Supplementary Materials

High-Resolution Mapping and Spatial Pattern Analysis of Areca Palm Plantations in Sanya, China, Using SAMLoRA

Contents

The following supporting information accompanies this article: Figure S1: acquisition dates and spatial coverage of Google Earth imagery; Figure S2: architectures of ResNet U-Net and SAMLoRA; Figure S3: training and validation loss curves; Table S1: imagery acquisition dates and image counts; Table S2 and Code S1: LandTrendr parameters and Google Earth Engine code; and Table S3: years, magnitudes, and durations of the candidate spectral events.

Supplementary Figures

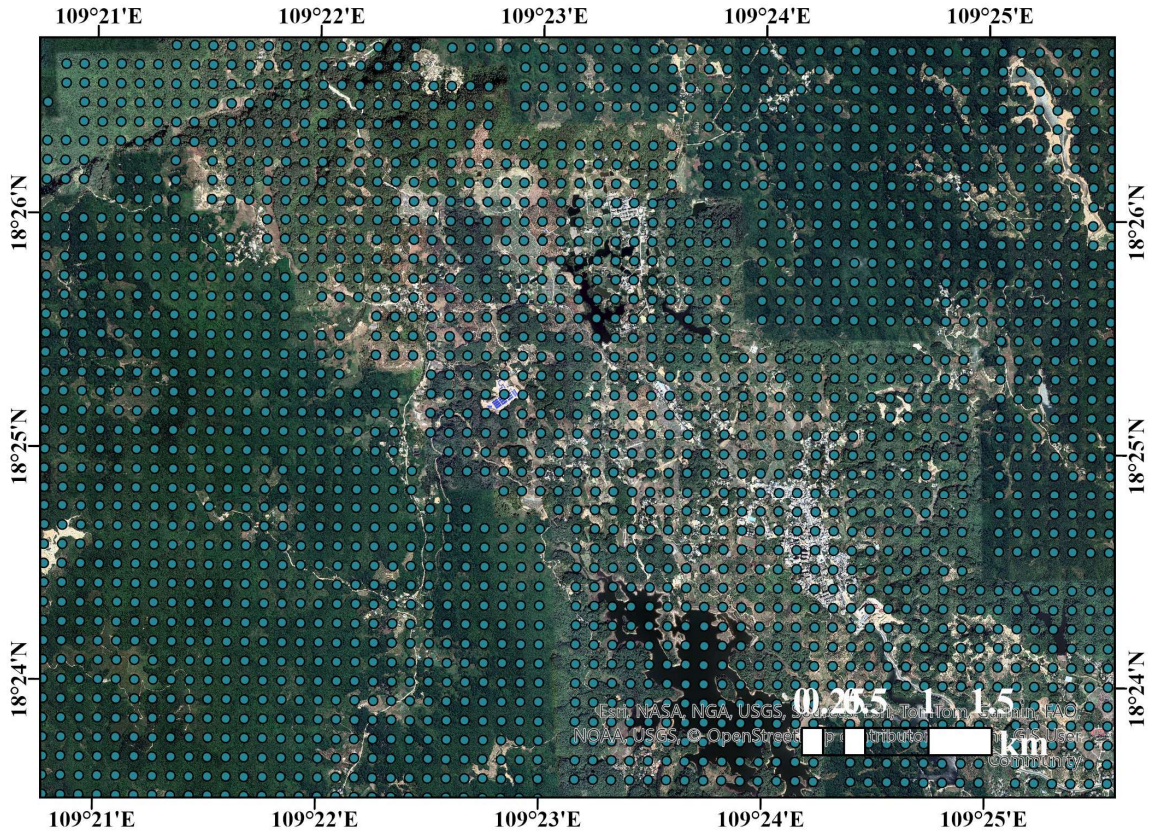


Figure S1. Spatial coverage of the 0.59 m Google Earth imagery used in this study. The overlaid points record image-acquisition information; detailed acquisition dates and image counts are provided in Table S1.

