

Land cover and forest change

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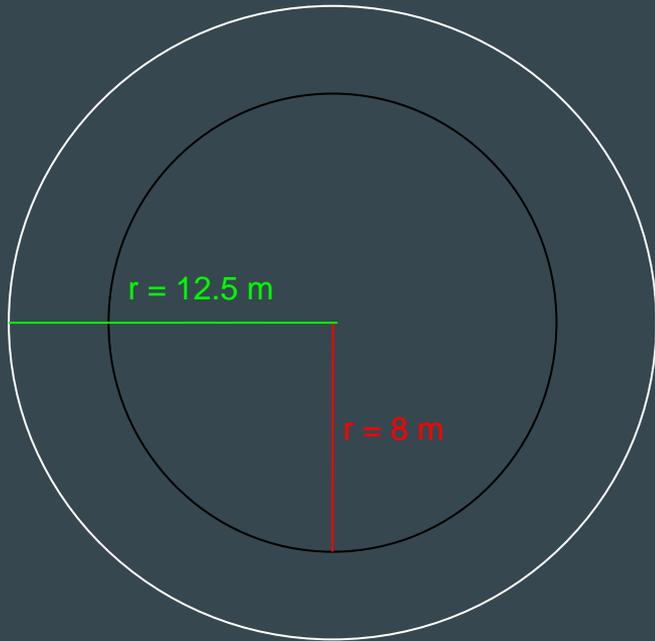
Contents

- Nayang tai village
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Overview of Nayang tai

- ❑ Tai Lue people, 112 households.
- ❑ Hmong people, 30-40 households.
- ❑ Religion: mostly believe in Buddhism.
- ❑ Livelihood: Handicraft-bases production, Since 2000.
- ❑ Rubber plantation since 2006.
- ❑ Tourism in 2018.
- ❑ Forest type: Mixed forest.

Plot design and data collection



- DBH was measured at breast height; 1.3 m.
- Inner circle (r=8 m) : $8 \leq \text{DBH} \leq 24.9$ cm.
- Outer circle (r= 12.5 m) : $\text{DBH} \geq 25$ cm.
- Bamboo clumps are counted.

Plot nomenclature

- E = Early successional, <15 years
- I = Intermediate, 15-20 years
- L = Late successional, >20 years
- P = Plantation (rubber) only

Area of 8 m circle = 201 m²

Area of 12.5 m circle = 409 m²

Plot locations

No. of surveyed plots:

6 Early

7 Intermediate

11 Late

6 Plantations

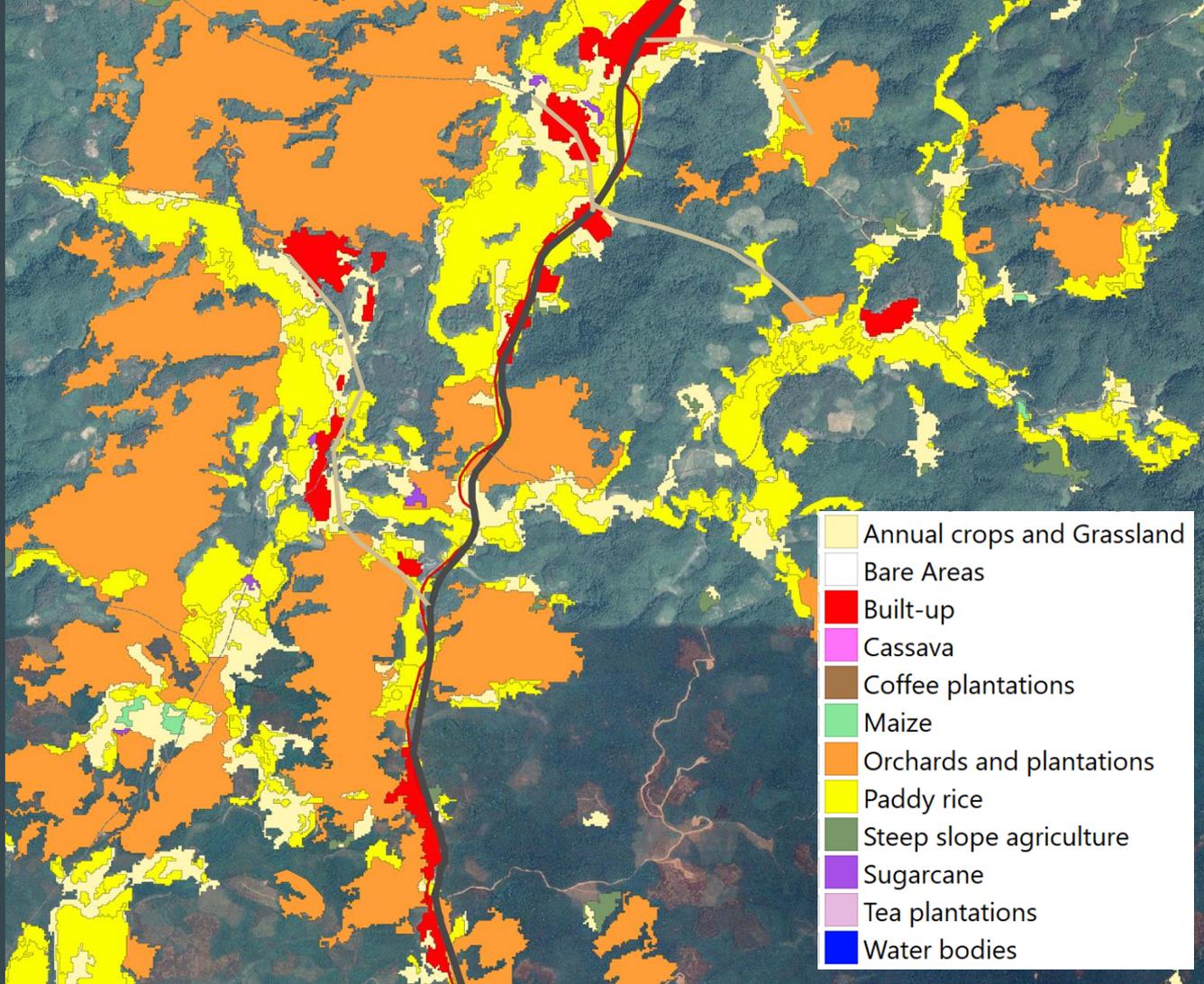
Total: 30 plots



Land cover

Data sourced from the
Laos Land Resources
Information
Management System,
by DALaM.

Data is for 2019.



Plot data: Early succession

Row Labels	Number of trees	Number of species	Canopy cover (%)	No. of bamboo clusters	Elevation
Early					
E2	4	3	76.0	14	415
E3	5	5	84.6	13	430
E4	9	7	90.1	29	445
E5	14	10	89.8	9	456
E6	7	6	89.1	12	427
E7	3	3	84.4	18	444
Subtotal	42	27	85.7 (mean)	95	436 (mean)

Plot data: Intermediate succession

Row Labels	Number of trees	Number of species	Canopy cover (%)	No. of bamboo clusters	Elevation
Intermediate					
I1	13	9	84.4	17	421
I2	1	1	83.1	12	445
I3	16	10	87.8	10	468
I4	7	6	84.4	7	473
I5	14	10	79.7	12	475
I6	9	6	78.1	17	464
I7	12	11	93.5	11	458
I8	8	6	86.5	16	443
Subtotal	80	38	84.7 (mean)	102	456 (mean)

Plot data: Late succession

Row Labels	Number of trees	Number of species	Canopy cover (%)	No. of bamboo clusters	Elevation
Late					
L1	13	10	86.7	13	428
L2	12	8	90.9	13	429
L3	8	7	88.8	10	438
L4	22	13	90.6	20	458
L5	18	7	86.2	30	464
L6	9	5	77.6	13	458
L7	5	3	89.8	19	473
L8	11	8	81.0	23	486
L9	4	4	82.0	16	492
L10	12	5	81.8	24	502
L11	20	10	79.2	11	511
Subtotal	134	44	85.0 (mean)	192	467 (mean)

Plot data: Plantation

Row Labels	Number of trees	Number of species	Canopy cover (%)	No. of bamboo clusters	Elevation
Plantation					
P1	34	1	100.0	0	389
P2	17	1	100.0	0	405
P3	36	1	100.0	0	395
P4	26	1	100.0	0	396
P5	34	1	100.0	0	401
P6	30	1	100.0	0	383
Subtotal	177	1	100.0 (mean)	0	395

Plot	Top 3 abundant	Number of tree	Top 3 species with highest basal area	basal area m ²
Early	ดอกกีบแก้ว (Dok Kib Kao)	6	ปอขาว (Por Kaw)	9518.1
	<i>Polyalthia sp.1</i>	4	ดอกกีบแก้ว (Dok Kib Kao)	9085.9
	ปอขาว (Por Kaw)	3	<i>Semecarpus cochinchinensis</i>	8666.2
	<i>Pterospermum megalocarpum</i>	3		
Intermediate	<i>Polyalthia sp.2</i>	6	<i>Ficus sp.2</i>	42103.7
	<i>Canarium sp.</i>	5	<i>Canarium sp.</i>	15934.1
	<i>Alstonia rostrata</i>	5	<i>Polyalthia sp.2</i>	10418.9
	<i>Polyalthia sp.1</i>	5		
Late	<i>Alstonia rostrata</i>	20	<i>Alstonia rostrata</i>	93744.7
	<i>Nephelium hypoleucum</i>	13	หมากเงือก	25184.6
	ไม้ซาดาว (Mai Ka Haw)	12	ขี้ป่า	22534.1

