Geospatial Data to Evaluate and Target Aid

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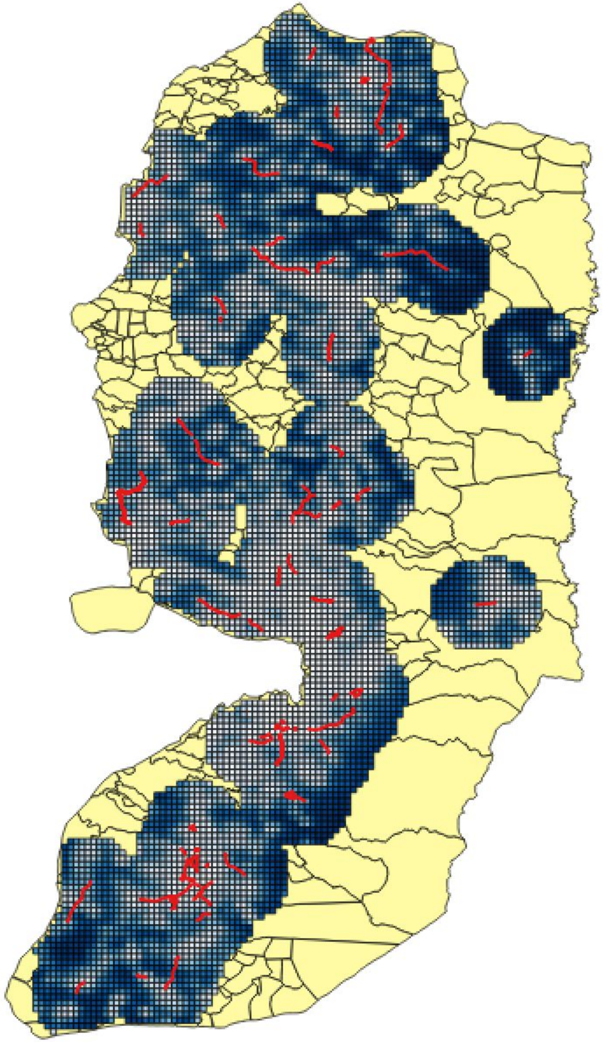
Geospatial Data is Reaching Adulthood

- 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

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[2]College of William and Mary
[3] Global Land Cover Facility, University of Maryland

Objectives

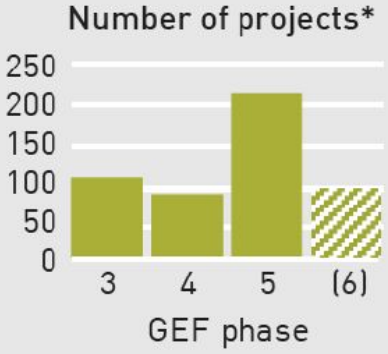
(1) Portfolio-wide impact evaluation (top-down)
(2) Identification of factors frequently associated with positive ou
(3) Valuation in terms of Carbon Sequestration

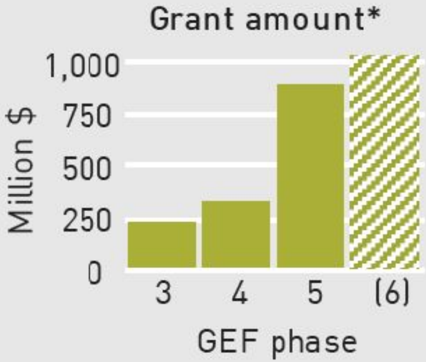
PORTFOLIO HIGHLIGHTS

237
projects

$630 million
in grant funding

$2.97 billion
in cofinancing





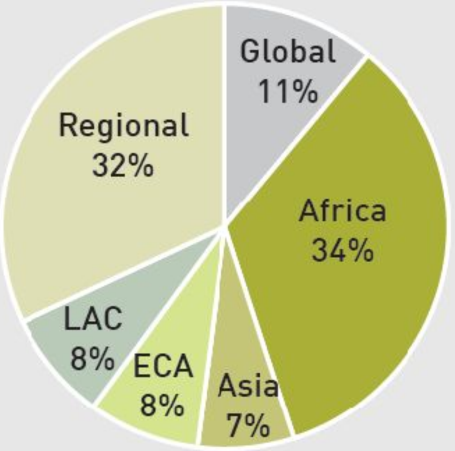
Top 3 agencies*

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

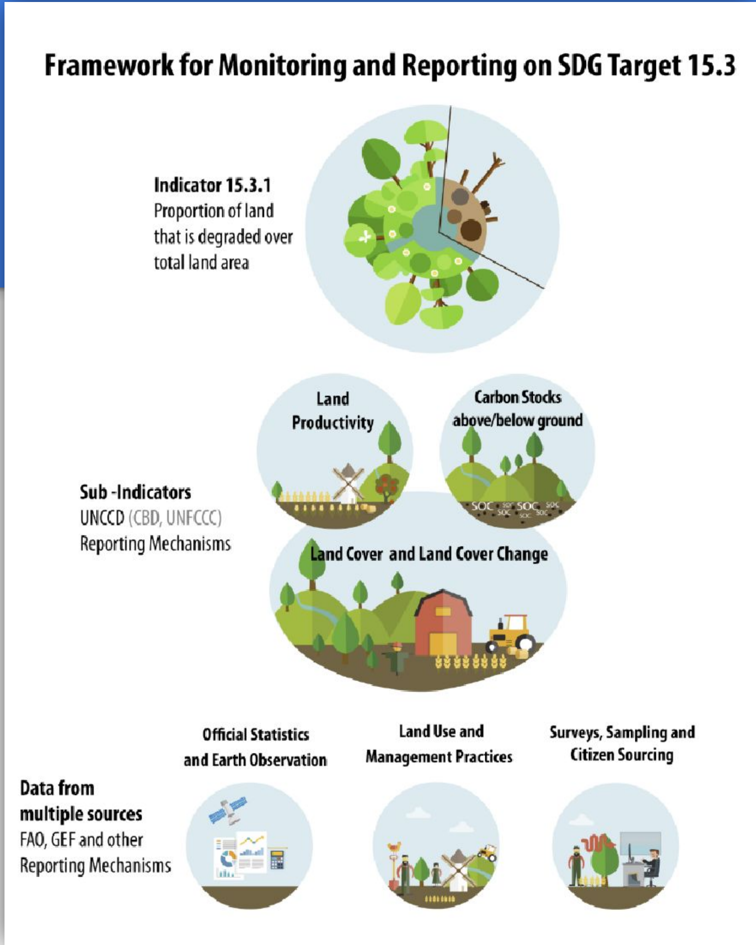
Total GEF funding per region*



*Includes LDFA and multifocal projects.

