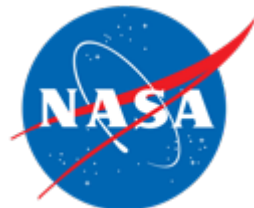


**Note: The content in this presentation has not been published yet and should not be used without the authors' consent.**

# Nationwide mapping of shifting cultivation in Laos over the past three decades

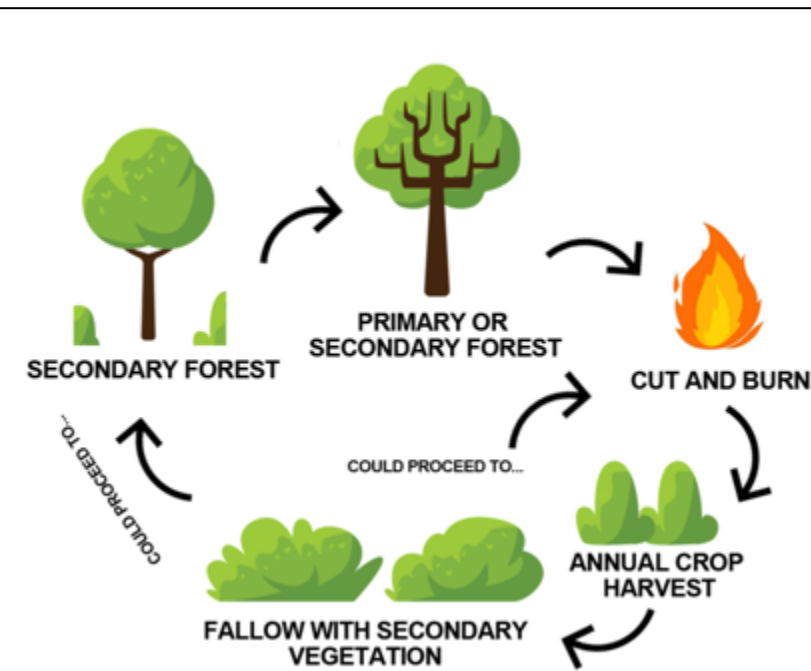
Shijuan Chen, Pontus Olofsson, Saphangthong Thatheva, Curtis Woodcock

Acknowledgement: NASA, USGS, SilvaCarbon for funding. Hanfeng Gu and Kangjoon Cho for sample interpretation.

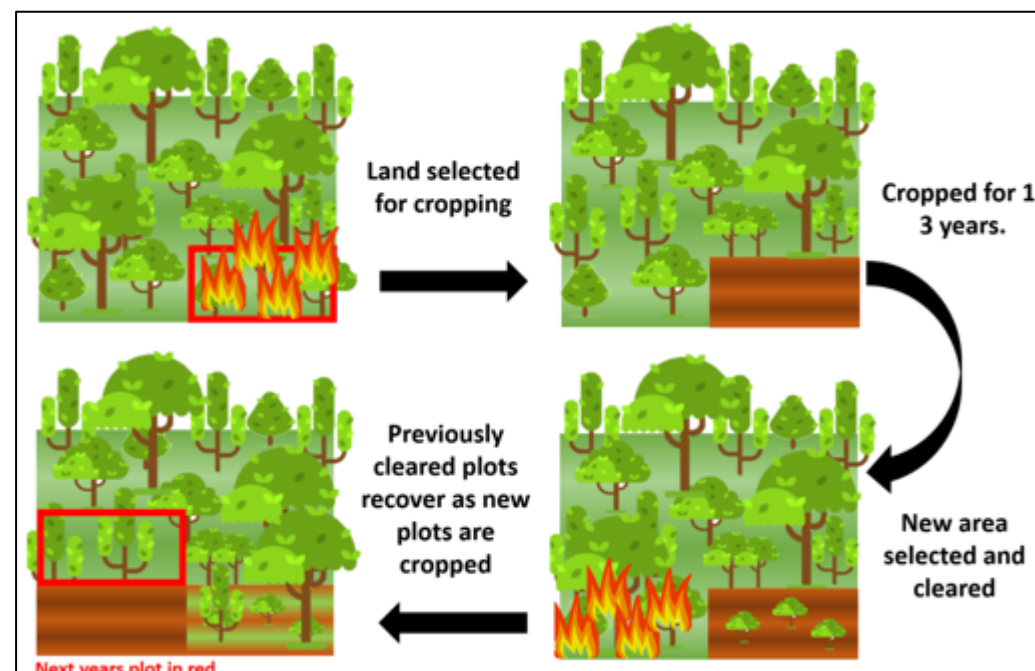


# Shifting cultivation

- Also called slash-and-burn, shifting agriculture, or swidden agriculture.
- One of the major causes of forest degradation in the tropics.
- Long-term carbon impact.



