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Forest aboveground biomass stock and resilience in a tropical landscape of Thailand

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Table S1. **Lidar metrics (n = 21) and their descriptions**

Performance comparisons of several lidar-derived metrics to infer AGB at 0.5-ha resolution. Metrics (1-17) were calculated directly from the lidar cloud dataset and metrics (18-21) were derived from the canopy height model (CHM), which itself derived from the lidar cloud data. LOOCV-RMSE is the back-transformed error of the lidar-AGB log-log model obtained through a leave-one-out scheme (see methods). The relative RMSE is the ratio of this LOOCV-RMSE to the mean of field AGB. From all the metric the mean top-of-canopy-height (TCH) derived from CHM was the best metric selected, highlighted row in table.

S.No.	*Lidar metric*	*LOOCV-RMSE*	*Relative RMSE (in%)*
1	H_{10} *(10th Percentile)*	93.53	29.70
2	H_{25} *(25th Percentile)*	72.13	22.90
3	H_{50} *(50th Percentile)*	48.73	15.47
4	H_{75} *(75th Percentile)*	50.08	15.90
5	H_{95} *(95th percentile)*	67.78	21.52
6	H_{IQR} *(HIQR = Q75 - Q25)*	81.02	25.72
7	H_{mean}	47.16	14.97
8	H_{sqmean} *(quadratic mean)*	48.44	15.38
9	H_{cv} *coefficient of variation of all height*	94.79	30.10
10	Bin95 *(Percent of points within Q95)*	93.95	29.83
11	Bin75 *(Percent of points within Q75)*	96.51	30.64
12	Bin50 *(Percent of points within Q50)*	95.54	30.33
13	Bin25 *(Percent of points within Q25)*	95.51	30.32
14	Hperc10 *Percentage of height ranges in 0–10m*	91.76	29.13
15	Hperc20 *Percentage of height ranges in 0–20m*	74.45	23.64
16	Hperc30 *Percentage of height ranges in 0–30m*	74.98	23.81
17	Hperc40 *Percentage of height ranges in 0–40m*	89.75	28.50
18	TCH (*Mean of top of Canopy Height)*	45.2	14.35
19	CHM_H50	47.8	15.18
20	$CHMH_{relief}$ *(((mean - min) / (max – min))*	90.12	28.61
21	CHMSqMean	46.83	14.87

Table S2. Results from the model selection approach using TCH and any other of the additional lidar-based metrics described in Table S1 in a log-log linear model of the form $log\ (AGB) = a + b \times log\ (TCH) + c \times log\ (X)$, where X is the additional metric tested given in the table. LOOCV-RMSE is the back-transformed error of this model obtained through a leave-one-out scheme (see methods). The relative RMSE is the ratio of the LOOCV-RMSE to the mean of field AGB. Adding a second predictor did not reduce the relative LOOCV-RMSE by more than 1%, so only TCH was selected as final predictor.

Log- Log Model	**LOOCV-RMSE RMSE**	**Relative RMSE Relative to mean AGB**
AGB~TCH	45.2	14.35%
AGB~ **TCH** + Bin 95	44.90	14.26%
AGB~ **TCH** + Bin 95+H10	43.86	13.96%
AGB~ **TCH** + Bin 95+H10+Hperc40	45.11	14.32%

Table S3: Landsat Time-series data used for the study with corresponding validation score