Plot	Top 3 species with highest basal area	basal area m ²	Top 3 abundant in each plot	Number of tree
E2	<i>Engelhardtia sp.</i>	1668.6	<i>Engelhardtia sp.</i>	2
	ปอขาว	709.2		
	ไม้ใบป็น	244.2		
E3	ปีกแห้ง	1604.6	No dominant	
	<i>Alstonia rostrata</i>	1100.6		
	<i>Markhamia stipulata</i>	355.1		
E4	ปอขาว	8809.0	ปอขาว	2
	ปีกเหนียง	6373.4	ดอกกีบแก้ว	2
	ดอกกีบแก้ว	6182.8		

Plot	Top 3 species with highest basal area	basal area m ²	Top 3 abundant in each plot	Number of tree
E5	หมากหม่น	3195.9	ดอกก๊ีบแก้ว	3
	ไม้ก้านยาว	3057.1	<i>Polyalthia sp.1</i>	2
	ตั้งเสี้ยน	2982.7	<i>Pterospermum megalocarpum</i>	2
E6	หนังกลอง	4556.1	หนังกลอง	2
	หมากไฟ	621.9		
	<i>Pterospermum megalocarpum</i>	336.2		
E7	<i>Semecarpus cochinchinensis</i>	8666.2	No dominant	
	ไต่โค	3100.9		
	<i>Cinamomum iners</i>	2192.9		

Plot	Top 3 species with highest basal area	basal area m ²	Top 3 abundant in each plot	Number of tree
I1	<i>Ficus sp.2</i>	42103.7	จวง	2
	ไม้หาด	7716.8	<i>Canarium sp.</i>	2
	<i>Polyalthia sp.1</i>	7089.2	<i>Ficus sp.2</i>	2
			<i>Polyalthia sp.1</i>	2
I2	<i>Alstonia rostrata</i>	1048.8	No dominant	
I3	<i>Canarium sp.</i>	9683.3	<i>Polyalthia sp.2</i>	5
	<i>Polyalthia sp.2</i>	9651.5	<i>Nephelium hypoleucum</i>	2
	<i>Knema sp.1</i>	1926.7	<i>Canarium sp.</i>	2
I4	ไม้ขี้	2607.1	<i>Knema sp.2</i>	2
	<i>Knema sp.2</i>	2506.9		
	<i>Stereospermum neuranthum</i>	2230.0		

Plot	Top 3 species with highest basal area	basal area m ²	Top 3 abundant in each plot	Number of tree
15	<i>Lagerstroemia sp.</i>	7846.2	<i>Ficus sp.4</i>	3
	ไม้พอง	4093.4	<i>Nephelium hypoleucum</i>	2
	<i>Ficus sp.4</i>	2579.2	<i>Pterospermum megalocarpum</i>	2
16	<i>Alstonia rostrata</i>	2694.7	<i>Polyalthia sp.1</i>	2
	<i>Wrightia arborea</i>	2354.3	นางเขี้ยว	2
	นางเขี้ยว	981.2	<i>Alstonia rostrata</i>	2
17	หนังกลอง	6292.6	ไม้พอง	2
	<i>Knema sp.1</i>	3893.8		
	ไม้พอง	2475.3		

Plot	Top 3 species with highest basal area	basal area m ²	Top 3 abundant in each plot	Number of tree
I8	ดอกปีด	2052.5	จำส้าน	3
	<i>Lithocarpus sp.</i>	1515.5		
	<i>Alstonia rostrata</i>	1247.4		
L1	ปอขาว	4283.3	<i>Wrightia arborea</i>	2
	<i>Myristicaceae sp.</i>	3170.5	ไม้ซ้าหา	2
	<i>Wrightia arborea</i>	2958.9	<i>Pterospermum megalocarpum</i>	2
L2	<i>Alstonia rostrata</i>	13875.2	<i>Polyalthia sp.2</i>	3
	หมากเคี้ยว	2995.0	<i>Alstonia rostrata</i>	3
	<i>Syzygium sp.</i>	2124.7		

Plot	Top 3 species with highest basal area	basal area m ²	Top 3 abundant in each plot	Number of tree
L3	ทะโล้	15583.0	ทะโล้	2
	<i>Engelhardtia sp.</i>	827.9		
	ปีป่า	484.2		
L4	<i>Alstonia rostrata</i>	44649.3	<i>Alstonia rostrata</i>	7
	หมากเคี่ยม	3922.0	<i>Castanopsis ceratacantha</i>	3
	<i>Nephelium hypoleucum</i>	3318.3	นางเขีย	2
L5	<i>Alstonia rostrata</i>	29854.3	<i>Alstonia rostrata</i>	8
	ปีป่า	15427.2	ปีป่า	4
	แฮกโยง	14401.1	<i>Nephelium hypoleucum</i>	2

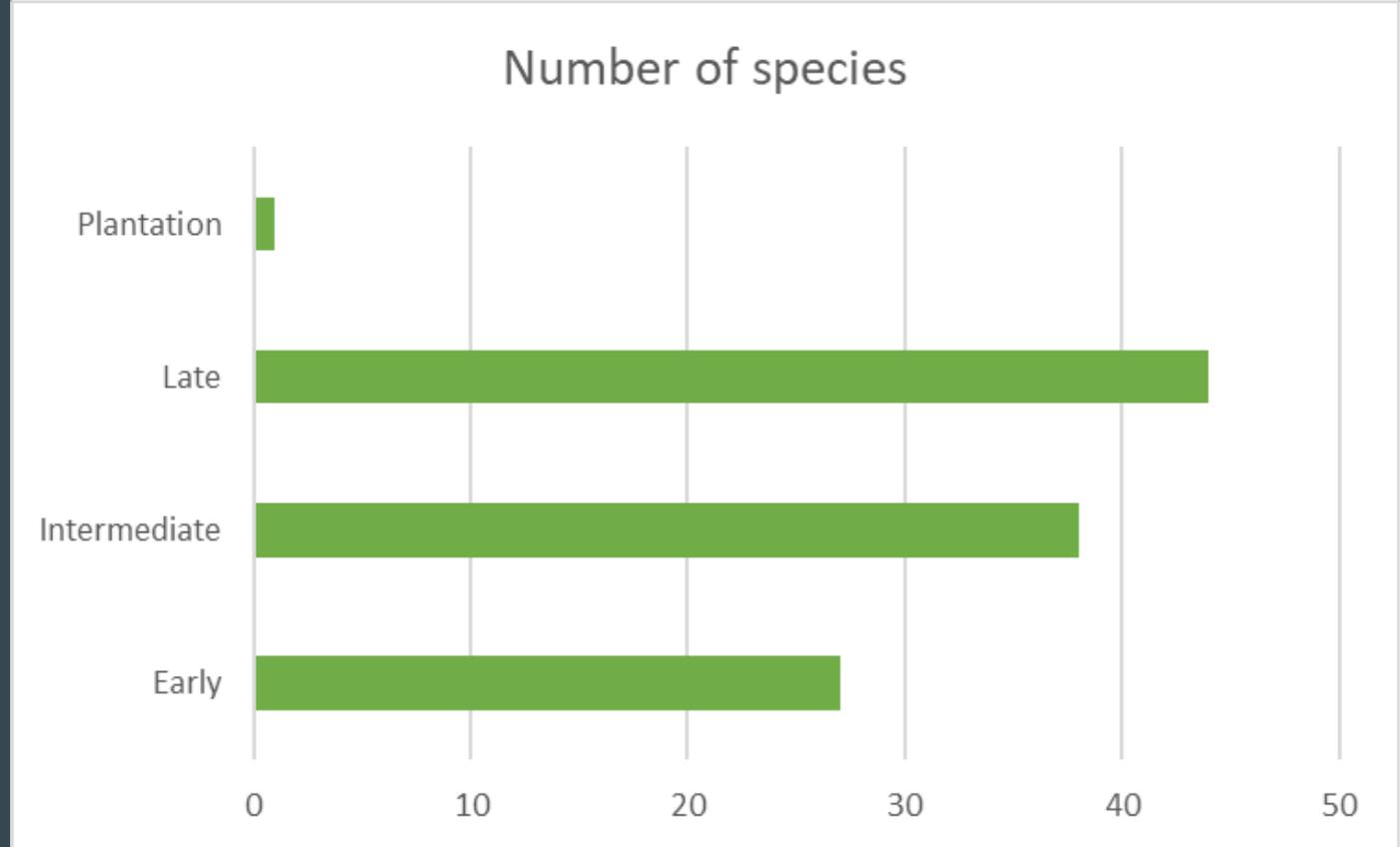
Plot	Top 3 species with highest basal area	basal area m ²	Top 3 abundant in each plot	Number of tree
L6	หมากเถือ้ม	13835.3	หมากเถือ้ม	3
	<i>Ficus sp.2</i>	12029.6	ไม้ซ้าหาว	2
	บิป่า	3193.8	บิป่า	2
L7	<i>Wrightia arborea</i>	5306.1	<i>Wrightia arborea</i>	3
	หมากก้าวม	2723.6		
	<i>Garcinia sp.</i>	2052.5		
L8	<i>Alstonia rostrata</i>	5366.0	<i>Castanopsis indica</i>	2
	หมากเถือ้ม	4432.3	ไม้ซ้าหาว	2
	ก้อกาลัง	1613.7	<i>Alstonia rostrata</i>	2