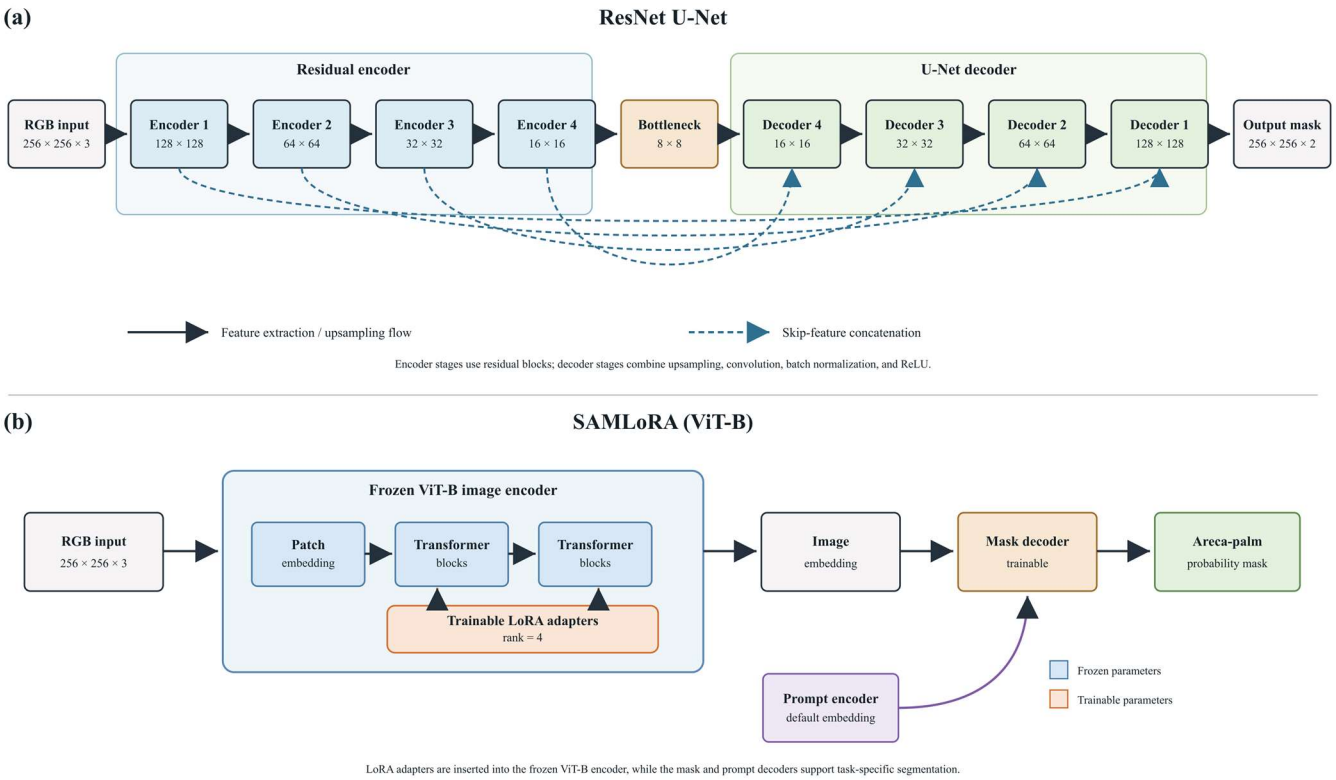


Figure S2. Architectures of the evaluated segmentation models: (a) ResNet U-Net with a residual encoder, skip-feature concatenation, and a U-Net decoder; and (b) SAMLoRA with a frozen ViT-B image encoder and trainable LoRA adapters (rank = 4).