S.No	Landsat Mission	Sensor	Date of collection	Validation Score
1	Landsat 1-3	MSS	19/12/1972	94.12
2	Landsat 1-3	MSS	6/1/1973	90.69
3	Landsat 1-3	MSS	13/12/1975	92.65
4	Landsat 1-3	MSS	18/01/1976	94.12
5	Landsat 1-3	MSS	18/11/1978	94.61
6	Landsat 1-3	MSS	1/12/1979	96.57
7	Landsat 1-3	MSS	13/01/1982	95.1
8	Landsat 4-5	TM	9/12/1987	94.61
9	Landsat 4-5	TM	11/12/1988	96.57
10	Landsat 4-5	TM	13/02/1989	96.08
11	Landsat 4-5	TM	5/4/1990	98.53
12	Landsat 4-5	TM	2/11/1991	97.06
13	Landsat 4-5	TM	18/03/1992	95.1
14	Landsat 4-5	TM	23/11/1993	96.08
15	Landsat 4-5	TM	28/12/1994	94.12
16	Landsat 4-5	TM	20/03/1996	96.08
17	Landsat 4-5	TM	20/12/1997	91.67
18	Landsat 4-5	TM	23/12/1998	92.65
19	Landsat 4-5	TM	26/12/1999	96.08
20	Landsat 4-5	TM	12/12/2000	95.1
21	Landsat 4-5	TM	2/3/2001	94.61
22	Landsat 4-5	TM	24/01/2002	97.06
23	Landsat 4-5	TM	21/11/2004	97.55
24	Landsat 4-5	TM	13/03/2005	98.04
25	Landsat 4-5	TM	13/12/2006	94.61
26	Landsat 4-5	TM	30/01/2007	95.1
27	Landsat 4-5	TM	18/12/2008	94.12
28	Landsat 4-5	TM	19/11/2009	92.65
29	Landsat 4-5	TM	25/01/2011	95.59
30	Landsat 8	OLI & TIRS	30/11/2013	89.71
31	Landsat 8	OLI & TIRS	19/12/2014	93.14
32	Landsat 8	OLI & TIRS	2/4/2015	91.67
33	Landsat 8	OLI & TIRS	11/3/2016	95.1
34	Landsat 8	OLI & TIRS	25/01/2017	96.57