Plot	Top 3 species with highest basal area	basal area m ²	Top 3 abundant in each plot	Number of tree
L9	<i>Alstonia scholaris</i>	3922.0	No dominant	
	ขี้ป่า	3285.8		
	<i>Nephelium hypoleucum</i>	2305.3		
L10	<i>Castanopsis indica</i>	5217.3	<i>Nephelium hypoleucum</i>	5
	หมากมุ่น	4637.4	ไม้ชาหาว	3
	<i>Nephelium hypoleucum</i>	2364.8	<i>Castanopsis indica</i>	2
L11	<i>Polyalthia sp.1</i>	20065.1	<i>Polyalthia sp.1</i>	6
	หมี่คำ	10222.0	ไม้ชาหาว	3
	<i>Engelhardtia sp.</i>	9803.6	<i>Cinamomum iners</i>	2
			<i>Engelhardtia sp.</i>	2
			ไต้โก	2

Plot	Top 3 species with highest basal area	basal area m ²	Top 3 abundant in each plot	Number of tree
P1	<i>Hevea brasiliensis</i>	23898.2	No dominant	
P2	<i>Hevea brasiliensis</i>	21893.7	No dominant	
P3	<i>Hevea brasiliensis</i>	39076.8	No dominant	
P4	<i>Hevea brasiliensis</i>	41304.6	No dominant	
P5	<i>Hevea brasiliensis</i>	26811.1	No dominant	
P6	<i>Hevea brasiliensis</i>	31495.5	No dominant	

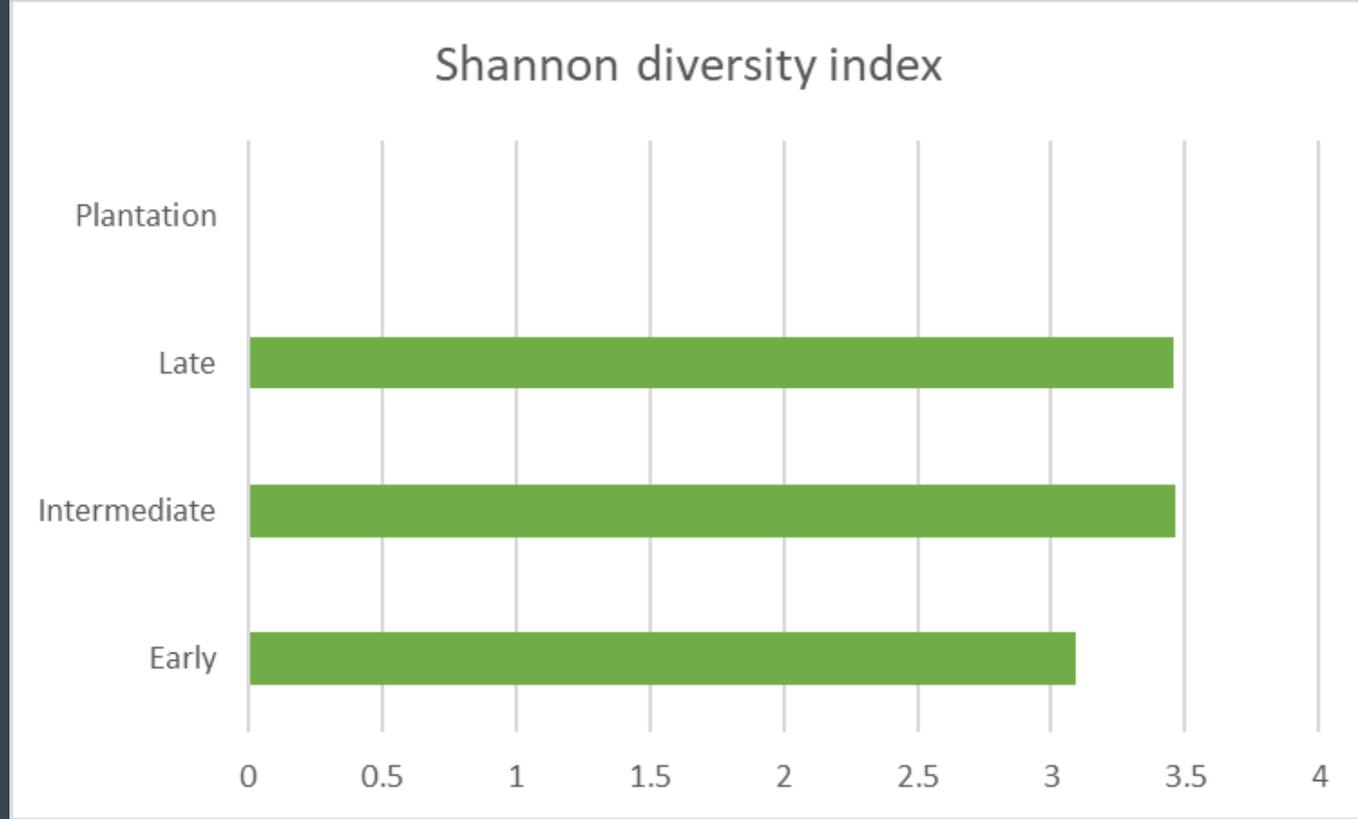
Species richness

- Mean species richness was significantly different across forest types (AOV $p = 0.00048^{***}$)
- Total number of species 81



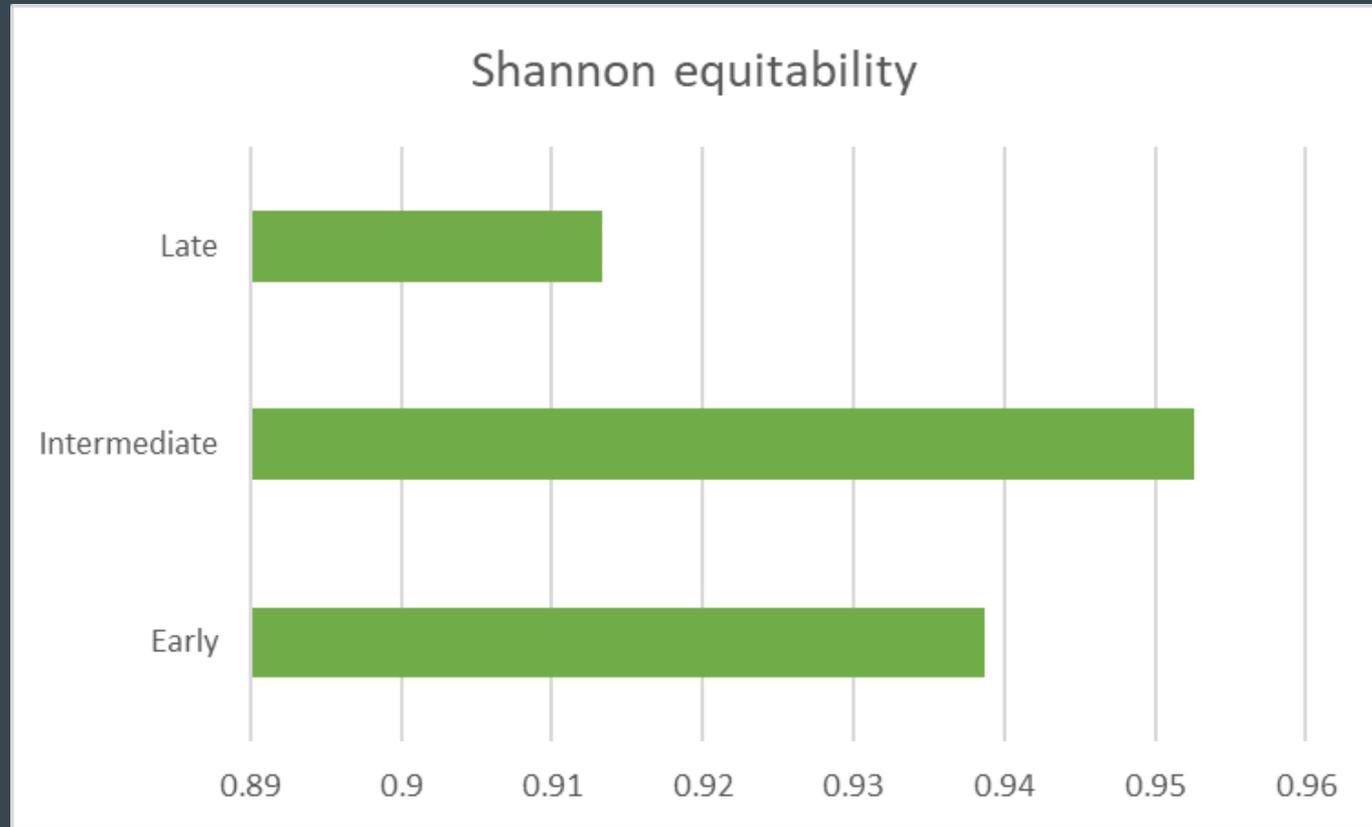
Species diversity

- $H = -\sum p_i * \ln(p_i)$
- Significant difference in species diversity between forest types (AOV $p = 6.78e-7^{***}$)