Conceptual figure at plot level



Conceptual figure at landscape level



A field photo of shifting cultivation in northern Laos

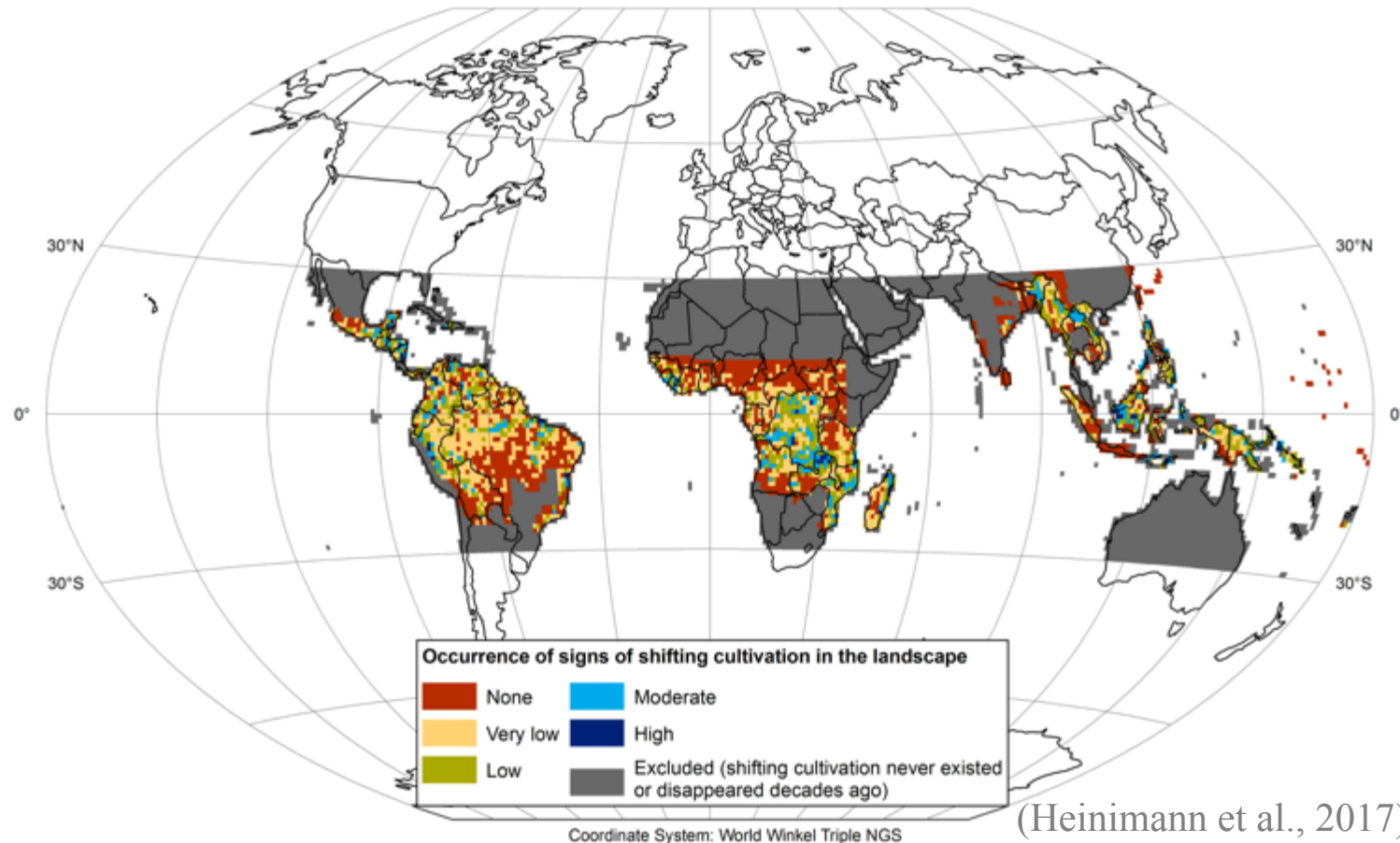
# Introduction

## Literature review of shifting cultivation

- Very few large-scale studies.
- Inconsistent estimated trends.