Figures

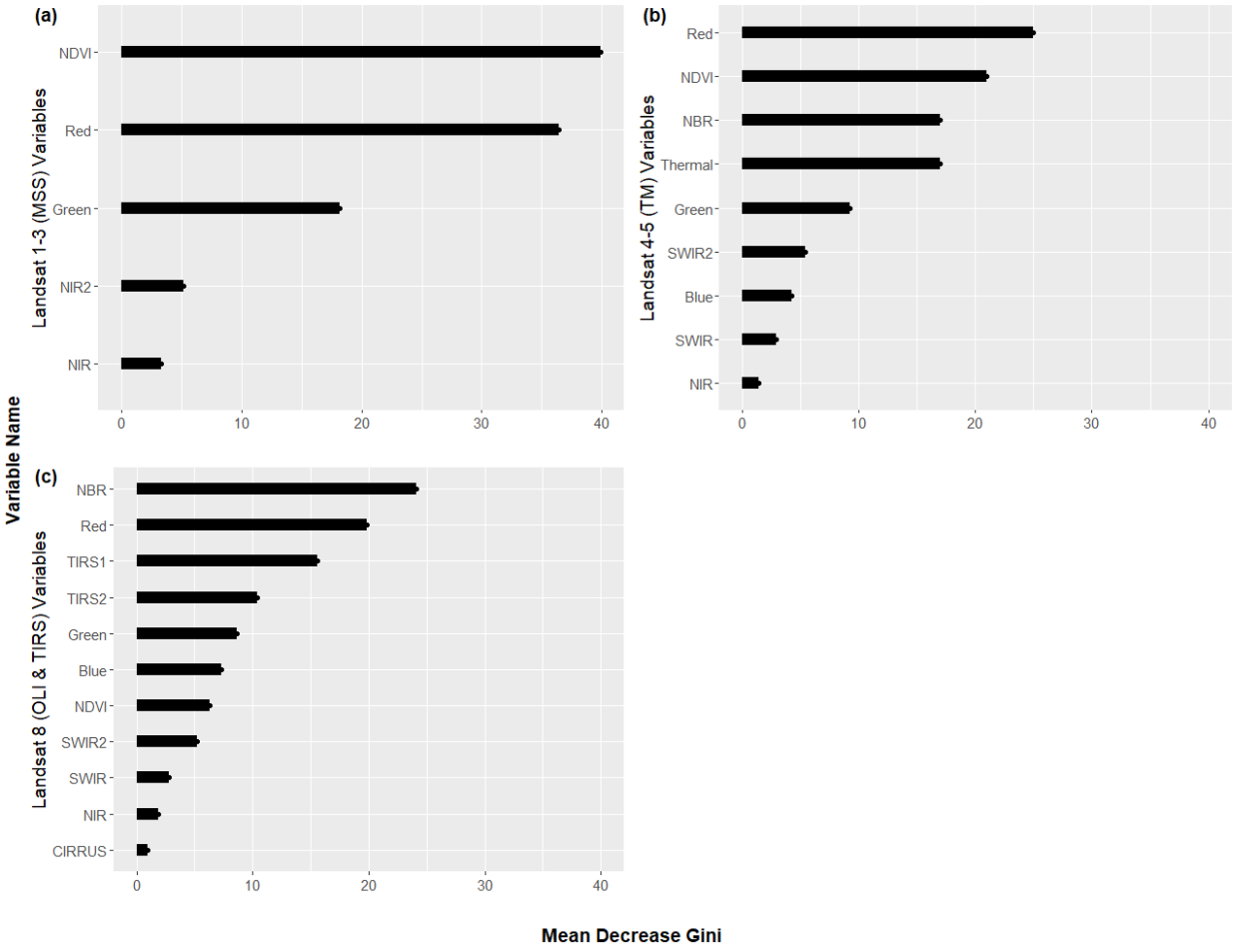

Fig S1: Random Forest results showing the average variable importance in each Landsat sensors used for classification (a) Average variable importance for Landsat 1-3 (MSS) sensor images (1972–1983) (b) Average variable importance for Landsat 4-5 (TM) sensor images (1984–2011) (c) Average variable importance for Landsat 8 (OLI & TIRS) sensor images (2013-2017)

