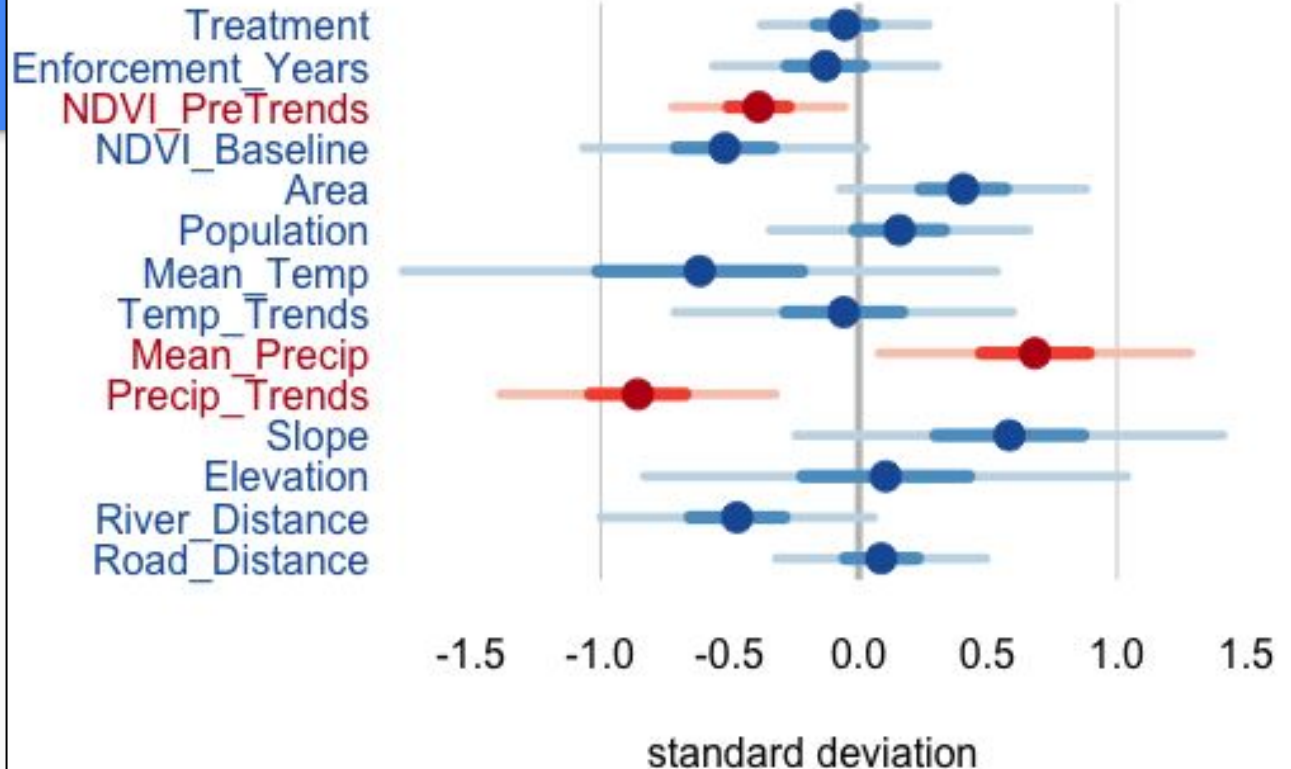




Demarcated vs. non-demarcated

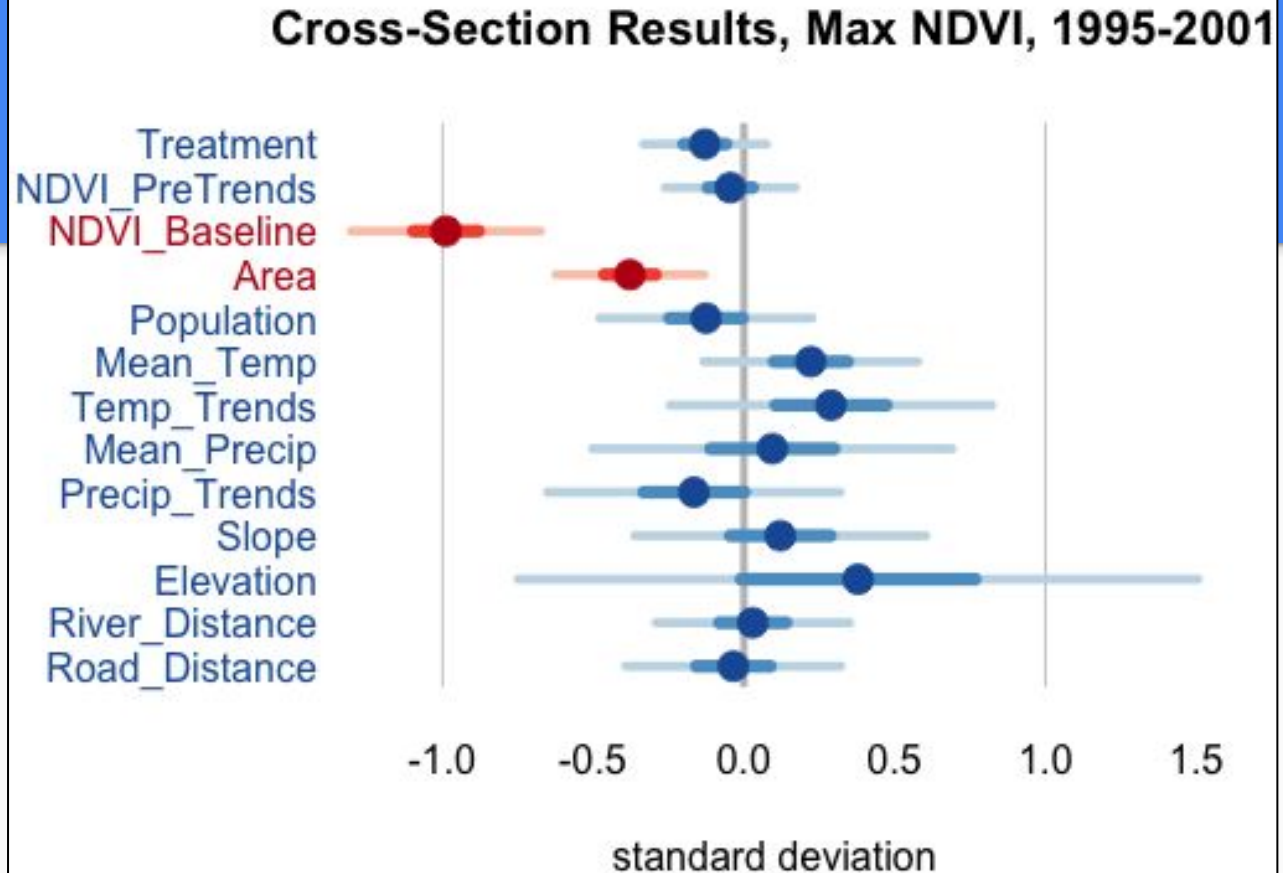
- **Treatment** = Demarcated between '95 and '08
- **Outcome** = Change in mean NDVI between '95 and '10
- Control for years in demarcation status; matched pairs of demarcated and non-demarcated (n=60).

Cross-Section Results, Max NDVI, 1995-2010



Early vs. Late demarcation

- **Treatment** = Demarcated between '95 and '01
- **Outcome** = Change in mean NDVI between '95 and '10
- Control for years in demarcation status; matched pairs of demarcated lands (n=80).