## Remote sensing monitoring

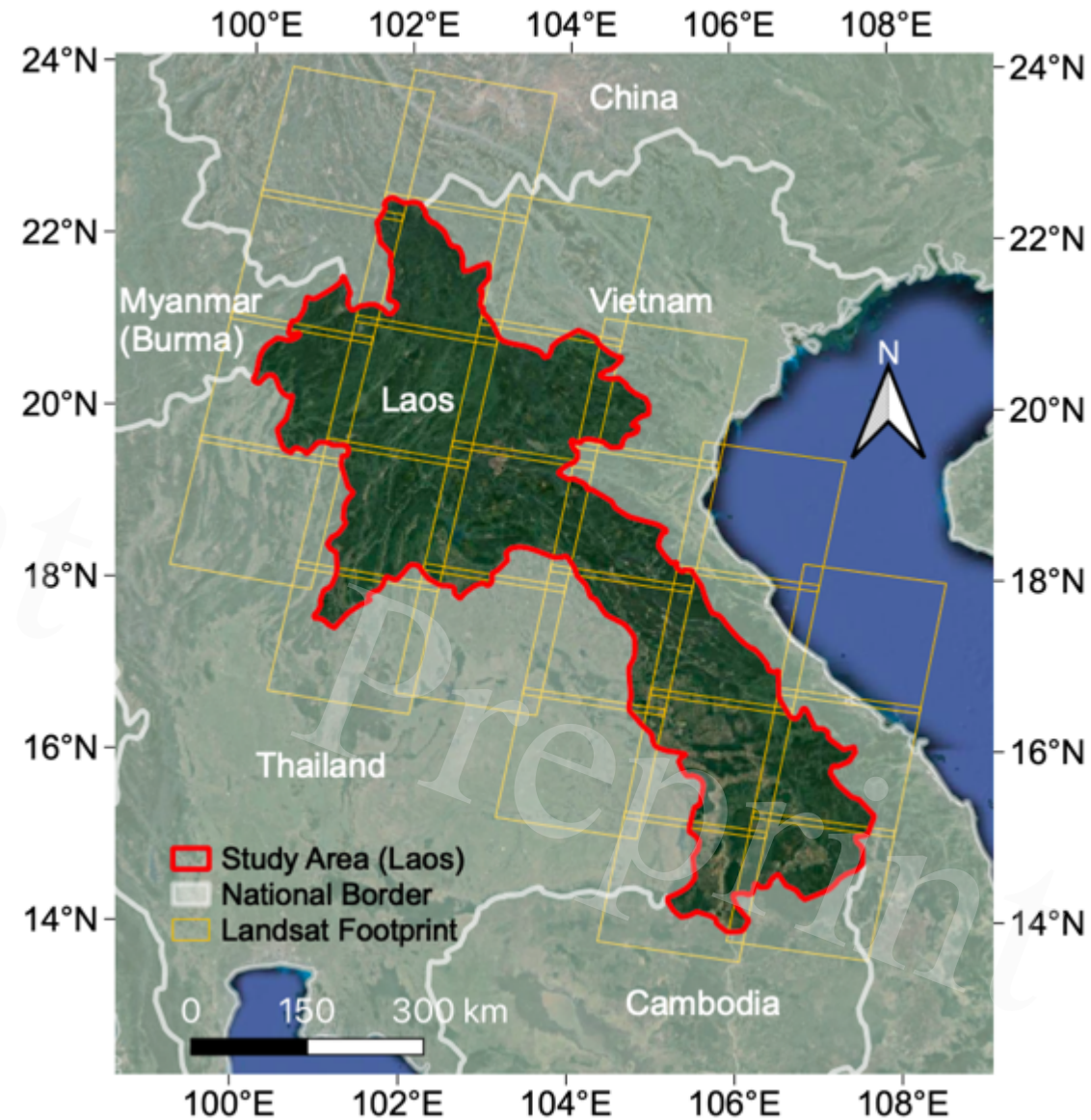
- Very few studies using time series analysis.
- Highly-dynamic; fine-scale event
- Poorly conducted accuracy assessment.



(Heinimann et al., 2017)

# Research objectives

- Develop a method to monitor shifting cultivation.
- Estimate the area of shifting cultivation in Laos.
- Analyze the spatial-temporal patterns of shifting cultivation in Laos.