Outcomes

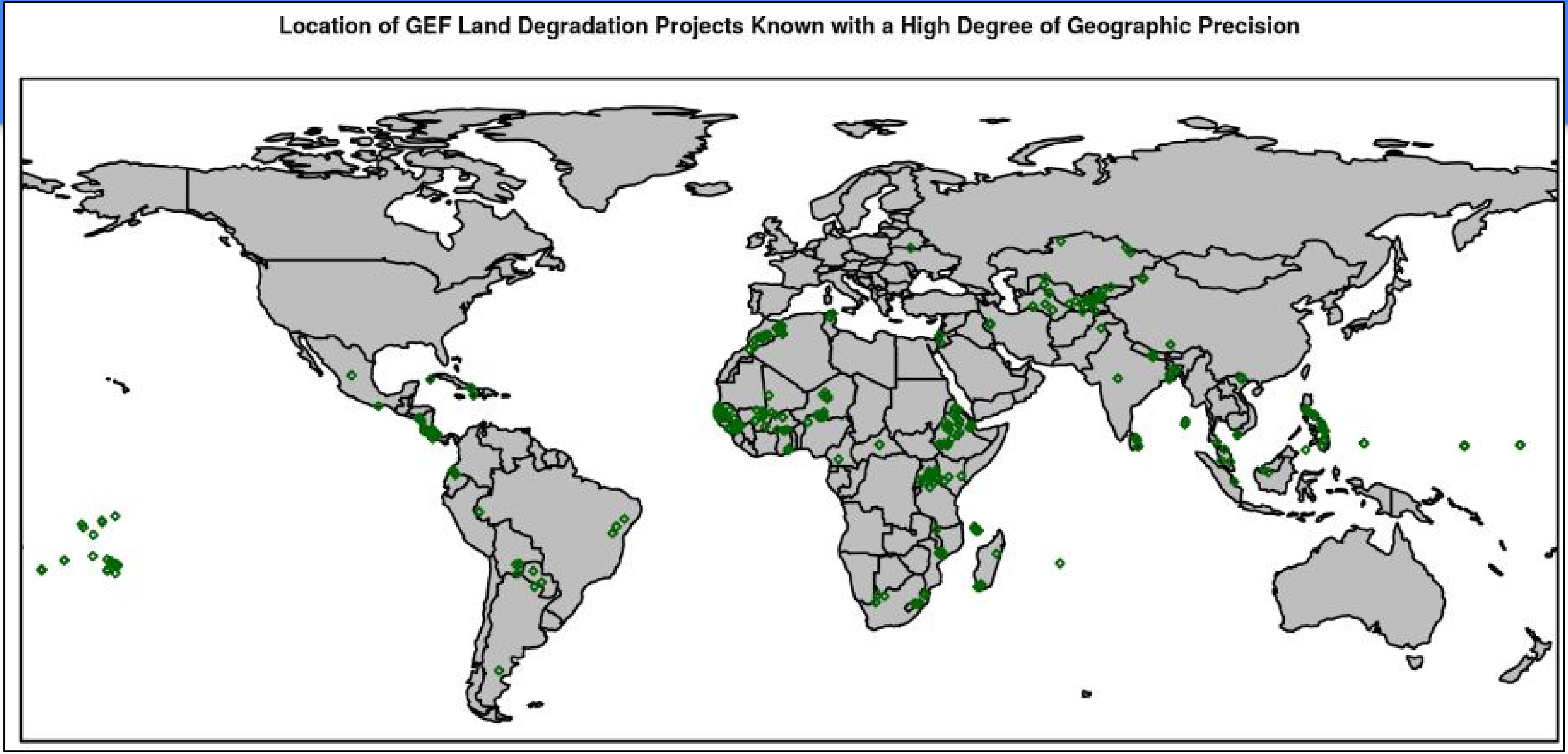
- Forest Cover
- Vegetative Density
- Forest Fragmentation