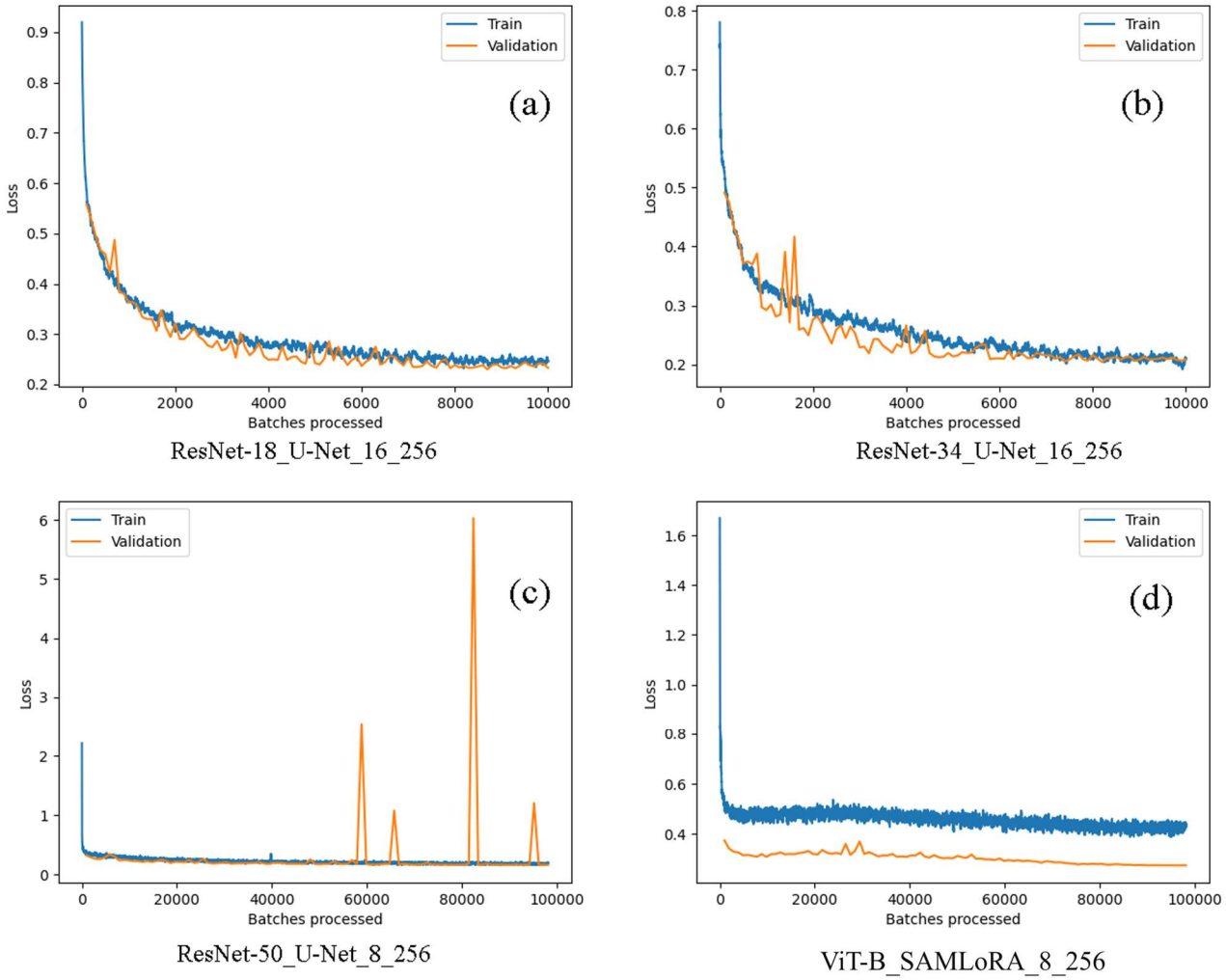


Figure S3. Training and validation loss trajectories of the evaluated models: (a) ResNet-18 U-Net; (b) ResNet-34 U-Net; (c) ResNet-50 U-Net; and (d) SAMLoRA with a ViT-B backbone. All models were trained for 100 epochs without early stopping. The horizontal axes report batches processed exactly as recorded in the original training logs.

Supplementary Tables and Code

Table S1. Google Earth image-acquisition dates and image counts by district in Sanya.

District	Image-acquisition date	Number of images
Jiyang District	2023-10-10	1520
Jiyang District	2024-12-07	10948
Jiyang District	2024-12-20	8546
Yazhou District	2021-10-29	2071
Yazhou District	2021-12-04	2889
Yazhou District	2022-01-14	25
Yazhou District	2022-01-31	2
Yazhou District	2023-01-22	1
Yazhou District	2023-01-29	1705
Yazhou District	2024-07-01	5395
Yazhou District	2024-11-08	4245
Yazhou District	2025-02-05	823
Tianya District	2021-10-29	4391
Tianya District	2022-05-20	6874
Tianya District	2022-12-13	312
Tianya District	2023-05-06	10
Tianya District	2023-12-18	597
Tianya District	2024-01-14	9755
Tianya District	2024-02-06	4341
Tianya District	2024-02-20	1552
Tianya District	2024-03-09	2326
Tianya District	2024-06-11	236
Tianya District	2024-12-30	2646
Tianya District	2025-01-29	1603
Tianya District	2025-02-01	3019
Tianya District	2025-02-05	6210
Haitang District	2021-10-30	1148
Haitang District	2021-12-13	3
Haitang District	2022-01-20	34
Haitang District	2022-04-19	70
Haitang District	2022-09-19	10
Haitang District	2022-10-28	484
Haitang District	2022-12-30	1385
Haitang District	2024-10-10	1892
Haitang District	2024-11-29	5160
Haitang District	2024-12-07	2726
Haitang District	2025-01-28	9

Table S2. LandTrendr parameter settings and output configuration.