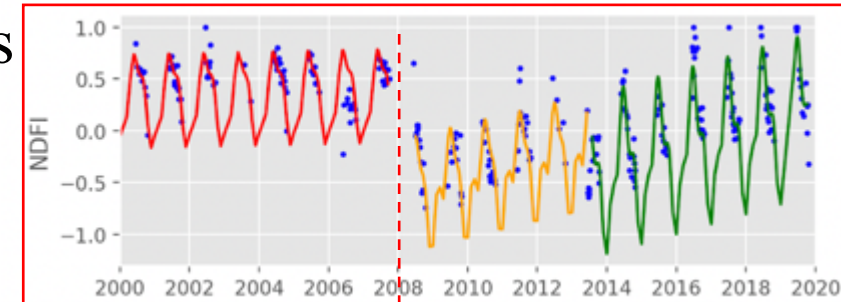
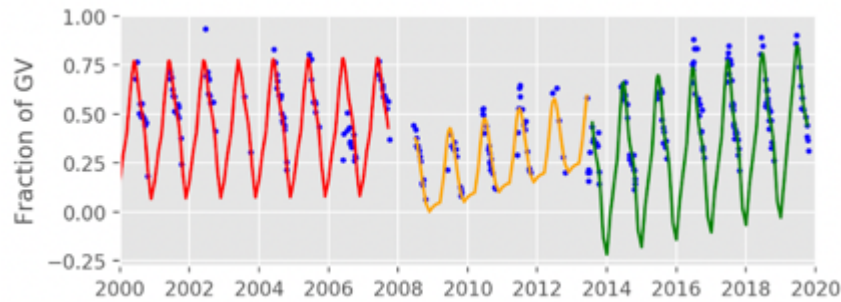
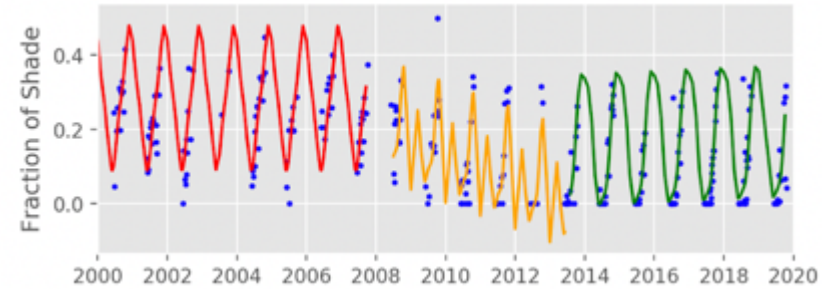
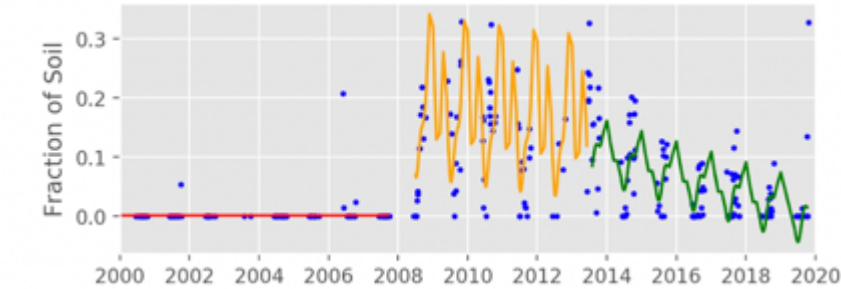


(Chen et al., 2022)



# Method – Monitor forest disturbance

- Data: Landsat data from 1987 – 2020.
- Platform: Google Earth Engine
- Detect disturbance:
  - CCDC-SMA (Continuous change detection and classification - Spectral Mixture Analysis)



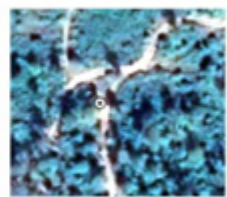
NDFI: Normalized difference fraction index