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

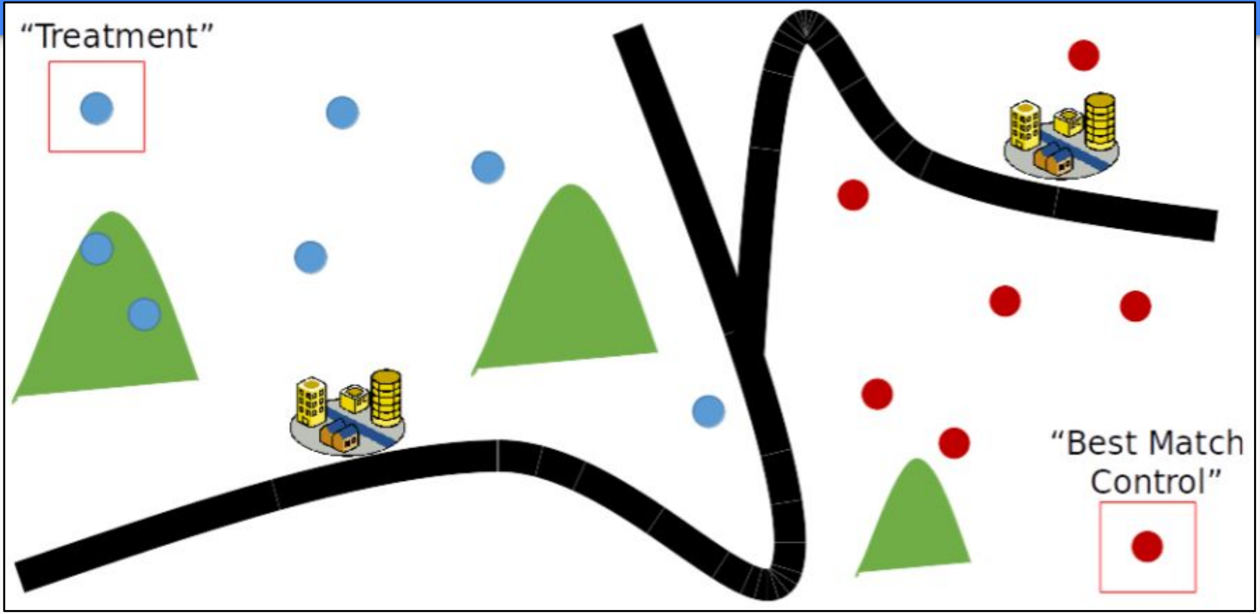


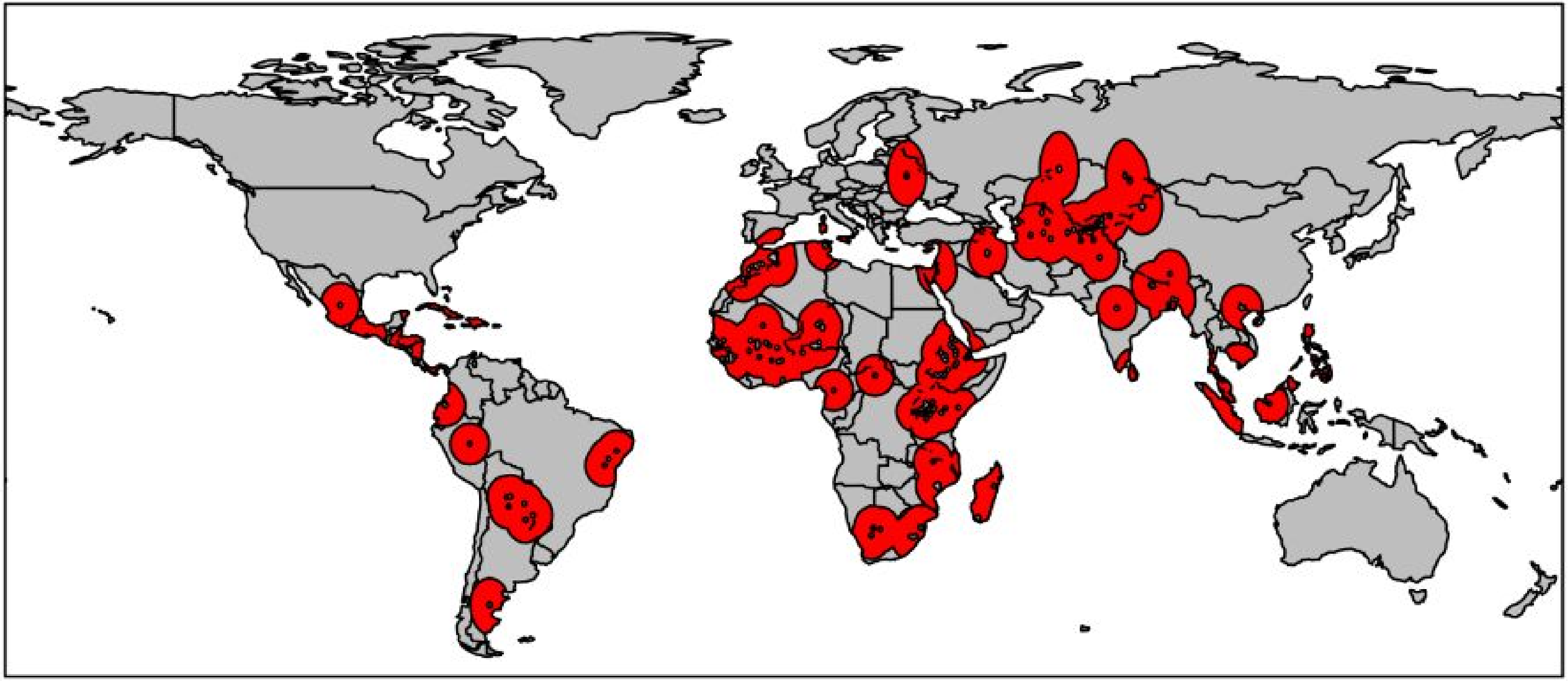
2. Data Integration

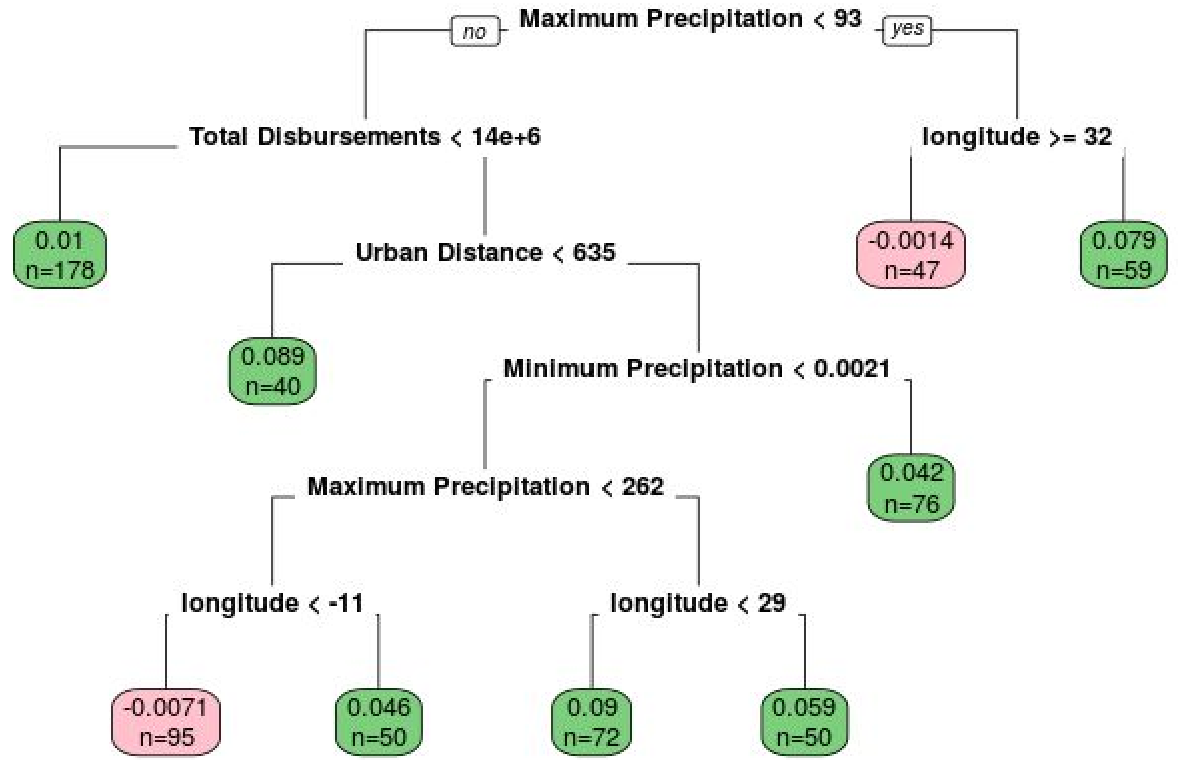
- Multi-sourced (including data from NASA, NOAA, a wide number of academic research groups, GEF project characteristics, and more.
- Multi-resolution (Monte Carlo simulation to capture uncertainties)
- Ancillary data included:
  - Distances to roads, rivers, cities, a variety of economic sites (i.e., 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.

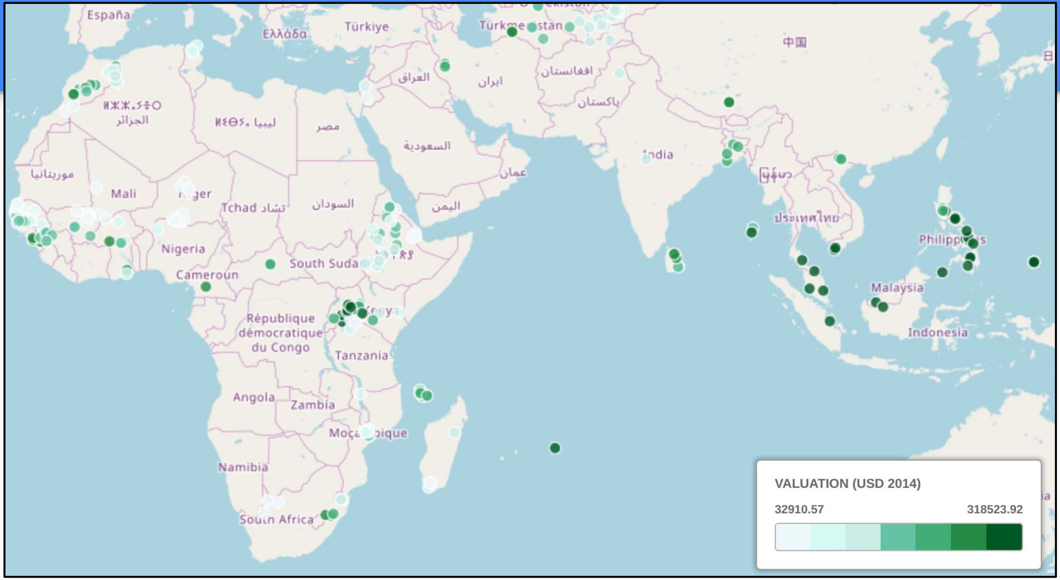





Maximum Precipitation < 93
no
yes
Total Disbursements < 14e+6
longitude >= 32
0.01
n=178
Urban Distance < 635
-0.0014
n=47
0.079
n=59
0.089
n=40
Minimum Precipitation < 0.0021
Maximum Precipitation < 262
0.042
n=76
longitude < -11
longitude < 29
-0.0071
n=95
0.046
n=50
0.09
n=72
0.059
n=50

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.