Species evenness

- $EH = H/\ln(S)$



DBH, BA, AGB, and C across vegetation types

Type	Mean DBH (cm)	Mean Height (m)	Mean BA (m ²)	Mean AGB (kg)	Mean C (kg)	Mean tree density (n/ha)	Total BA (m ²)	Total AGB (kg)	Total C (kg)
E	19.4 ± 11.9	87.3 ± 31.7	1,619.1 ± 1,878.1	423.6 ± 628.9	199.1 ± 295.6	312 ± 168	68,001.1	17,791.0	8,361.8
I	20.6 ± 15.1	89.4 ± 36.6	2,044.7 ± 3,598.0	640.0 ± 1,651.9	300.8 ± 776.4	447 ± 210	163,577.2	51,201.8	24,064.8
L	21.2 ± 16.2	89.8 ± 39.7	2,227.5 ± 3,390.5	702.3 ± 1,386.0	330.1 ± 651.4	536 ± 250	298,490.1	94,104.7	44,229.2
P	17.8 ± 3.9	86.3 ± 11.1	1,042.3 ± 460.4	202.9 ± 118.9	95.4 ± 55.9	1447 ± 338	184,479.9	35,921.8	16,883.3

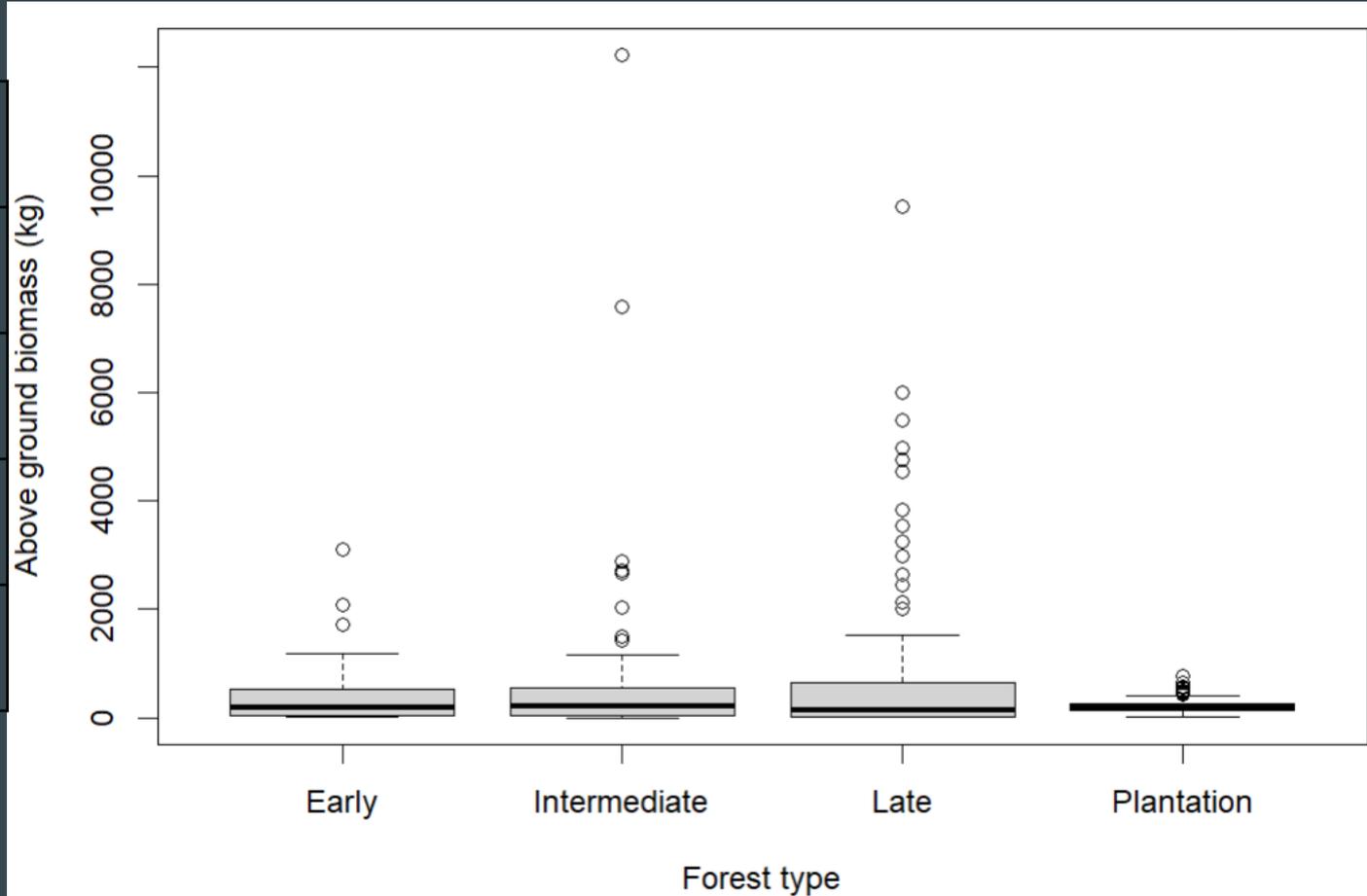
Height: $\log(H) = 1.2156 + 0.5782 \times \log(\text{DBH})$, from Feldspauch et al 2011

AGB = $e^{(-2.289 + 2.649 \times \ln(\text{DBH}) - 0.021 \times \ln(\text{DBH})^2)}$, from Pearson et al 2005

C fraction, taken as 47% of AGB, from Aalde et al 2006

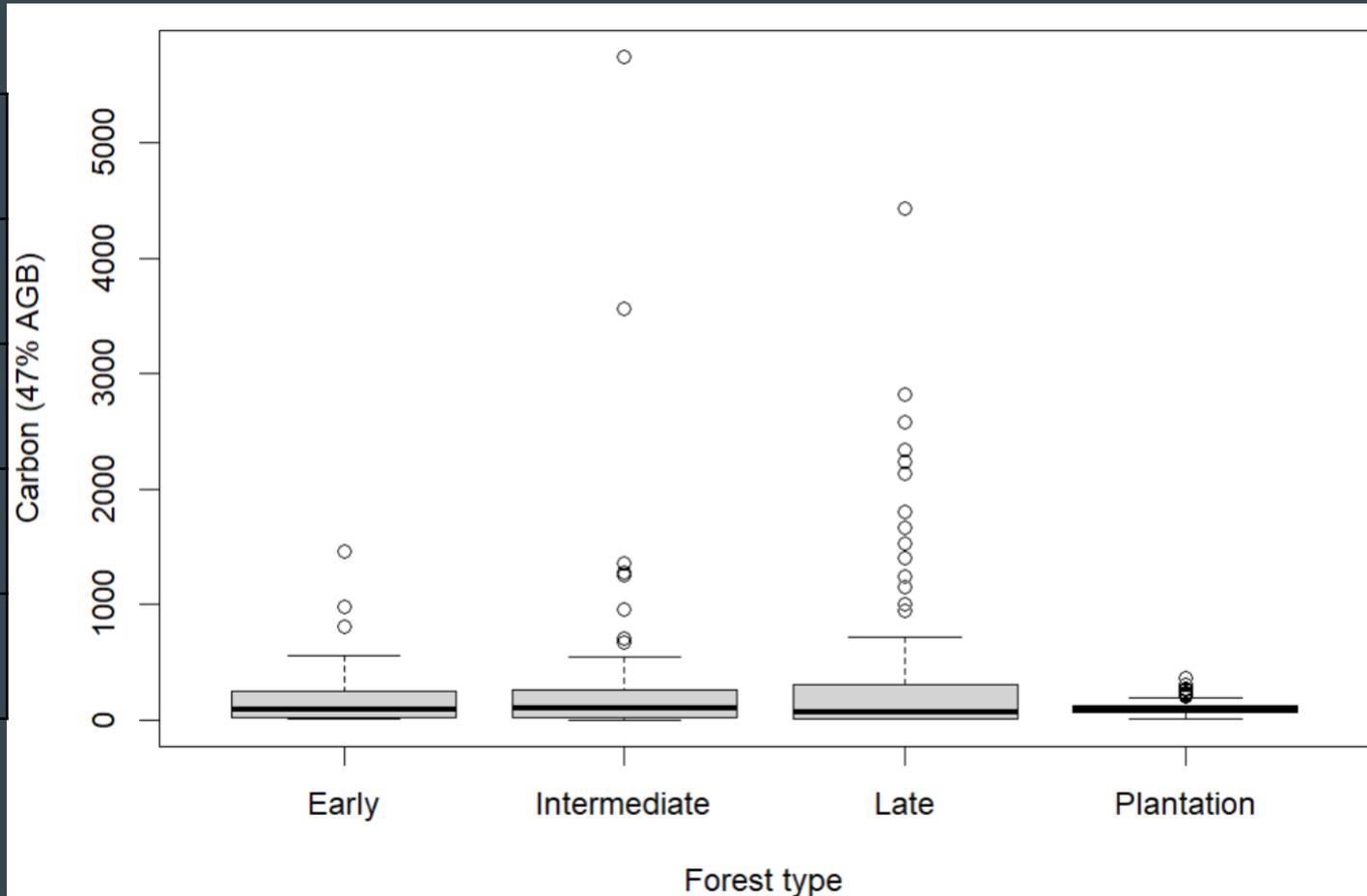
Aboveground biomass

Type	Total AGB
Early	17,79 1.0
Intermediate	51,20 1.8
Late	94,10 4.7
Plantation	35,92 1.8