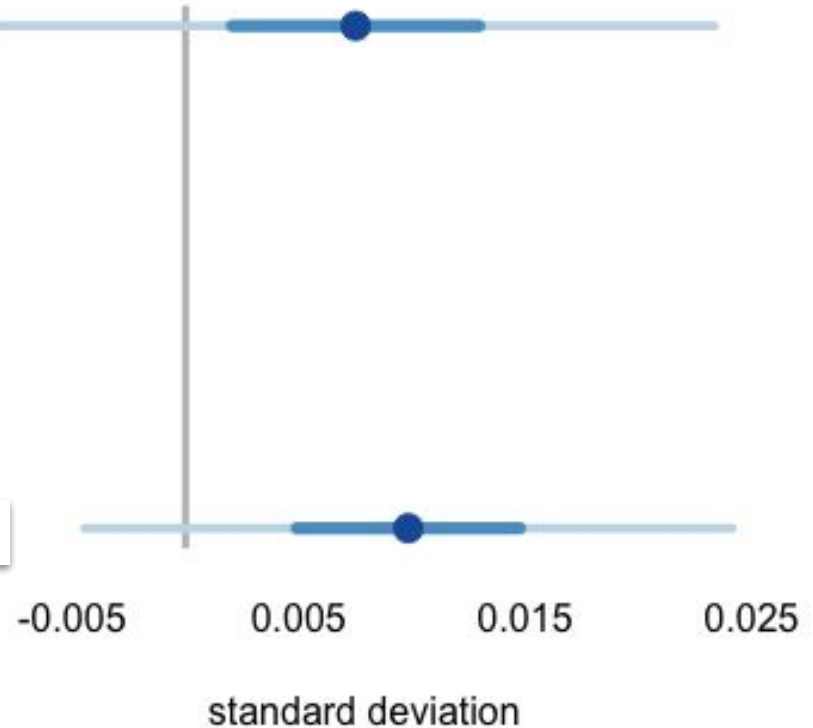
Panel Model

- **Treatment** = Year of demarcation.
- **Outcome** = Level of NDVI (max) each year
- Fixed effects, year trends.
- 2,128 annual observations; errors clustered by community and year.

Treatment_Demarcation

Treatment_Enforcement

Panel Results, Max NDVI

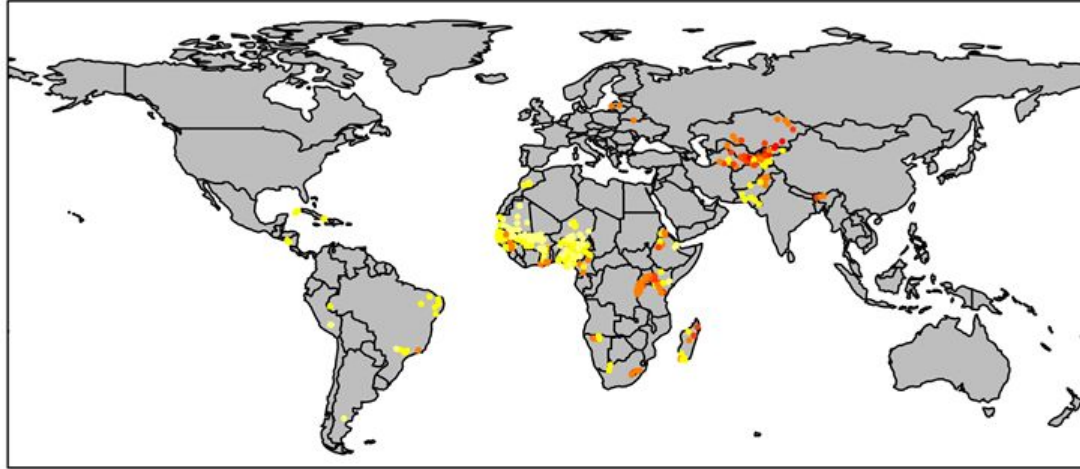


Take-aways

- No clear, robust evidence of differences in deforestation attributable to the PPTAL project
- Much lower rates of deforestation on indigenous lands in cross-section may not be related to land tenure status of these lands (or may be mediated through multiple, complex channels)