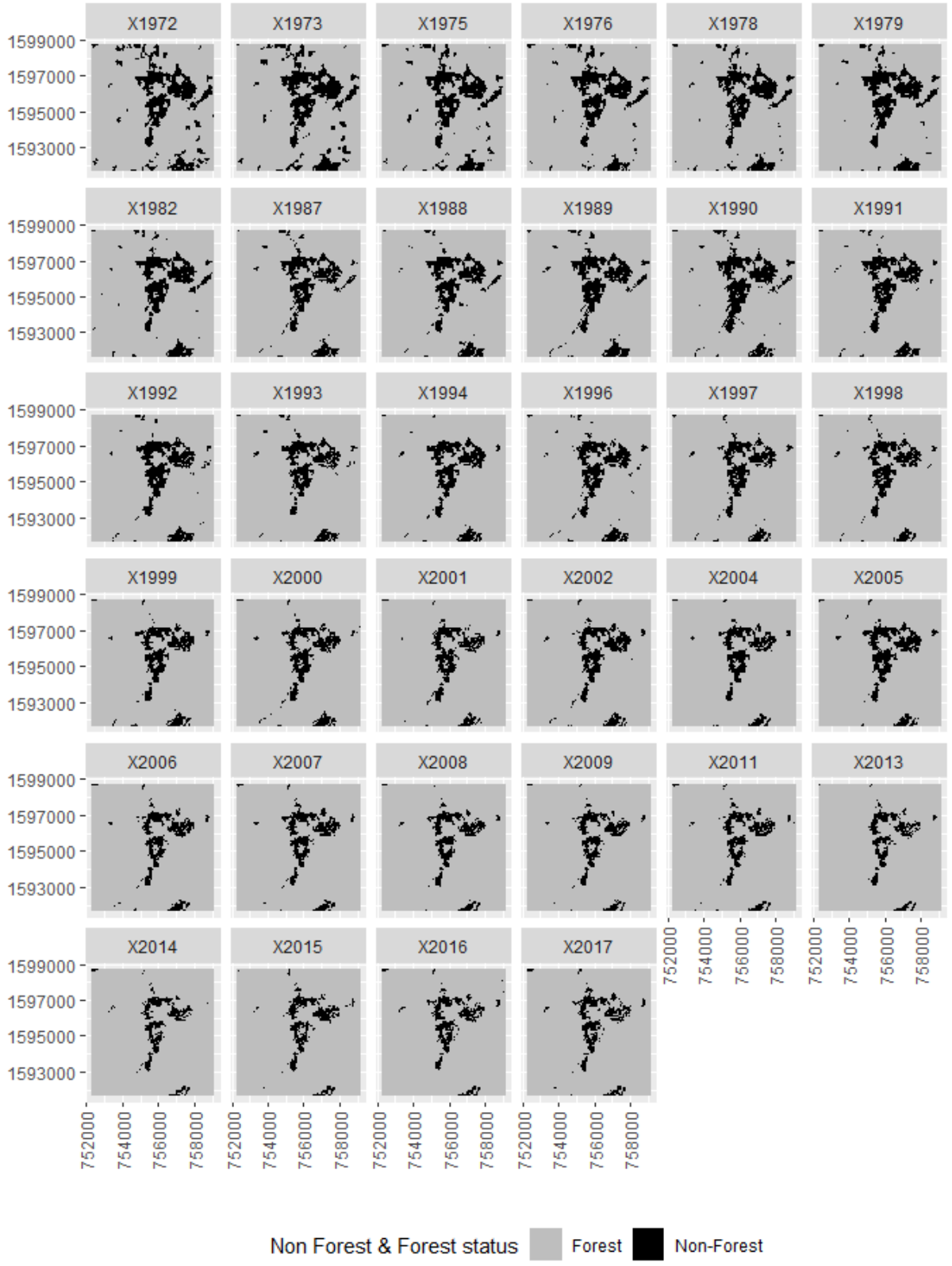

Fig S2: Non-Forest and Forest status across period (1972-2017)

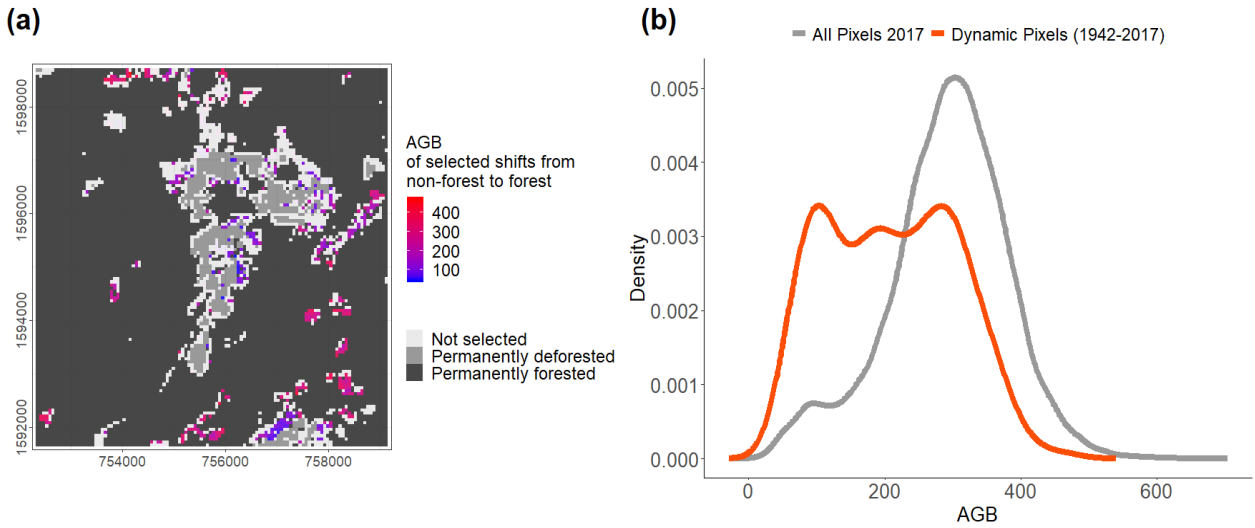

Fig S3: AGB recovery of the pixels that experienced a single shift from Non-Forest to Forest. (a)- Map showing spatialized single shifts from non-forests to forests with the corresponding AGB gain in 2017 as predicted by our lidar AGB map (Fig. 3a). The shade gradient represents pixels that did not experience any shift (permanently forested or deforested) and pixels that experienced a shift but that did not pass our quality procedure during the study period (Not selected) (b)- Density distribution of pixels with AGB gain which experiences single shifts over the landscape during the study period compared with the density distribution of predicted AGB over the full landscape in 2017 (Fig. 3b)