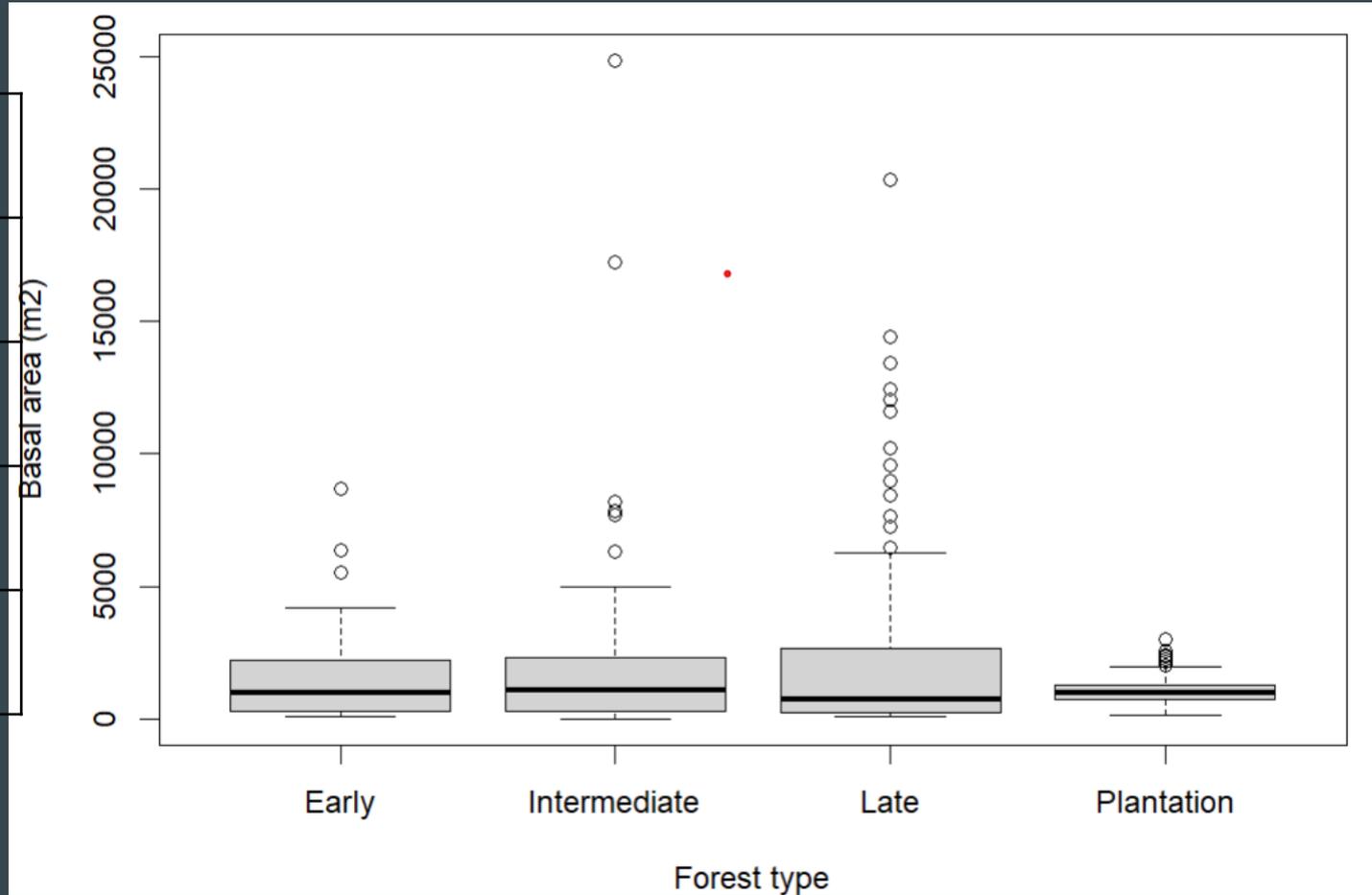
Carbon content

Type	Total C
Early	8,36 1.8
Intermediate	24,0 64.8
Late	44,22 9.2
Plantation	16,88 3.3



Basal area

Type	Total BA
Early	68,00 1.1
Intermediate	163,5 77.2
Late	298,4 90.1
Plantation	184,4 79.9

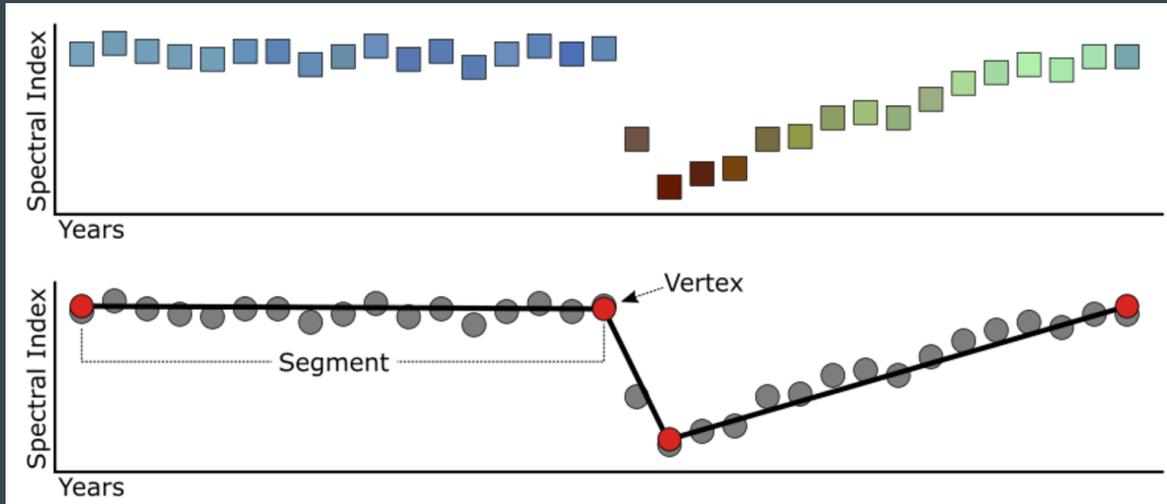


Landtrendr

Google Earth Engine tool for understanding vegetation patterns over time.

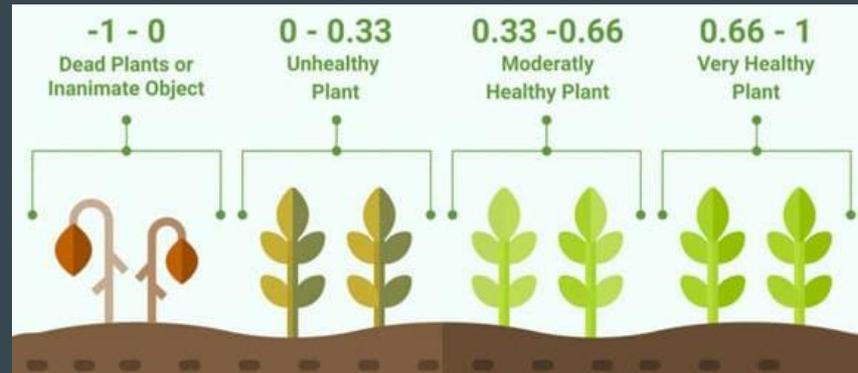
Contains 2 main functions: pixel time series plotter, and change mapper.

Relies on temporal segmentation of a vegetation index (e.g., NDVI).

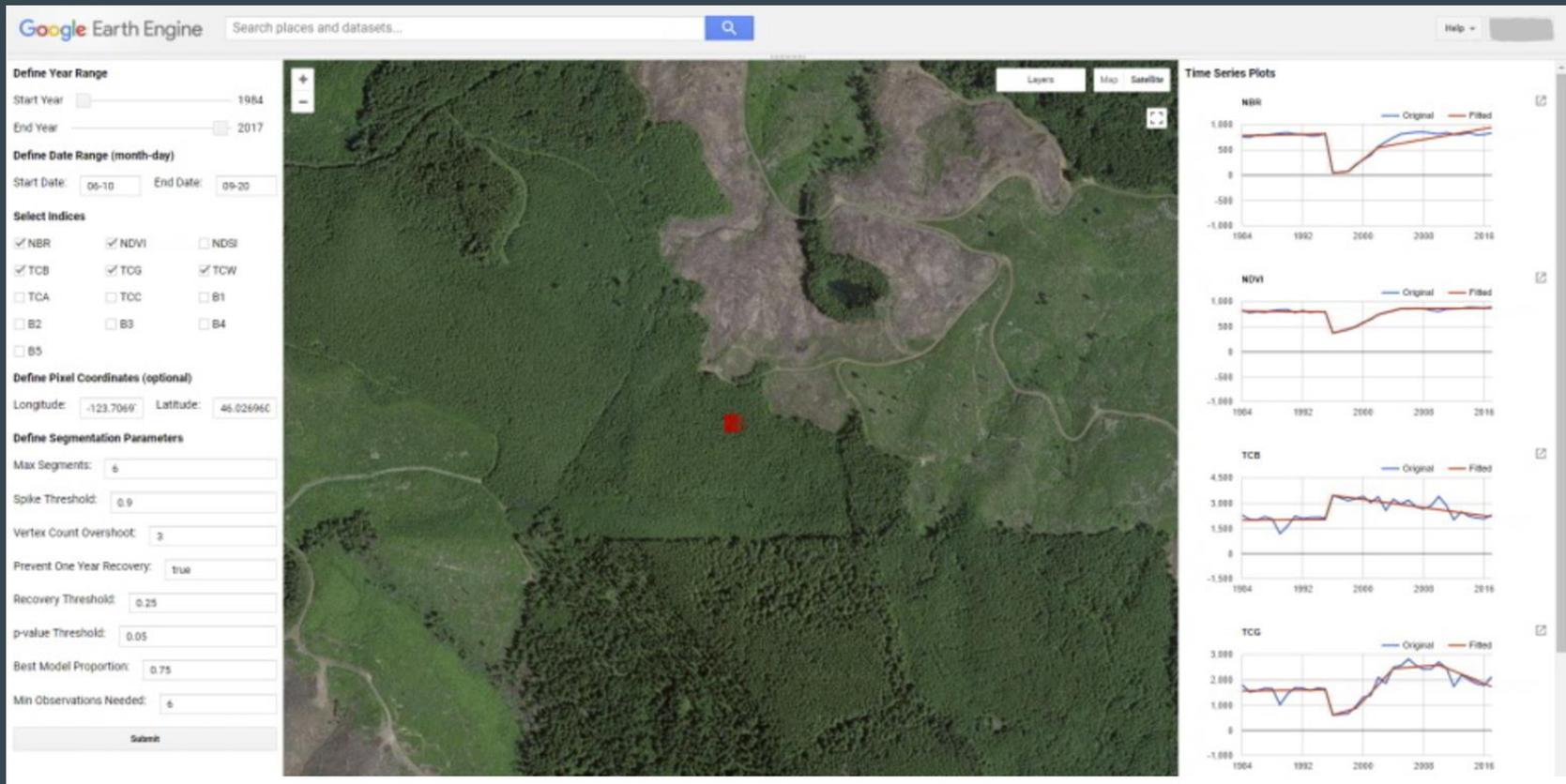


Normalized Difference Vegetation Index (NDVI)