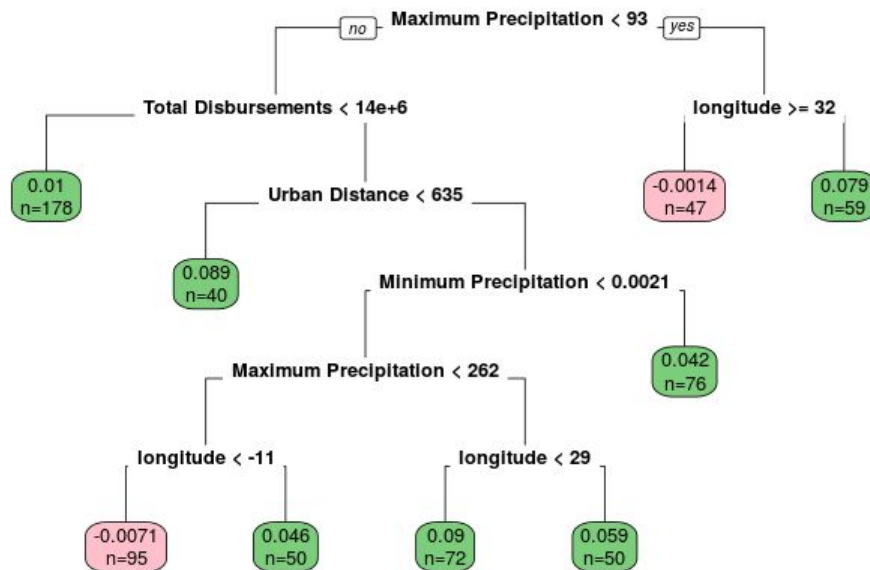
Questions

Uncertainty in Estimates (+/- @ 95% Confidence Interval)

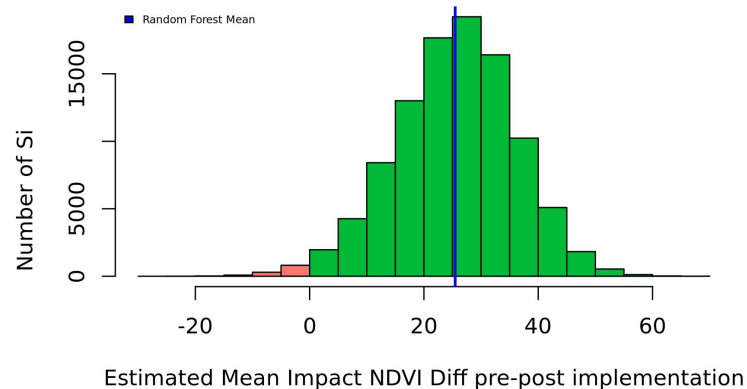


[96.86,130.8]
 (130.8,164.8]
 (164.8,198.8]
 (198.8,232.8]
 (232.8,266.7]

Matched Model: SFA Land (Treated), Null Case Comparisons (Control)	
	Dependent variable:
	NDVI Diff pre-post implementation
treatment	0.08*** (0.03, 0.14)
Dist. to Rivers (m)	-0.04 (-0.14, 0.07)
Dist. to Roads (m)	0.06* (-0.01, 0.12)
Elevation (m)	-0.18*** (-0.31, -0.06)
Slope (degrees)	-0.11** (-0.21, -0.02)
Urb. Dist. (rel)	-0.01 (-0.08, 0.07)
Pop. Density (2000)	0.06 (-0.04, 0.17)
Protected Area %	0.09*** (0.03, 0.14)
Treecover (2000, %)	0.05 (-0.04, 0.13)
Latitude	-0.09* (-0.18, 0.003)
Longitude	-0.13*** (-0.22, -0.03)
Max Precip. (2002, mm)	-0.42*** (-0.58, -0.27)
Min Precip (2002, mm)	-0.08* (-0.17, 0.01)
Mean Precip (2002, mm)	0.27*** (0.08, 0.45)
Max Temp (2002, C)	0.004 (-0.33, 0.34)
Min Temp (2002, C)	-0.28 (-0.78, 0.22)
Mean Temp (2002, C)	-0.23 (-0.98, 0.52)
Nighttime Lights (2002, Relative)	-0.02 (-0.10, 0.06)
NDVI (2002, Unitless)	0.01 (-0.07, 0.10)
Urb. Dist. (rel) *Treatment	-0.004 (-0.08, 0.07)
Dist. to Rivers (m) *Treatment	-0.04 (-0.14, 0.07)
Dist. to Roads (m) *Treatment	-0.03 (-0.10, 0.04)
Pop. Density (2000) *Treatment	-0.06 (-0.17, 0.04)
Latitude *Treatment	0.03 (-0.06, 0.12)
Longitude *Treatment	0.08 (-0.02, 0.17)
NDVI (2002, Unitless) *Treatment	0.07* (-0.01, 0.15)
Elevation (m) *Treatment	0.25*** (0.12, 0.37)
Slope (degrees) *Treatment	-0.12** (-0.22, -0.02)
Treecover (2000, %) *Treatment	-0.03 (-0.11, 0.06)
Max Temp (2002, C) *Treatment	0.57*** (0.24, 0.90)
Mean Temp (2002, C) *Treatment	-1.05*** (-1.80, -0.31)
Min Temp (2002, C) *Treatment	0.80*** (0.30, 1.30)
Max Precip. (2002, mm) *Treatment	-0.06 (-0.21, 0.10)
Mean Precip (2002, mm) *Treatment	0.06 (-0.12, 0.25)
Min Precip (2002, mm) *Treatment	-0.12*** (-0.20, -0.03)
Nighttime Lights (2002, Relative) *Treatment	0.01 (-0.06, 0.09)
Protected Area % *Treatment	-0.02 (-0.07, 0.04)
Constant	-0.01 (-0.06, 0.05)
Observations	966
R ²	0.30
Adjusted R ²	0.27
Note:	*p<0.1; **p<0.05; ***p<0.01