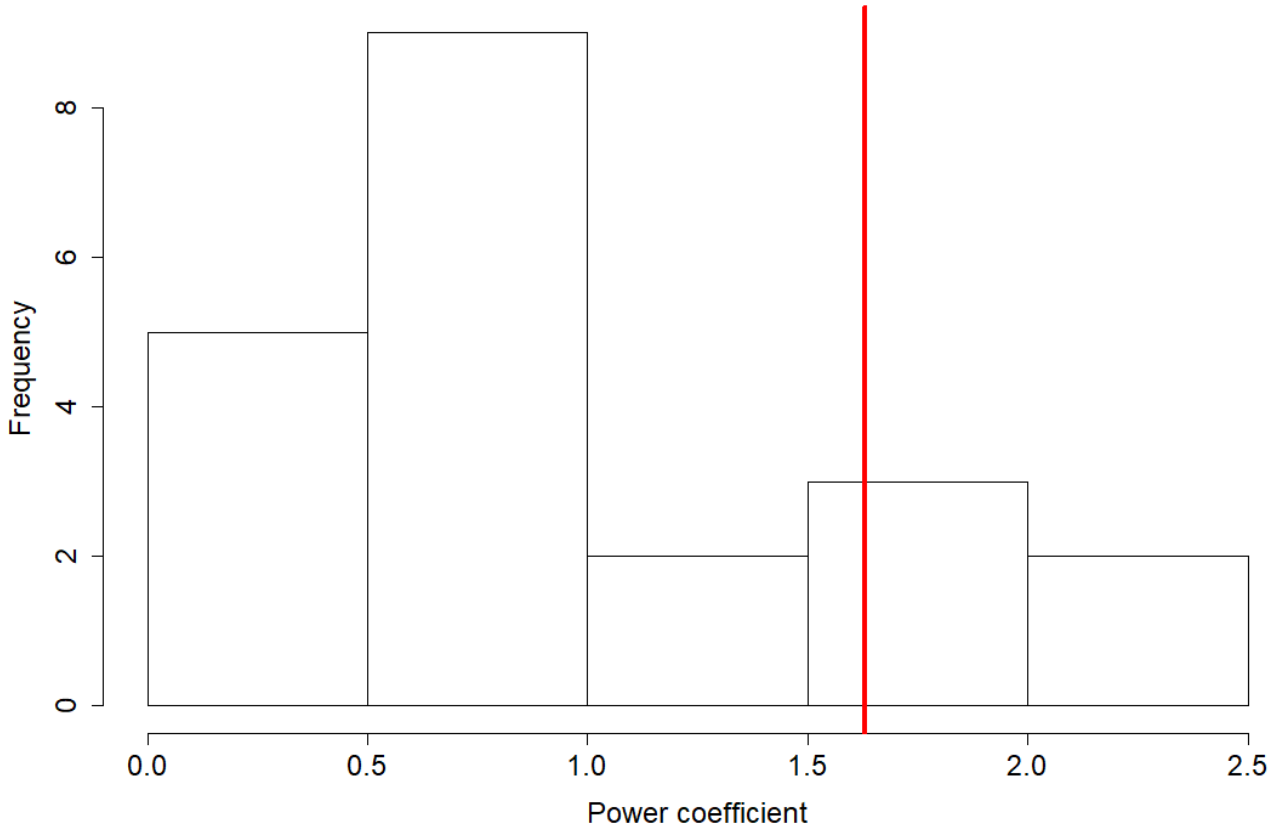

Fig S4: Distribution of the power coefficients obtained from site-specific power models fitted on AGB recovery versus forest age in 21 sites studied by Poorter et al. (2016) and in our site (red line). We only considered the sites having a minimum of 10 observations and that were younger than 45 years old. We excluded 7 sites matching those rules as they exhibited dubious patterns of carbon recovery through time that cannot be captured by a power model (sites Eastern Pará 2, El Carite, Mata Seca, Patos, San Carlos, Yucatán, Zona Norte).