06/16/2003



08/16/2013



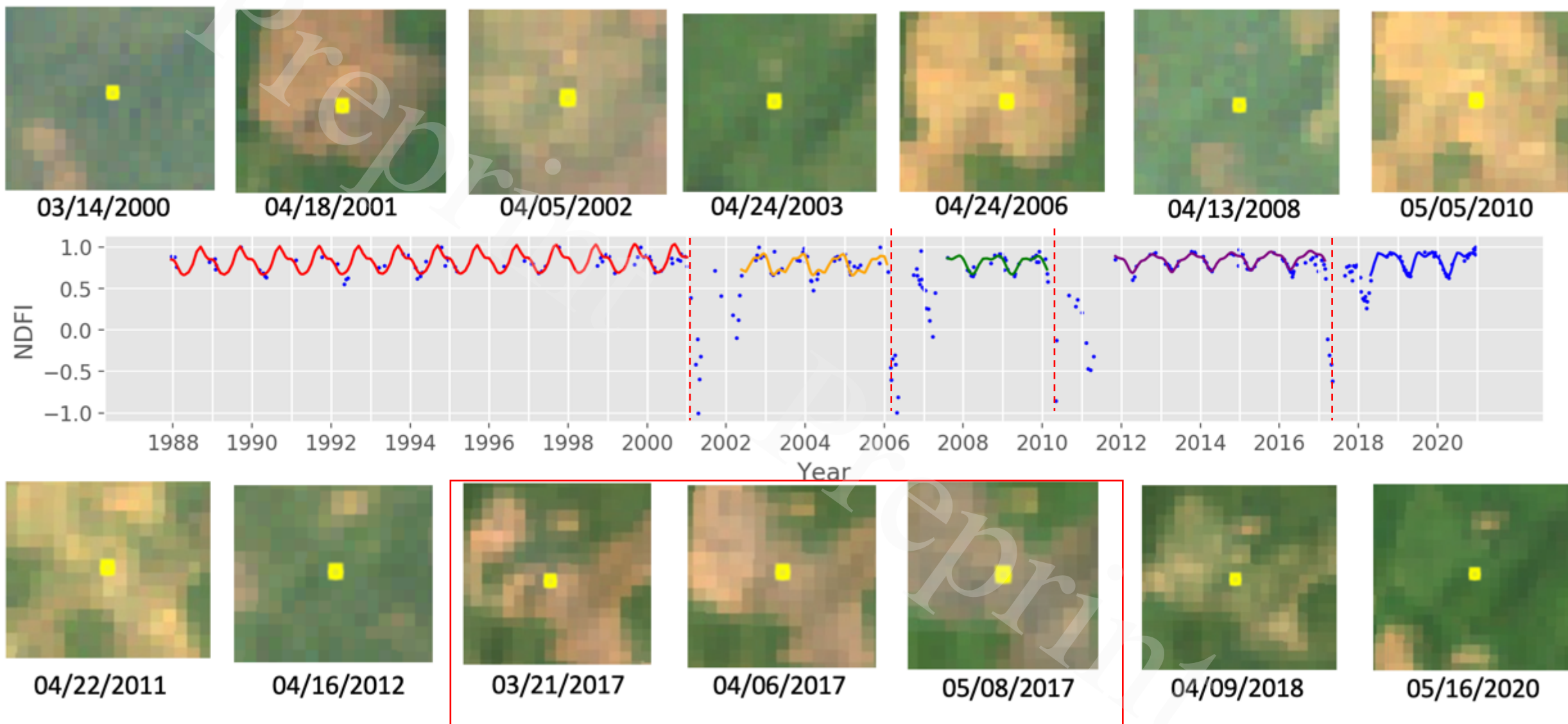
09/20/2018

(Chen et al., 2021)

Reference: [Chen, S., Woodcock, C.E., Bullock, E.L., Arévalo, P., Torchinava, P., Peng, S. and Olofsson, P., 2021. Monitoring temperate forest degradation on Google Earth Engine using Landsat time series analysis. Remote Sensing of Environment, 265, p.112648.](#)

See: [https://github.com/shijuanchen/forest\\_degradation\\_georgia](https://github.com/shijuanchen/forest_degradation_georgia)