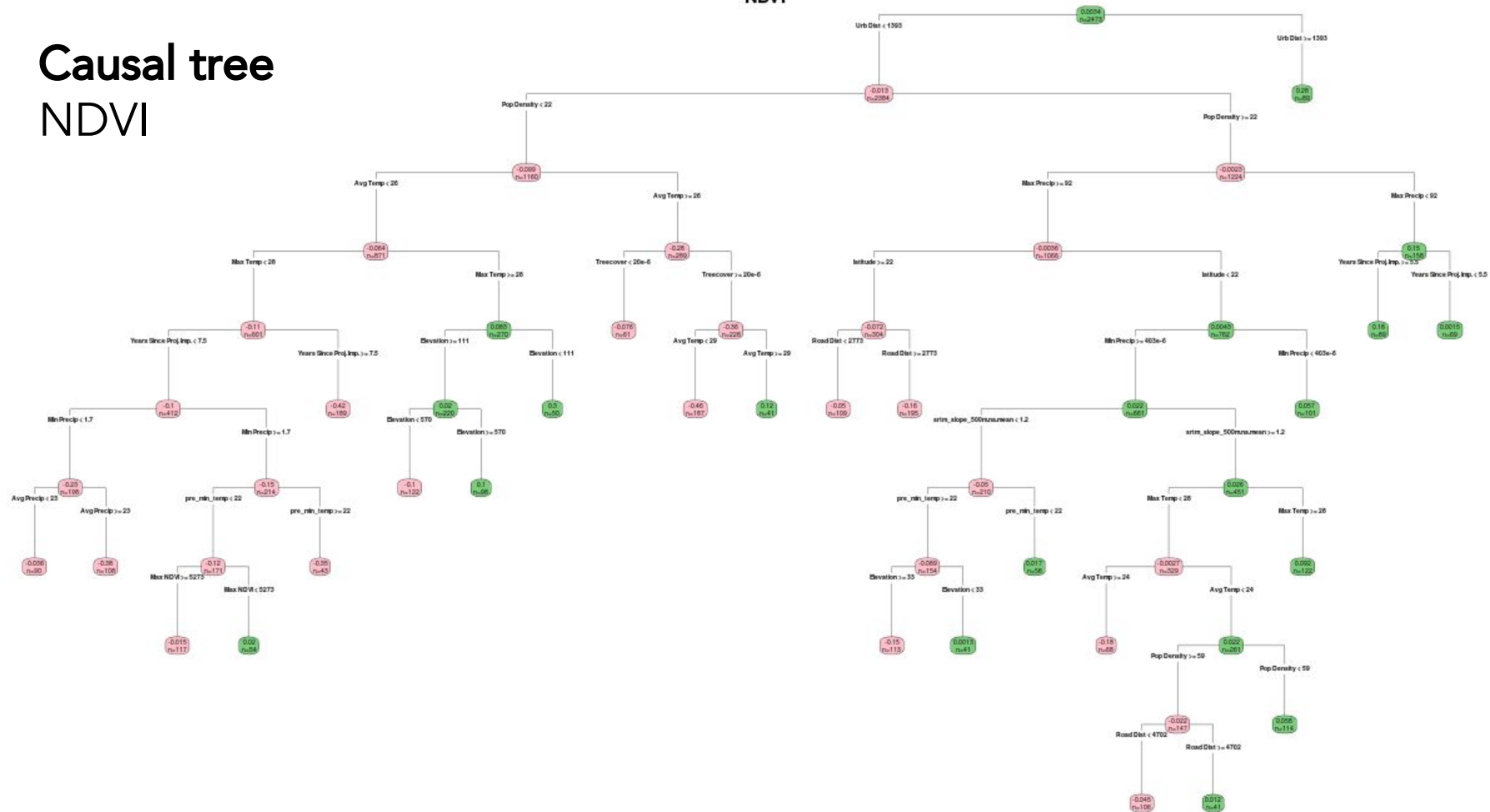
Model Uncertainty



Causal tree

NDVI