The NDVI index detects and quantifies the presence of live green vegetation using this reflected light in the visible and near-infrared bands.



Landtrendr: Pixel time series plotter



Landtrendr: Change mapper

Google Earth Engine Search places and datasets...

Define Year Range
Start Year: 1984
End Year: 2017

Define Date Range (month-day)
Start Date: 06-10 End Date: 09-20

Select Index
NBR

Define Pixel Coordinates (optional)
Longitude: -122.775 Latitude: 44.02635

Inspector mode

Define a Buffer Around Point (km)
Buffer: 50

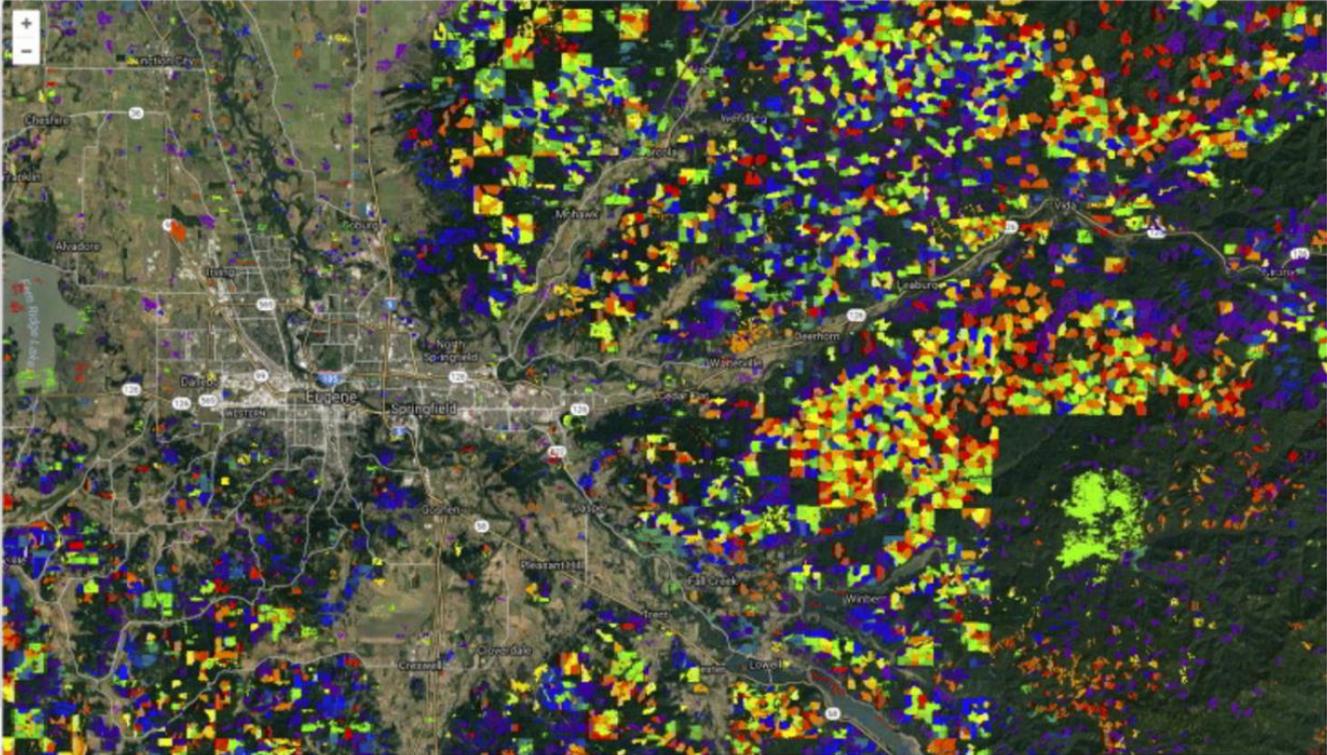
Define Disturbance Parameters
Select Dist Type: Greatest

Filter by year:
Start Year: 1986
End Year: 2017

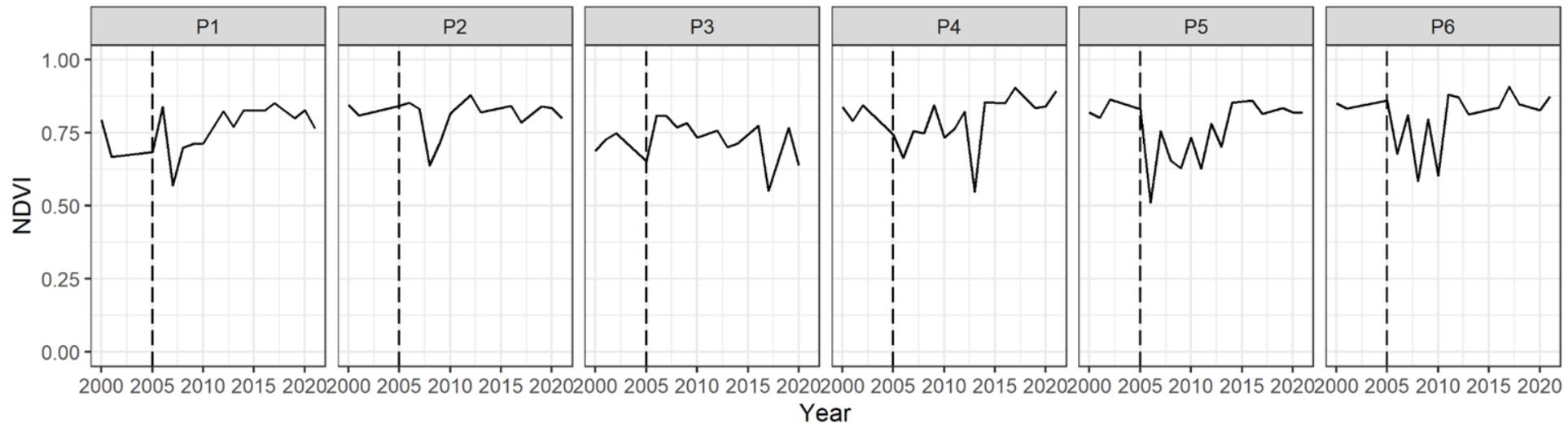
Filter by magnitude:
1-year: 200 20-year: 200