Parameter	Value	Description
startYear	1986	Start year of the time series
endYear	2016	End year of the time series
startDay / endDay	01-01 / 12-30	Annual compositing window
index	NBR	Spectral index used for fitting and change detection
maxSegments	6	Maximum number of segments in the fitted NBR series
spikeThreshold	0.9	Threshold used to dampen anomalous spikes
vertexCountOvershoot	3	Permitted vertex-count overshoot
preventOneYearRecovery	true	Prevents one-year recovery segments
recoveryThreshold	0.25	Recovery threshold
pvalThreshold	0.05	Model-fit significance threshold
bestModelProportion	0.75	Best-model proportion
minObservationsNeeded	6	Minimum number of observations required
maskThese	cloud, shadow, snow	Masked conditions
delta / sort	loss / greatest	Detects vegetation loss and ranks candidates by magnitude
year	1986–2016	Candidate-event year range
mag / dur / preval	> 0 / > 0 / > 0	Magnitude, duration, and pre-event value thresholds
mmu	12 pixels	Minimum mapping unit; approximately 1.08 ha at 30 m resolution
export scale	30 m	Output spatial resolution
CRS	EPSG:4326	Output coordinate reference system

Note: These parameters reproduce the settings used in this study; Code S1 provides the corresponding GEE implementation.

Code S1. Google Earth Engine JavaScript implementation of LandTrendr

```
// Load the LandTrendr module.
var ltgee = require('users/emaprlab/public:Modules/LandTrendr.js');


// Define the temporal window and study area.
var startYear = 1986;
var endYear = 2016;
var startDay = '01-01';
var endDay = '12-30';
var aoi = geometry;  // Replace with the imported study-area geometry.
var index = 'NBR';
var ftvList = [];


// LandTrendr temporal-segmentation parameters.
var runParams = {
  maxSegments:            6,
  spikeThreshold:         0.9,
  vertexCountOvershoot:   3,
  preventOneYearRecovery: true,
  recoveryThreshold:      0.25,
  pvalThreshold:          0.05,
  bestModelProportion:    0.75,
  minObservationsNeeded:  6
};


// Mask clouds, shadows, and snow.
var maskThese = ['cloud', 'shadow', 'snow'];


// Configure candidate vegetation-loss events.
var changeParams = {
  delta:  'loss',
  sort:   'greatest',
  year:   {checked: true, start: 1986, end: 2016},
  mag:    {checked: true, value: 0, operator: '>'},
  dur:    {checked: true, value: 0, operator: '>'},
  preval: {checked: true, value: 0, operator: '>'},
  mmu:    {checked: true, value: 12}
};
changeParams.index = index;


// Run LandTrendr and generate the candidate-change map.
Map.centerObject(aoi, 10);
Map.addLayer(aoi);
var lt = ltgee.runLT(
  startYear, endYear, startDay, endDay,
  aoi, index, ftvList, runParams, maskThese
);
print(lt);
var changeImg = ltgee.getChangeMap(lt, changeParams);
print(changeImg);


// Export the result to Google Drive.
var exportImage = changeImg.toFloat();
Export.image.toDrive({
  image: exportImage,
  description: 'LandTrendr_Change_Map',
  folder: 'GEE_Exports',
  scale: 30,
  crs: 'EPSG:4326',
  region: aoi,
  maxPixels: 1e13,
  fileFormat: 'GeoTIFF'
});
```

Table S3. Candidate spectral-event years, magnitudes, and durations for the currently mapped areca palm plantation patches larger than 2 ha, derived using LandTrendr for 1986–2016.

Area proportion	Candidate event year	Magnitude (×1000)	Duration (years)
22%	1987	213	13
1.7%	1988	171	22
<0.001%	1991	307	4
<0.001%	1992	337	2
1.3%	1993	275	3
<0.001%	1994	413	1
<0.001%	1995	277	1
<0.001%	1996	360	2
<0.001%	1997	372	1
0.2%	1998	315	3
0.1%	1999	337	3
0.04%	2000	366	2
0.5%	2001	385	2
0.4%	2002	373	2
0.4%	2003	350	2
0.3%	2004	400	2
0.3%	2005	320	2
0.1%	2006	370	1
0.3%	2007	335	1
0.05%	2008	318	2
0.1%	2009	339	2
0.2%	2010	372	2
0.2%	2011	314	3
0.2%	2012	305	2
0.2%	2013	330	2
0.1%	2014	338	2
0.1%	2015	304	2
0.1%	2016	265	1
70.1%	No candidate event	N/A	N/A

Note: Magnitude denotes the spectral-index change (×1000). Candidate LandTrendr vertices are not validated years of plantation establishment or management.