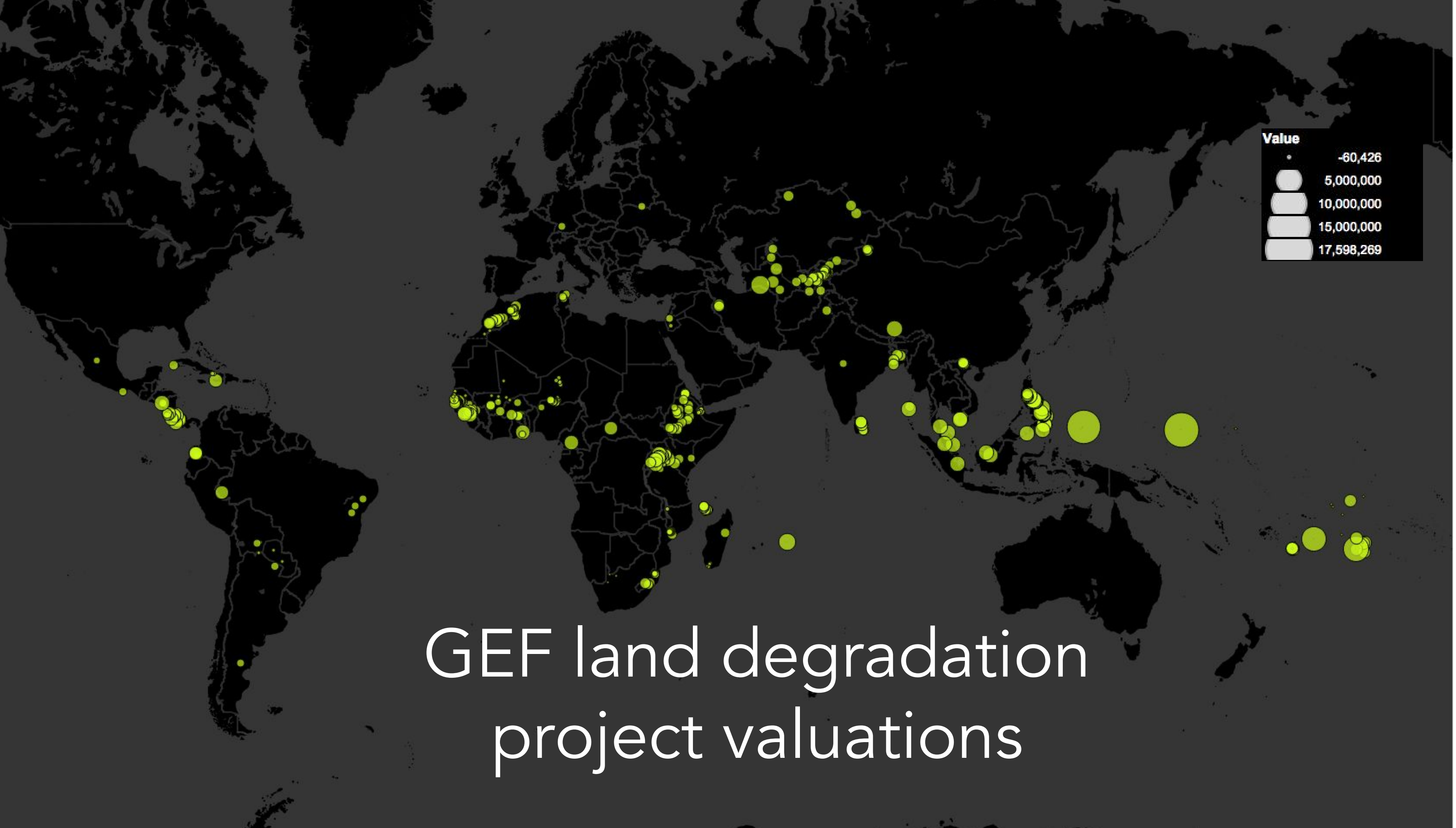


Key Findings

- 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).



GEF land degradation project valuations

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 BenYishay[1],Silke Heuser[2], Rachel Trichler[1], Dan Runfola[1]

[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

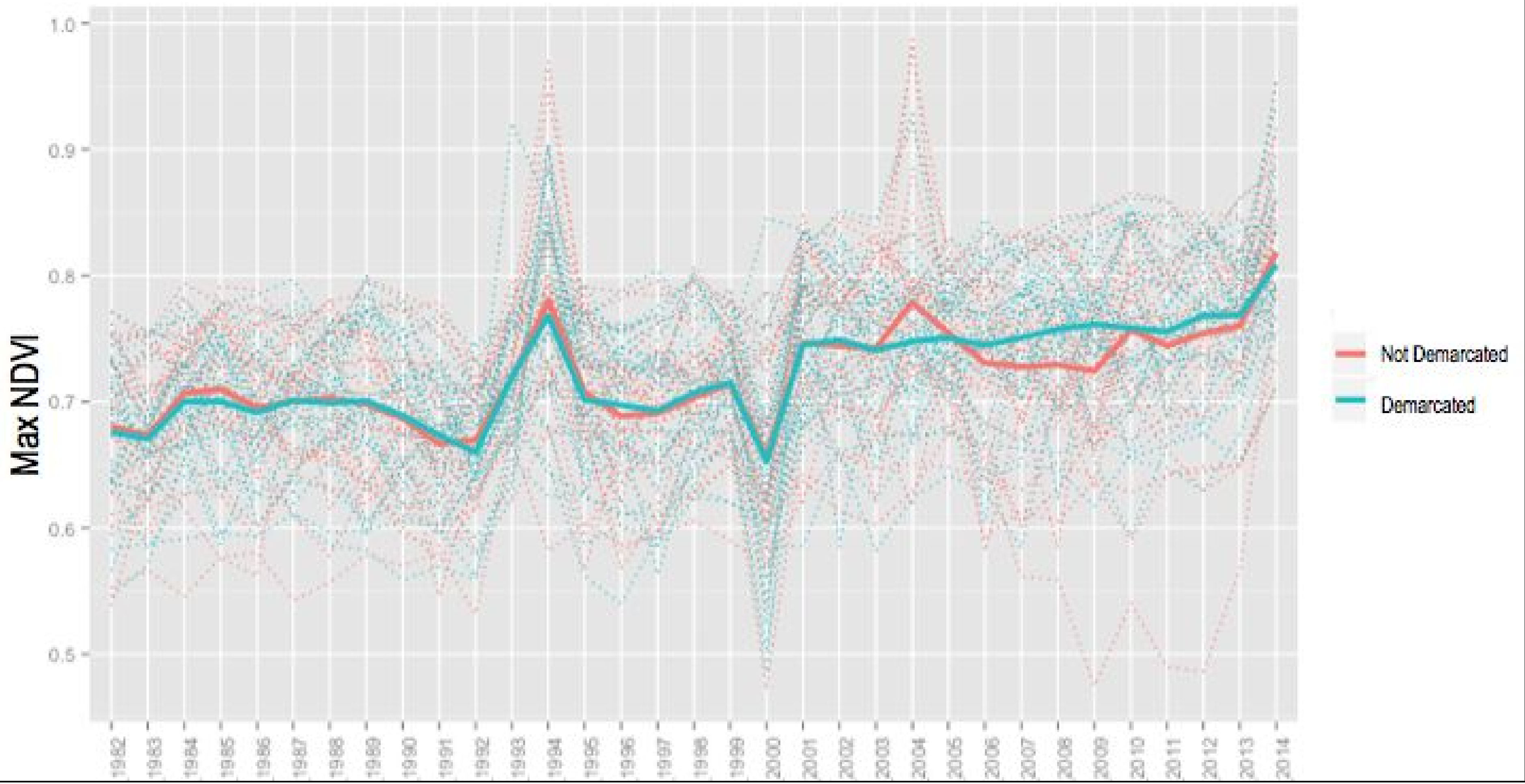
- Treatment status
  - Boundaries of community lands
  - Administrative data on demarcation dates
- Merged with satellite-based greenness measure
  - NASA Land Long Term Data Record (LTDR), 1982-2010
  - Processed to Normalized Difference Vegetation Index (NDVI)
  - Range is [0, 1] (0 = rocky, barren; 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