# Time series example of shifting cultivation

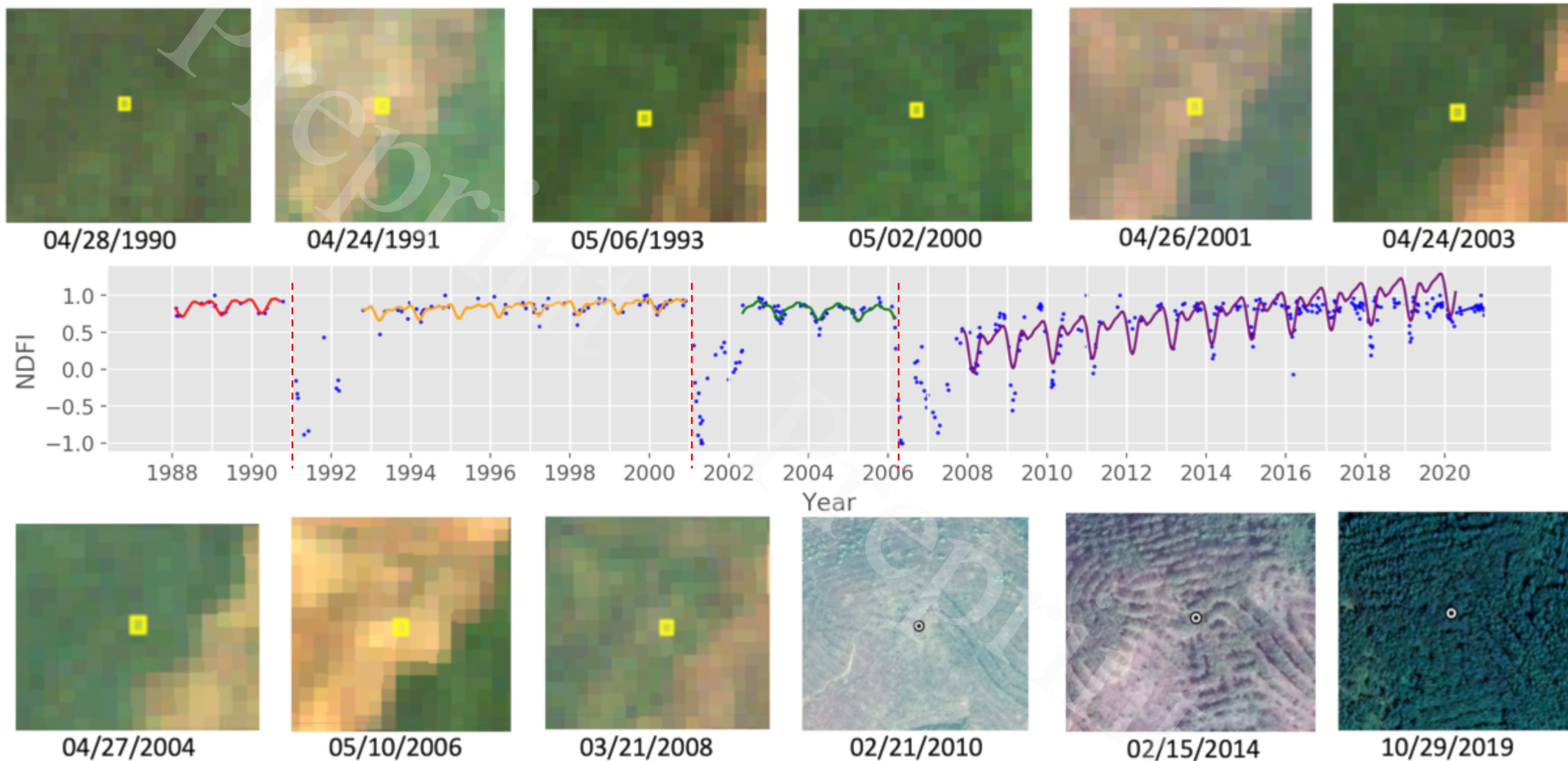


NDFI: Normalized difference fraction index

Snapshots of natural-looking Landsat image (RGB)

(Chen et al., 2022)