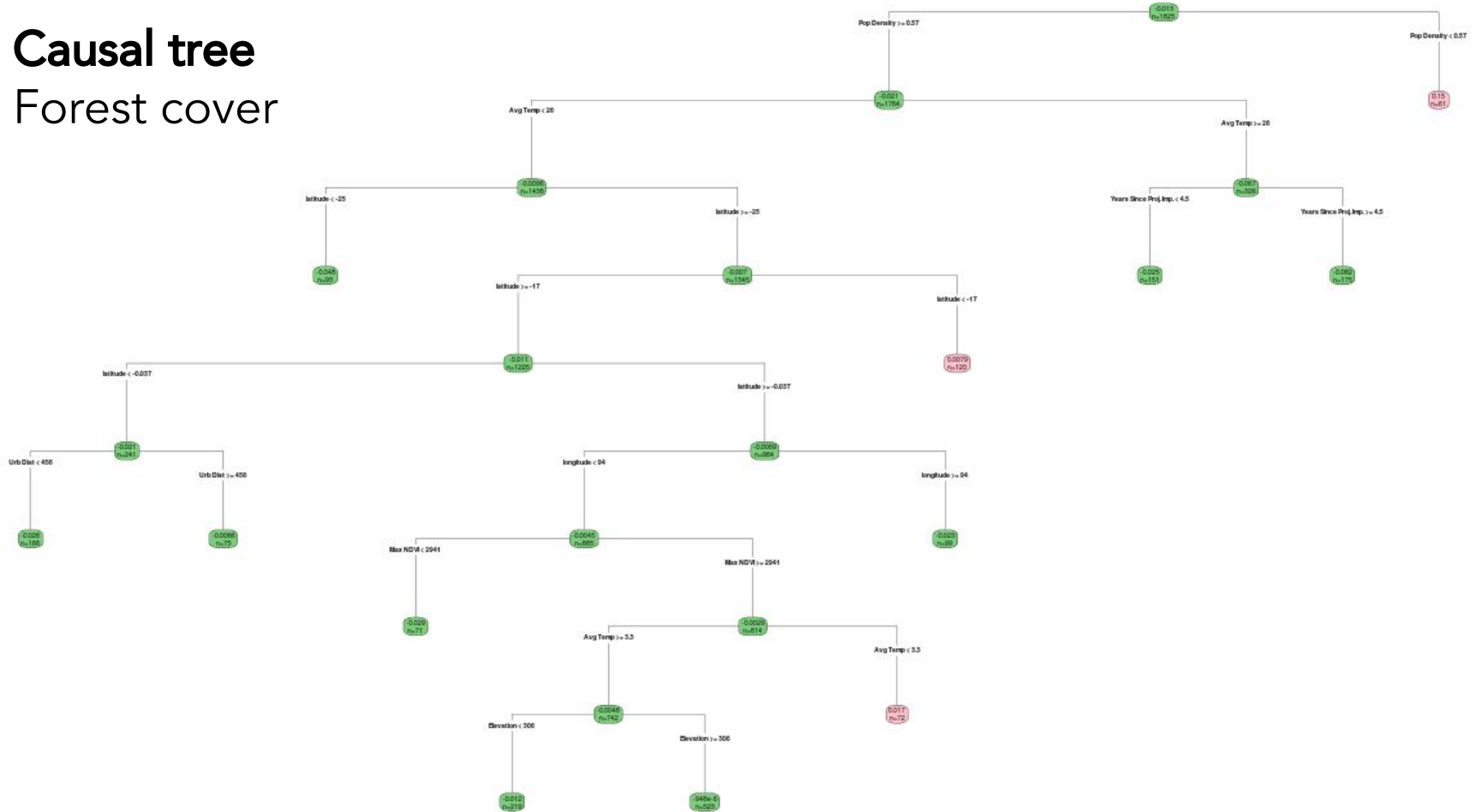
NDVI



Causal tree

Forest cover

Forest Landcover



NDVI trends