Max NDVI
1.0
0.9
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0.7
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1982
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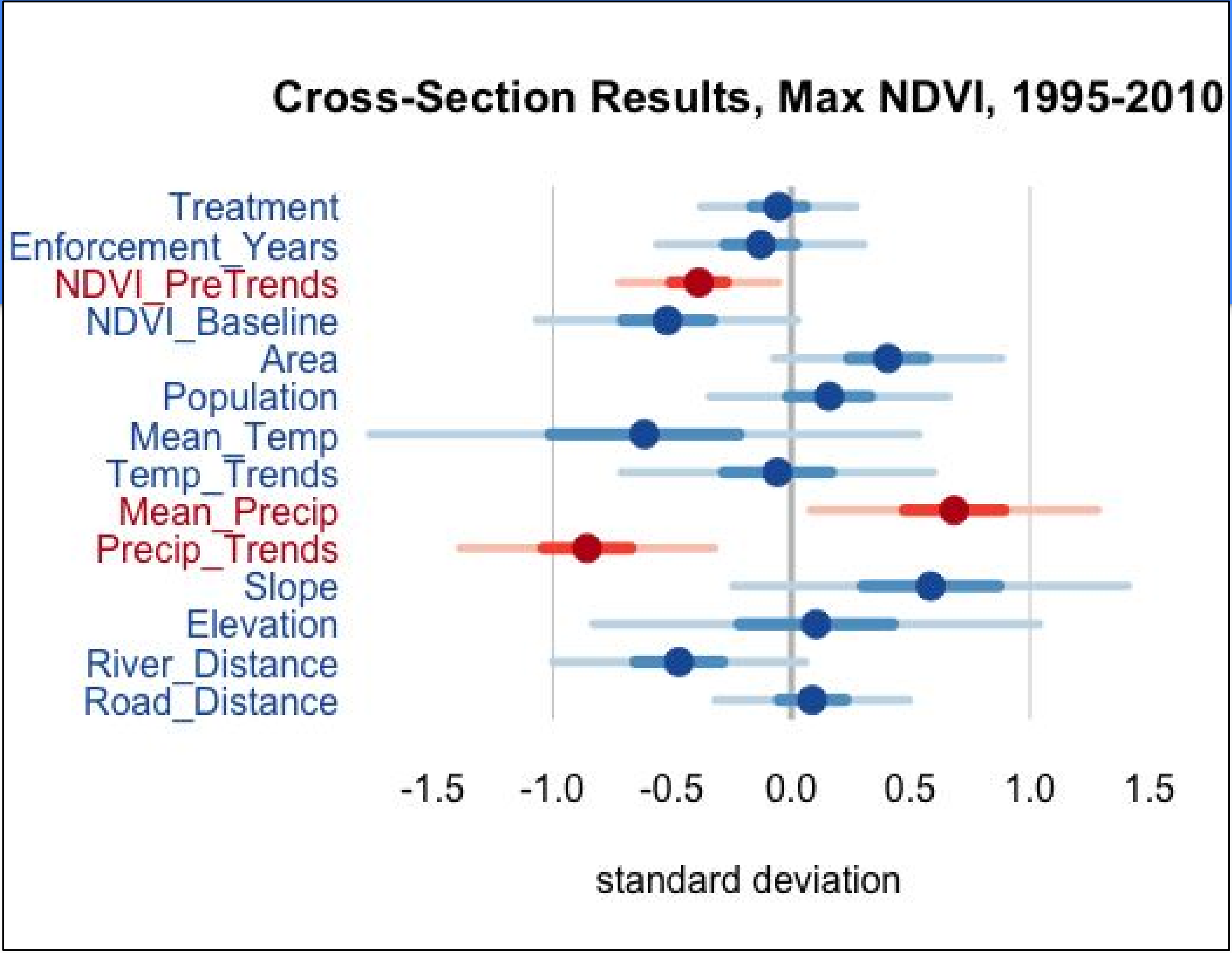
2012
2013
2014
Not Demarcated
Demarcated