# Time series example of new plantation

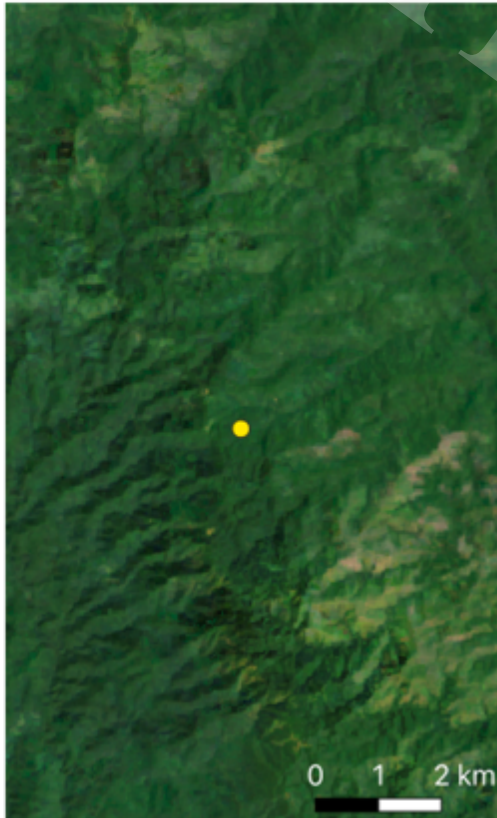
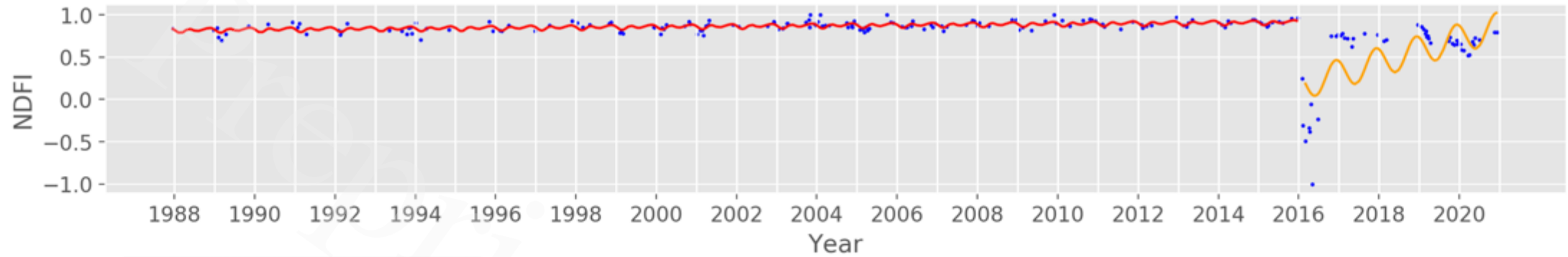


NDFI: Normalized difference fraction index

(Chen et al., 2022)