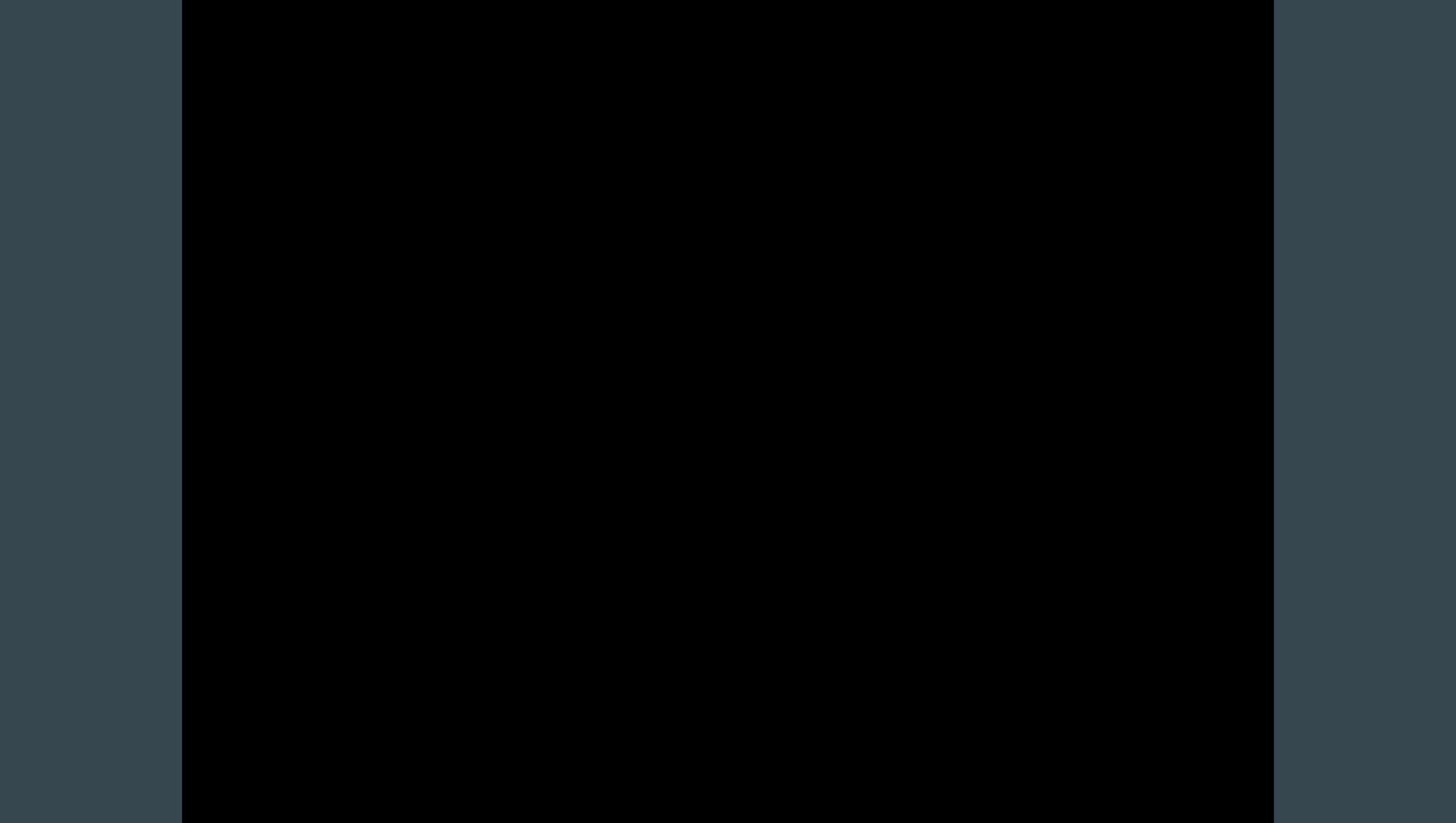
Filter by pre-dist value: 400

Filter by MMU: 11

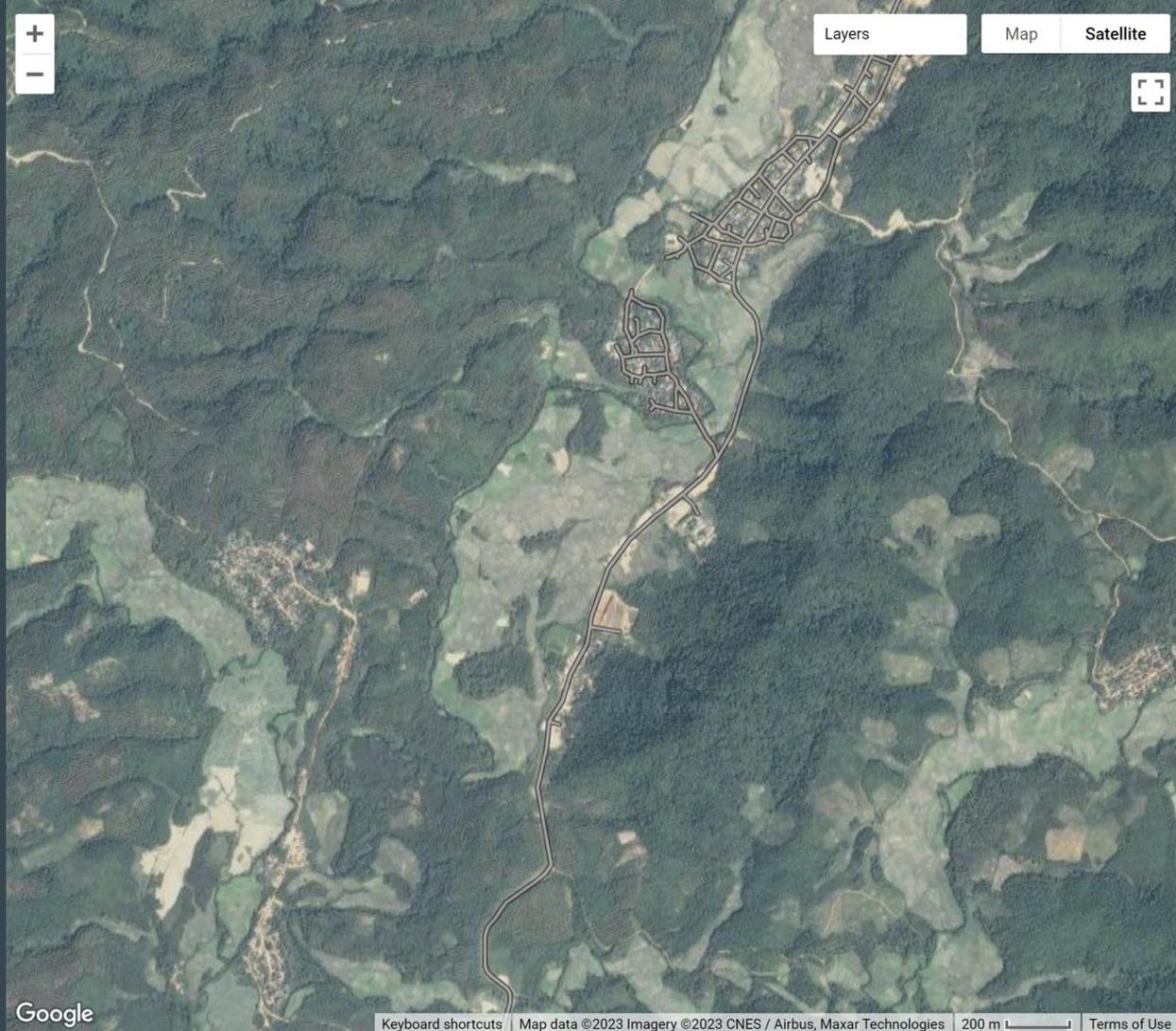


NDVI annual time series profiles





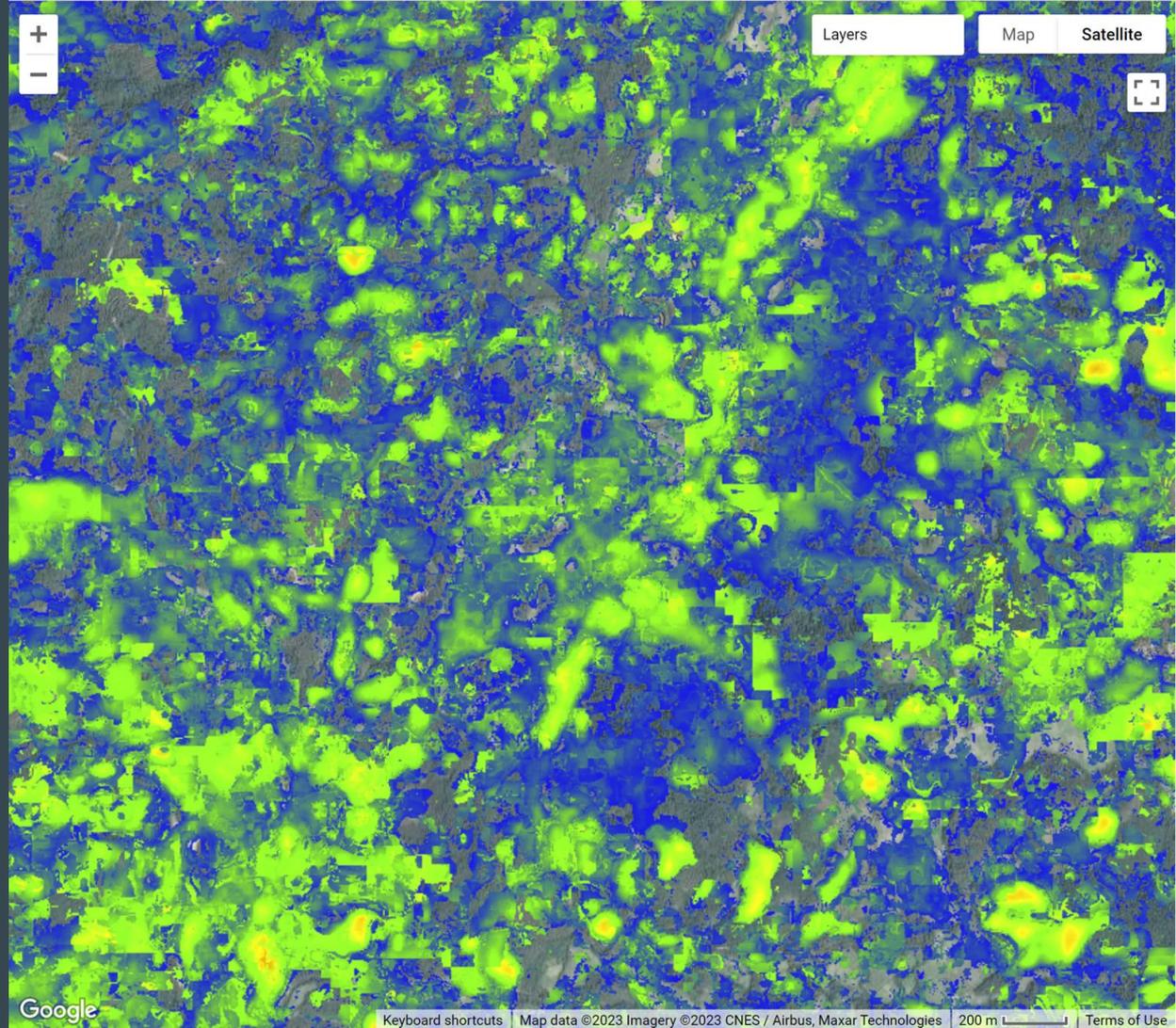
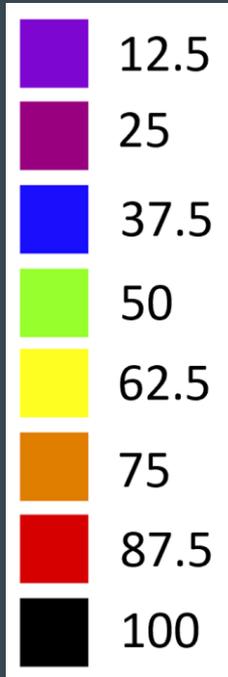
Google basemap