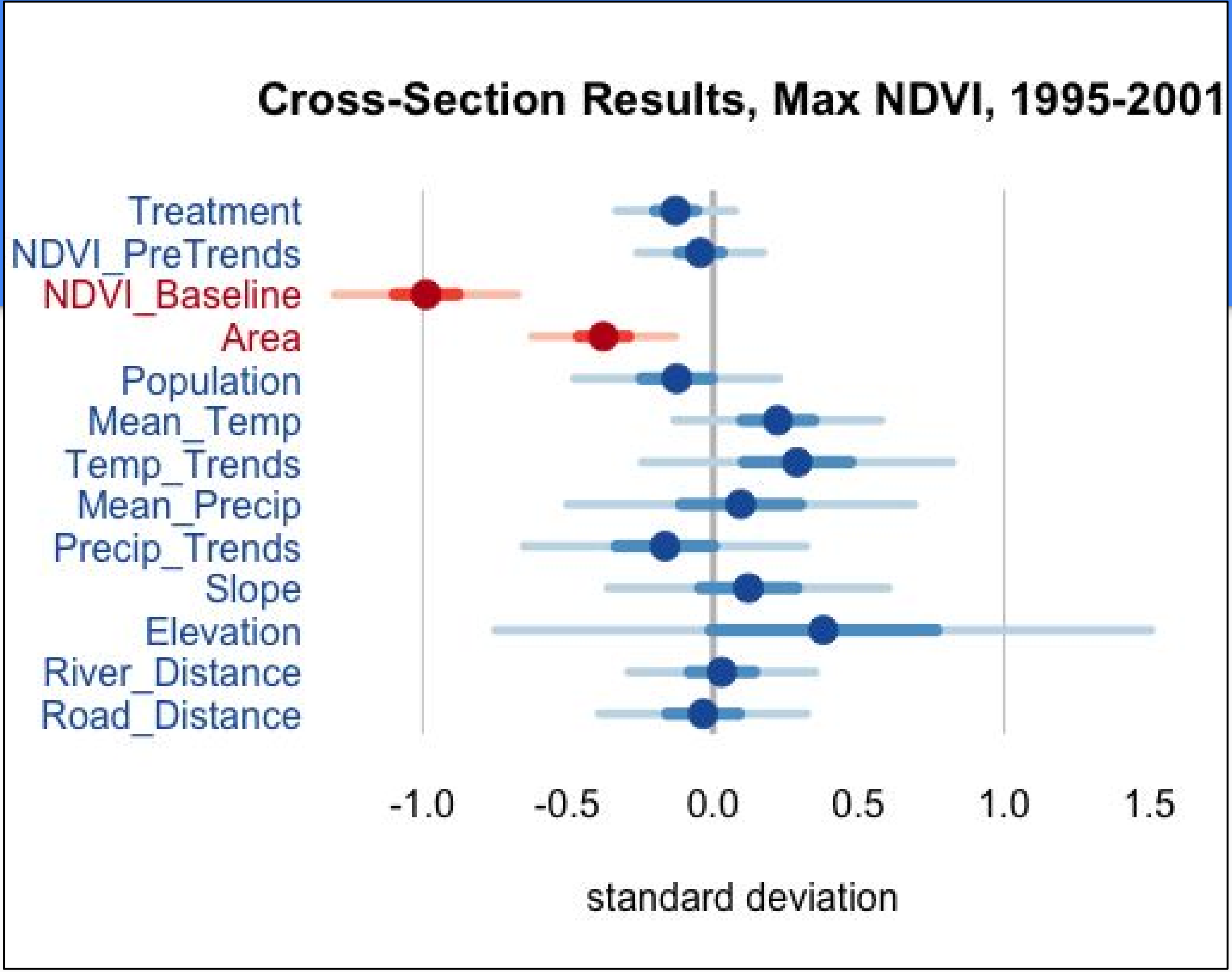
Demarcated vs. non-demarcated

- **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).



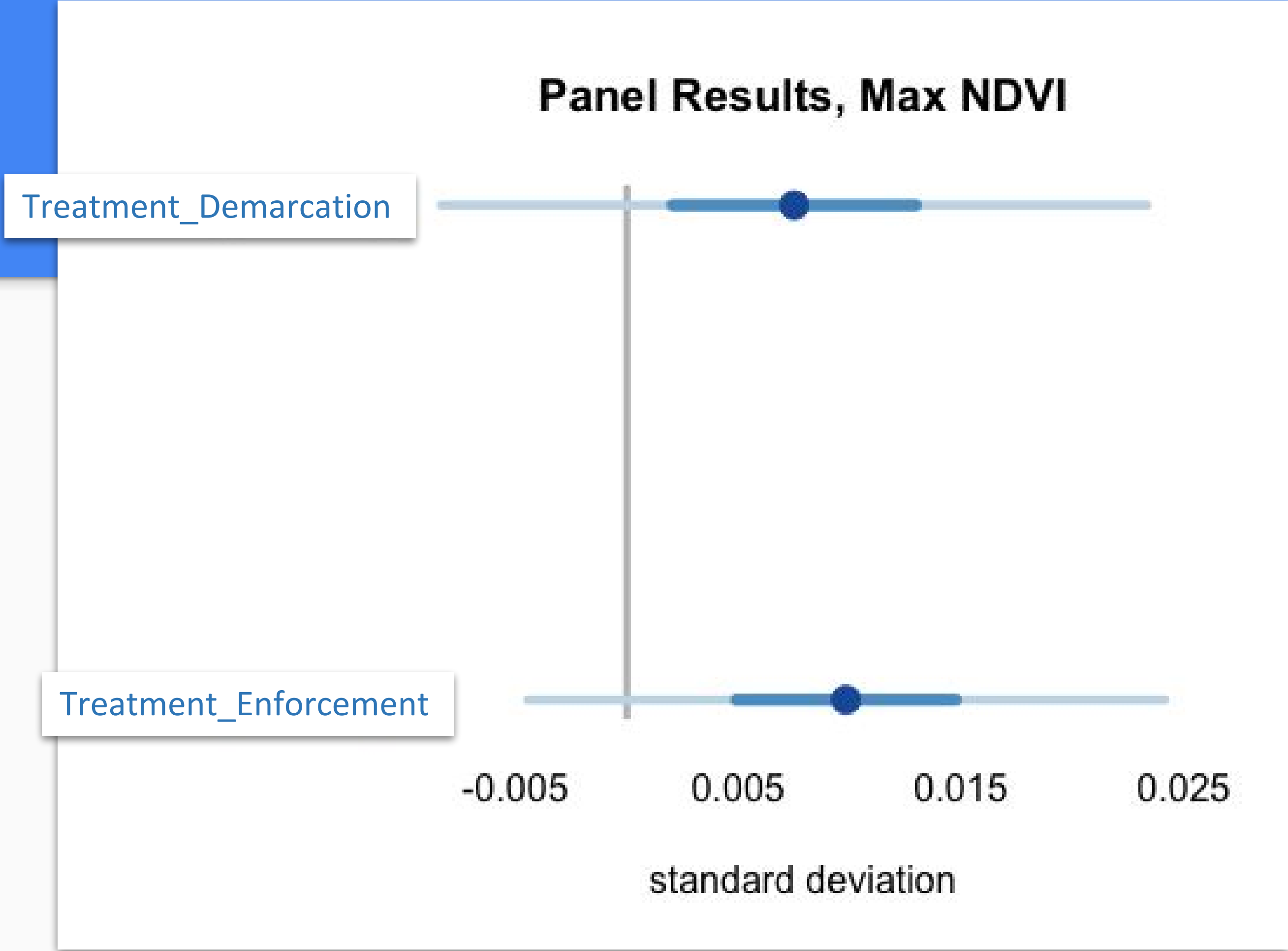
Early vs. Late demarcation

- **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

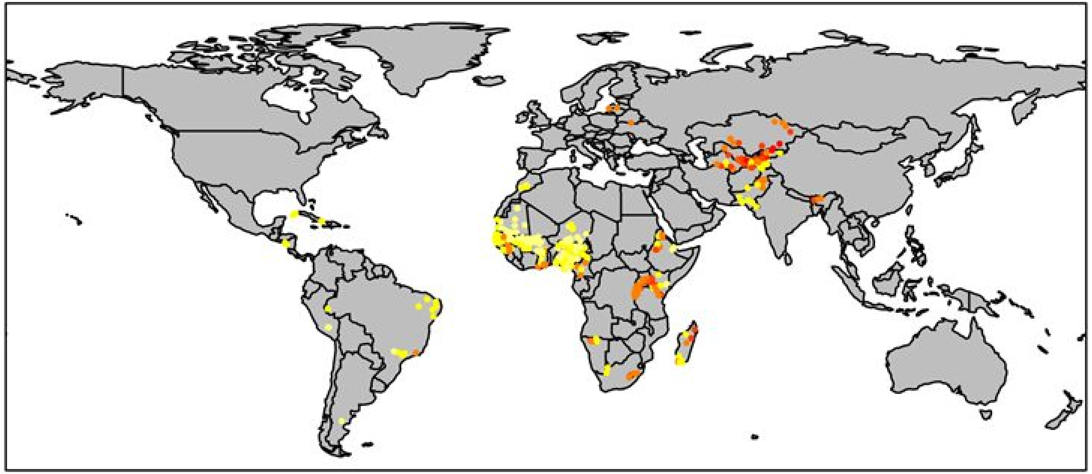
- **Treatment** = Year of demarcation.
- **Outcome** = Level of NDVI (max) each year
- Fixed effects, year trends.
- 2,128 annual observations; errors clustered by community and year.