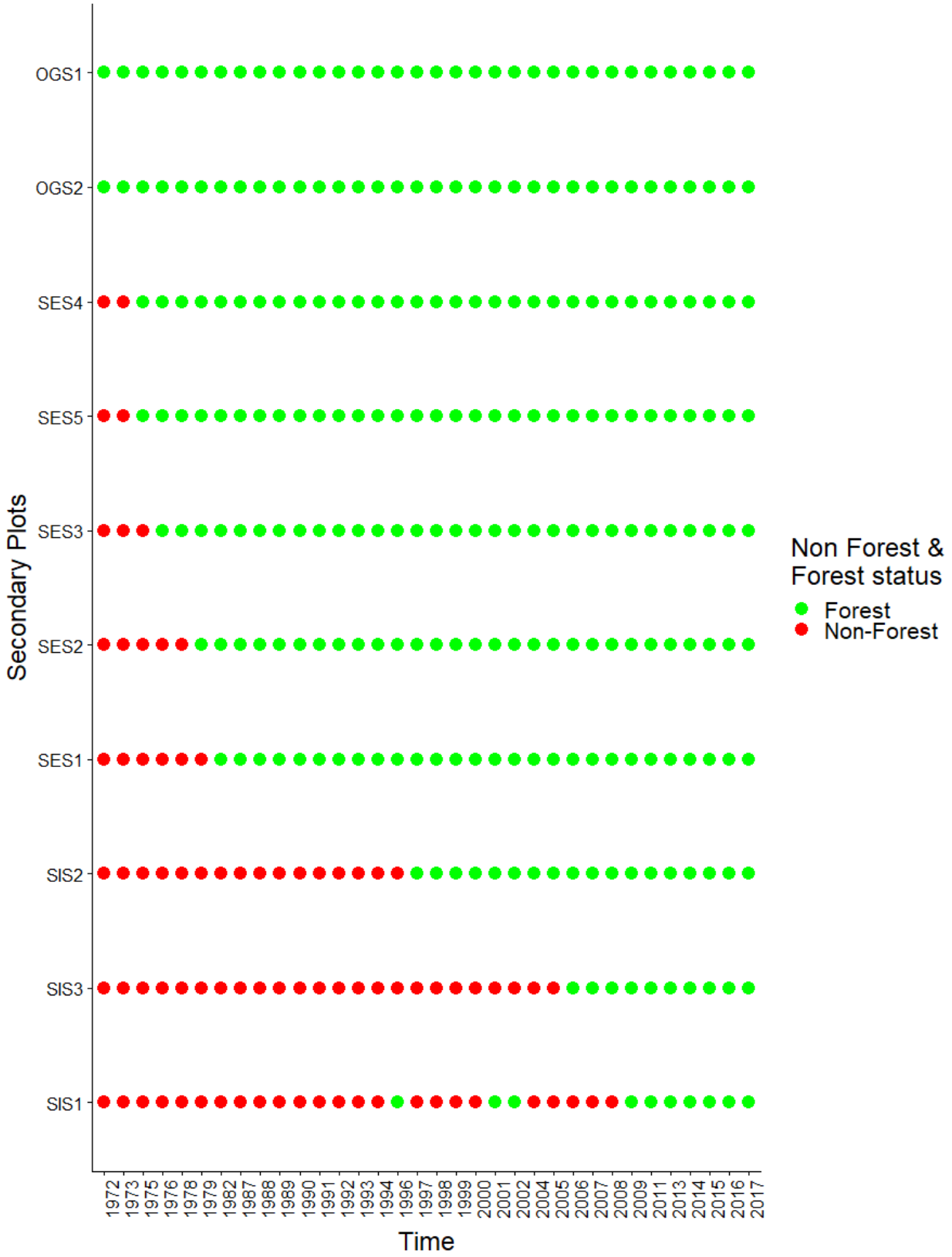

Fig S5. Non-forest (red) to forest (green) status during the 1972-2017 period in 10 field plots belonging to different successional stages as estimated from our forest classification approach. We did not represent here the subplots belonging to the Mo Singto plot as they all were in a forested status during the whole study period.