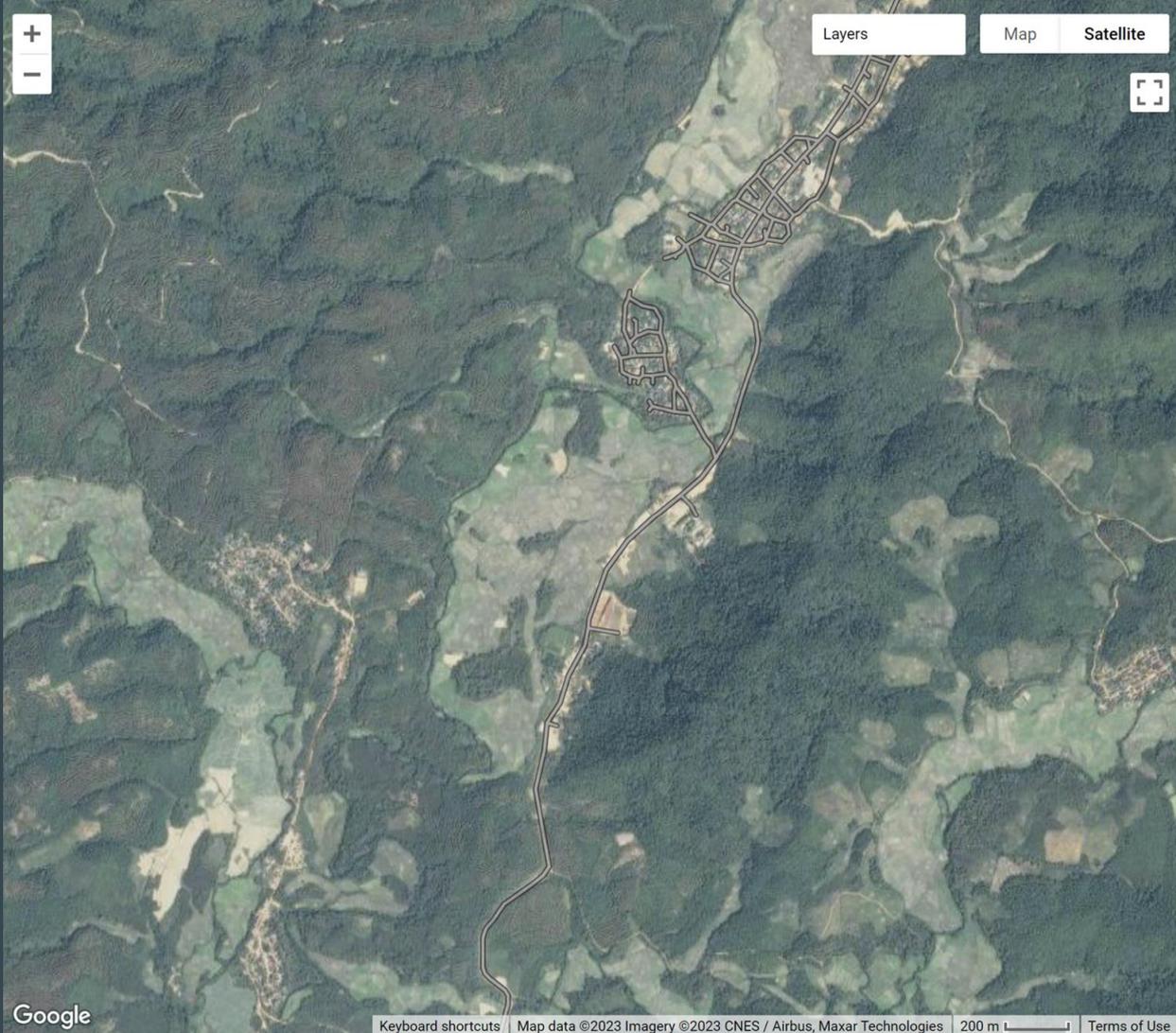
Google

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Magnitude of change



Google basemap



Layers

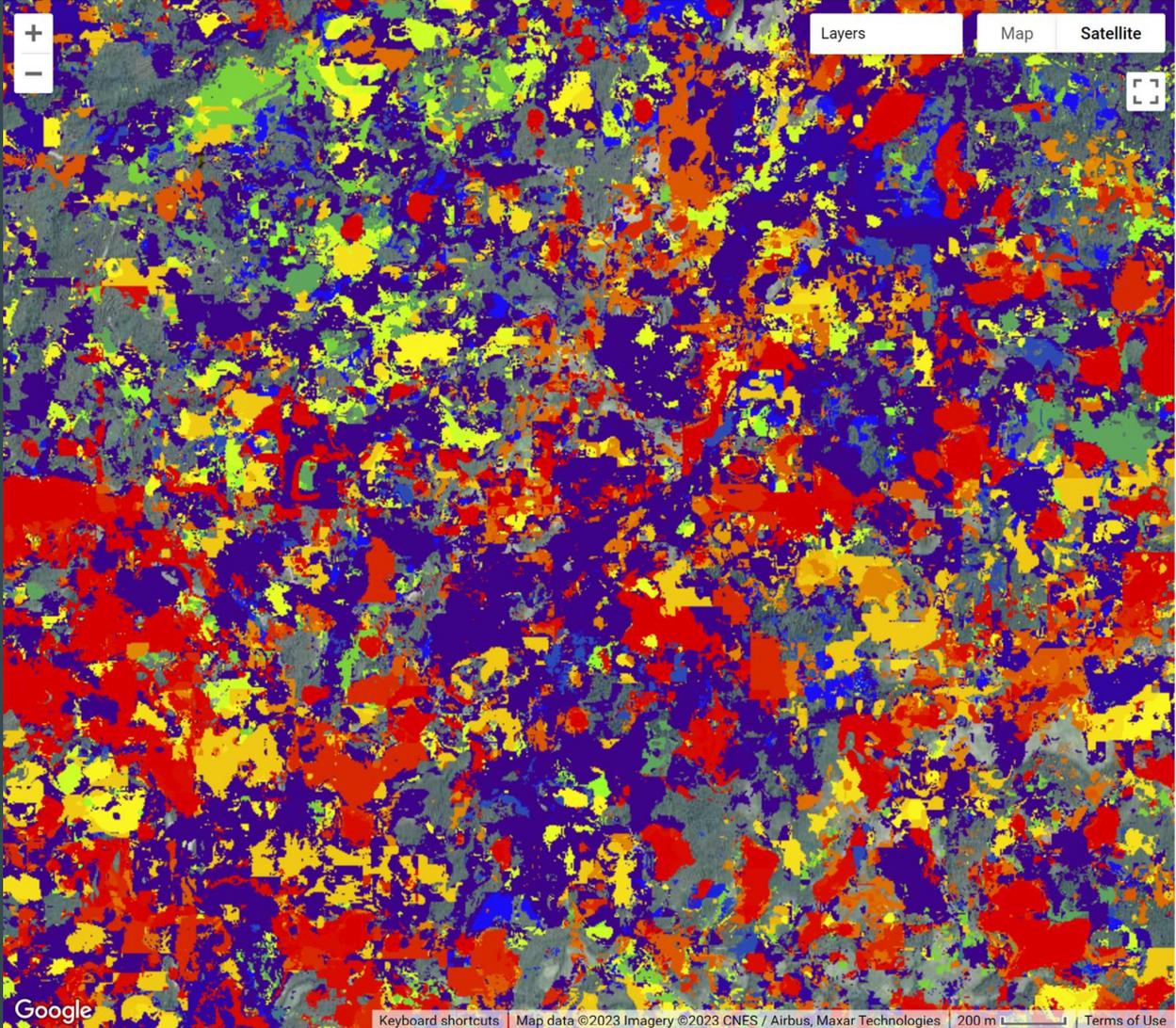
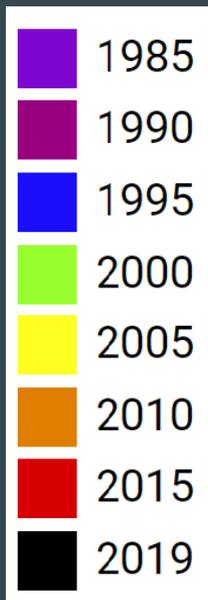
Map

Satellite



Google

Year of change



Conclusions

- Species richness and diversity were more or less similar in intermediate and later successional phase forests, but significantly different in early phase and plantation forest
- Species composition varied in forest types and all types had type-specific species, plantation type very distant to others
- No significant differences in C, AGB, BA in forest types, but much more variability in forests than in plantation
- From Landtrendr, vegetation trends for plantations generally experienced a decrease from 2005-2007, followed by a steady increase after rubber planting.