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



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)
Nightime 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)
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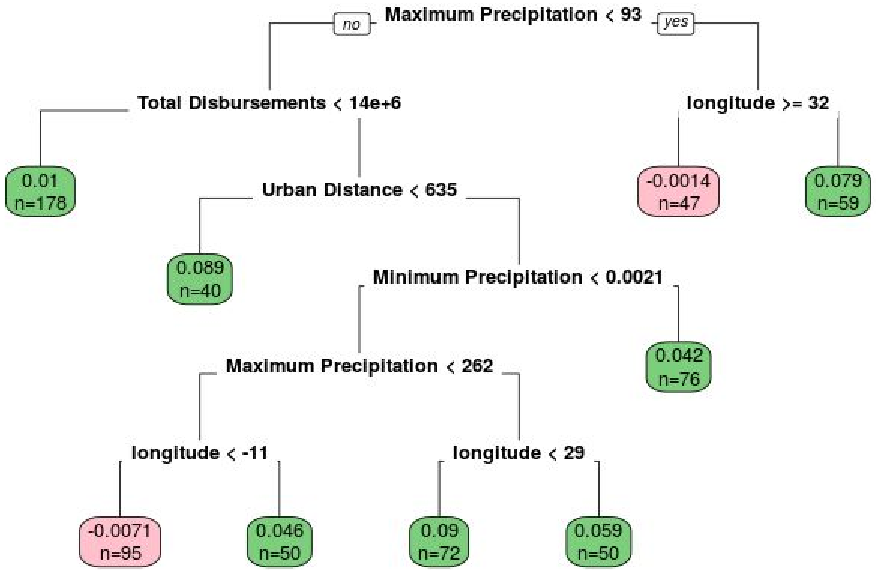
Pop. Density (2000) *Treatment	-0.06 (-0.17, 0.04)
Latitude *Treatment	0.03 (-0.06, 0.12)
Longitude *Treatment	0.08 (-0.02, 0.17)
NDVI (2002, Unitless) *Treatment	0.07* (-0.01, 0.15)
Elevation (m) *Treatment	0.25*** (0.12, 0.37)
Slope (degrees) *Treatment	-0.12** (-0.22, -0.02)
Treecover (2000, %) *Treatment	-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)
Nightime 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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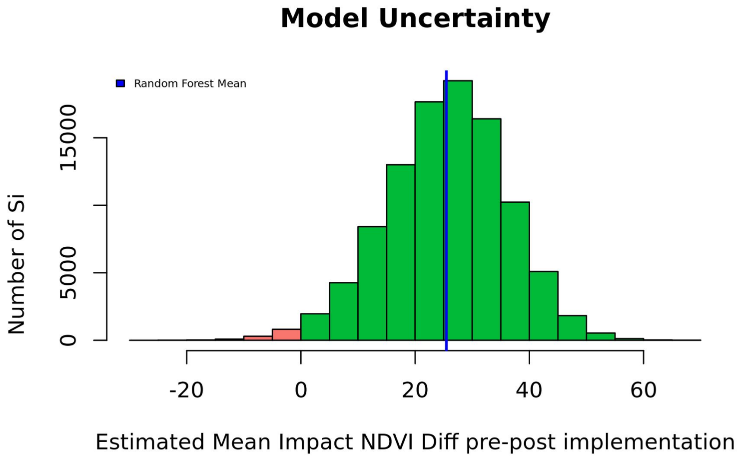
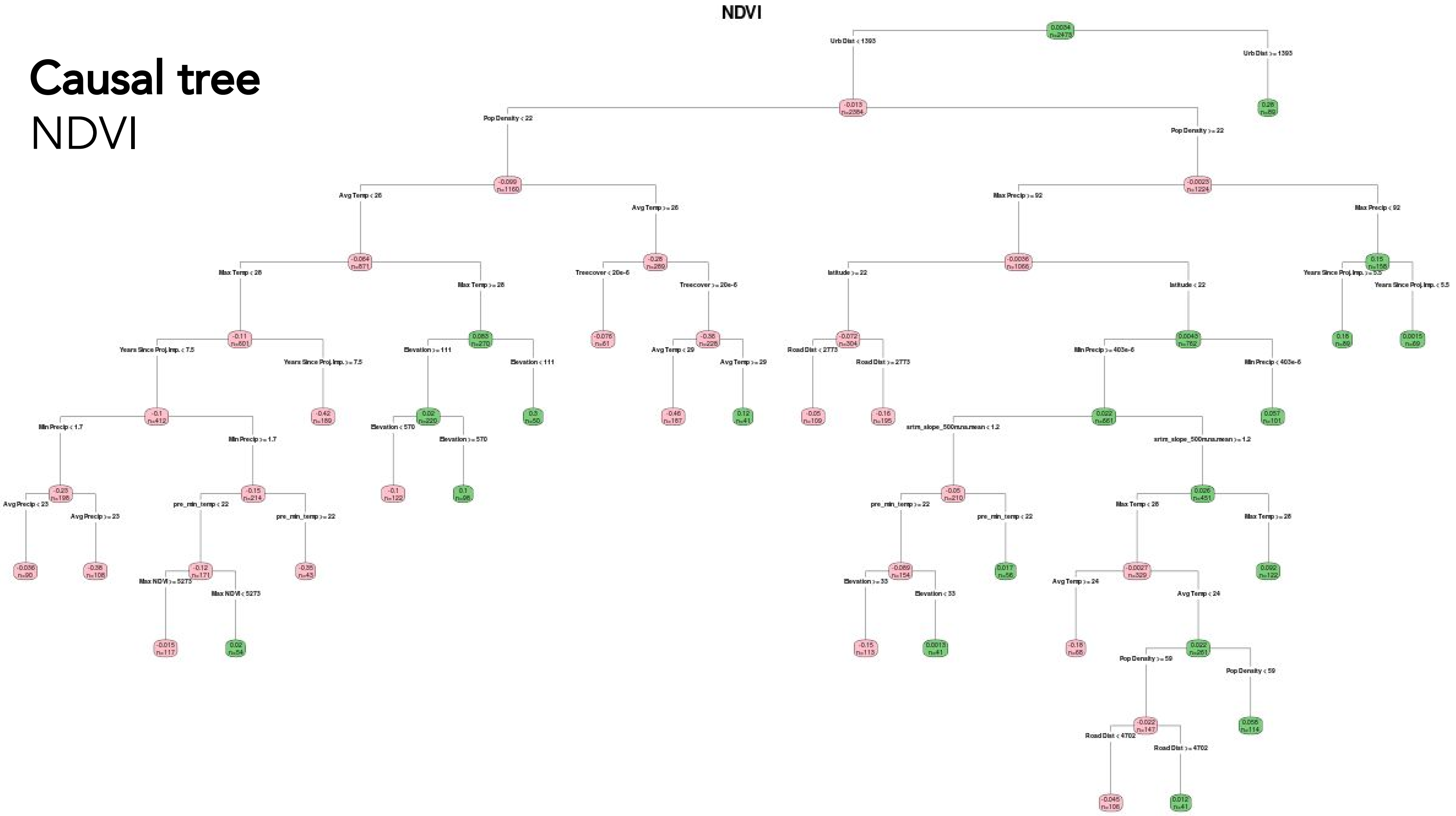
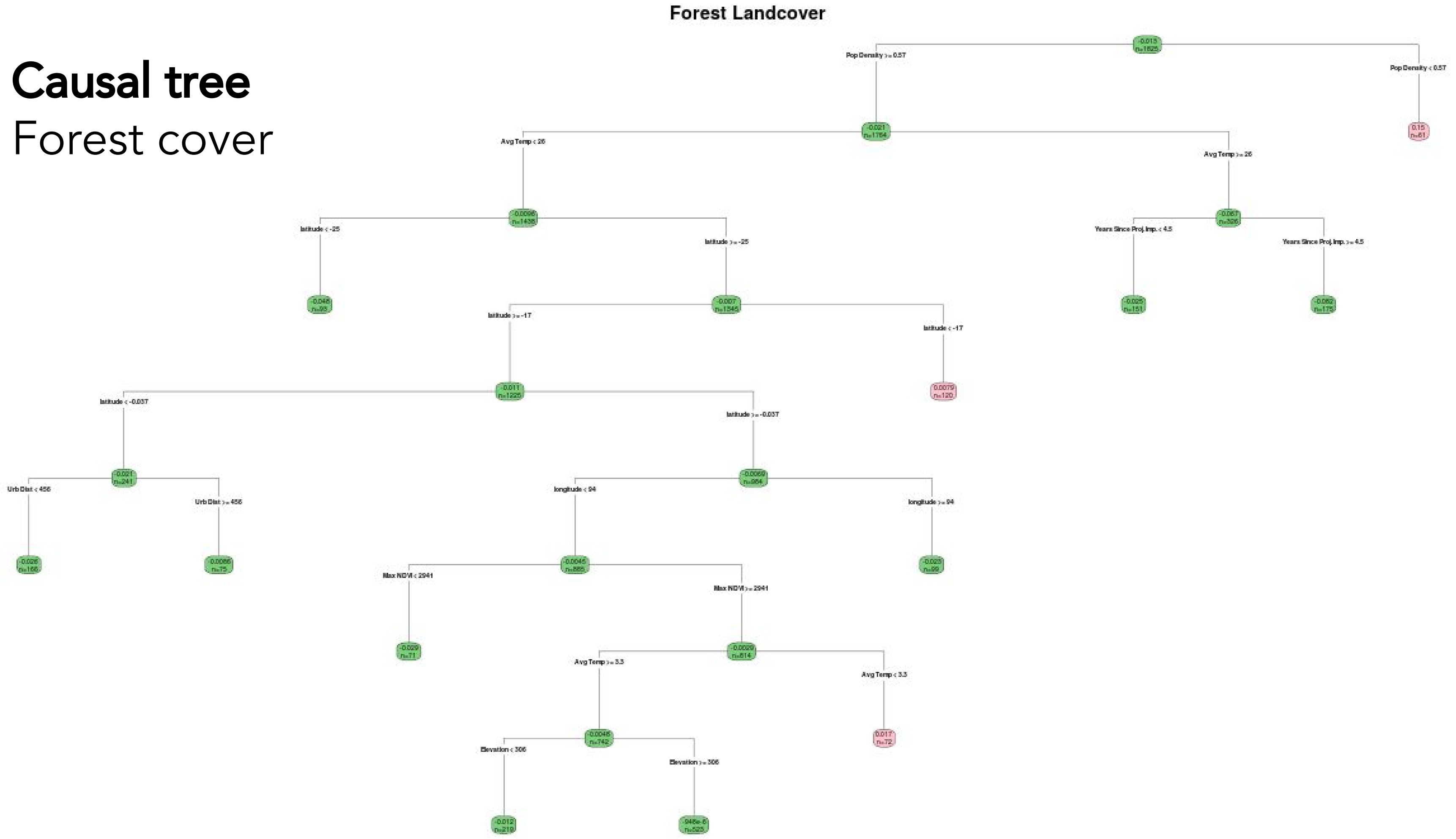

Model Uncertainty
Random Forest Mean
Number of Si
0
5000
15000
-20
0
20
40
60
Estimated Mean Impact NDVI Diff pre-post implementation

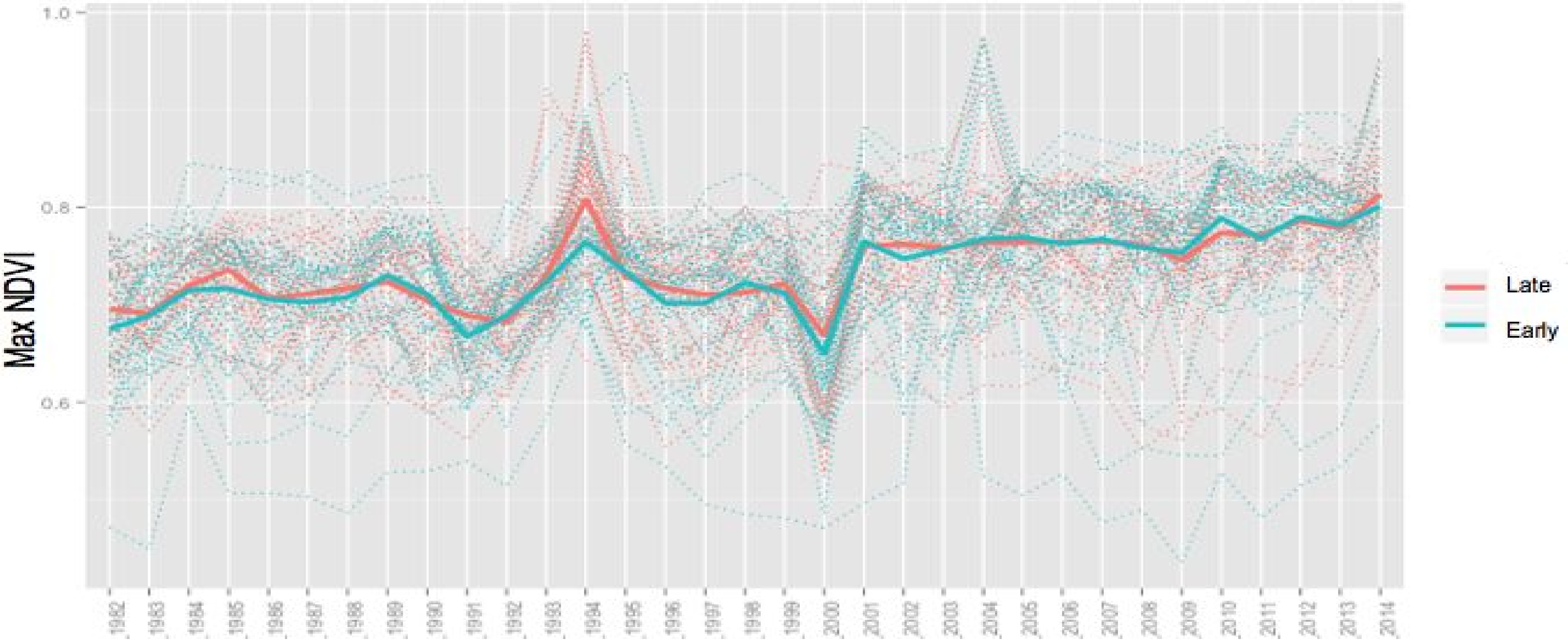
Causal tree
NDVI



Causal tree
Forest cover



NDVI trends



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1982
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