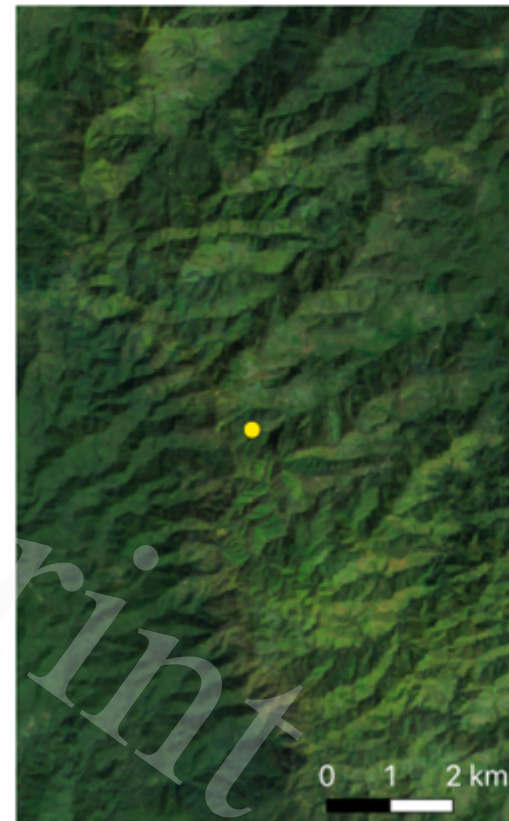
# Time series example of severe drought



2015



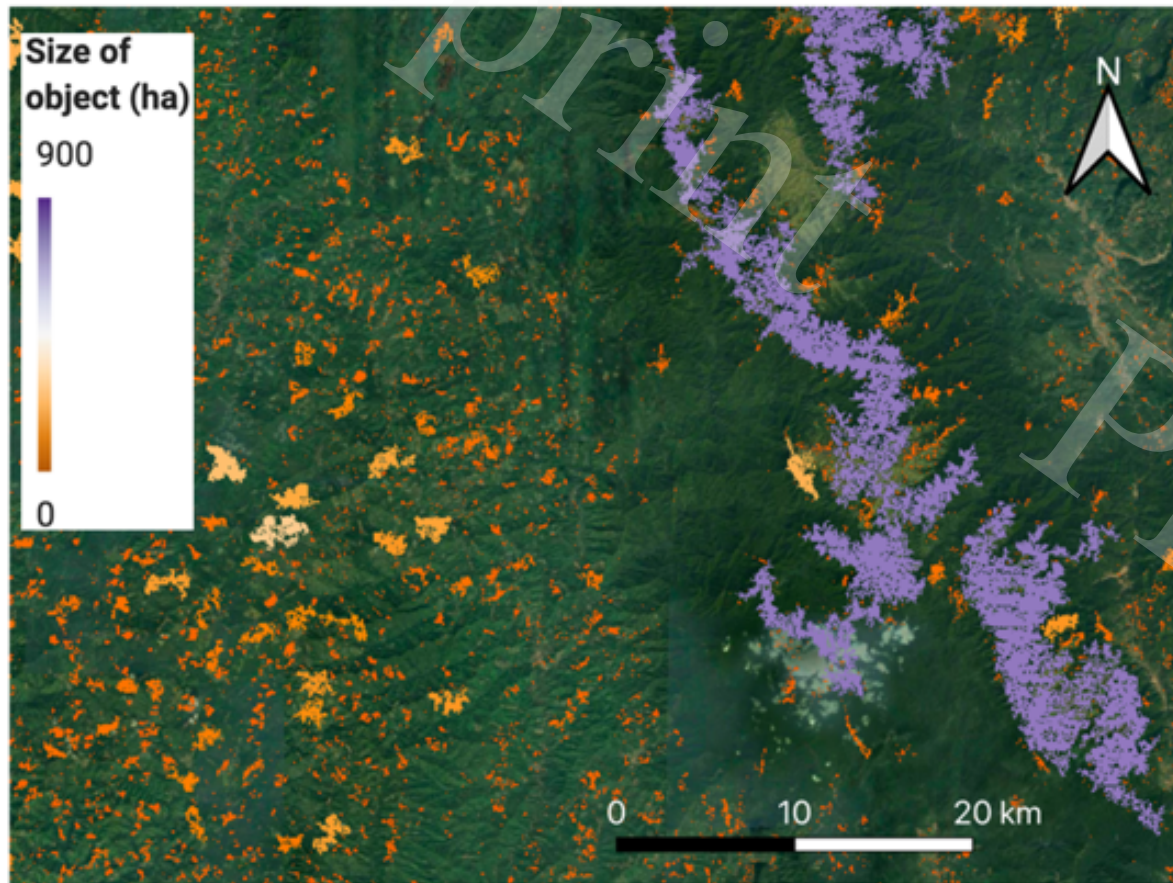
2016



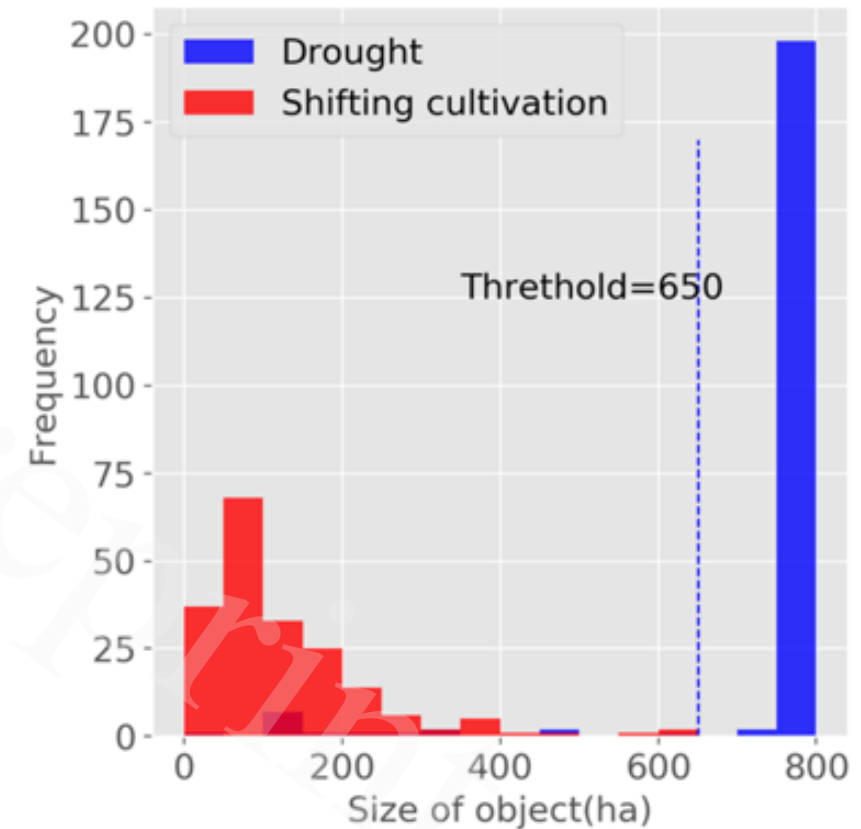
2017



# Differentiate drought and shifting cultivation using object-based image analysis (OBIA)

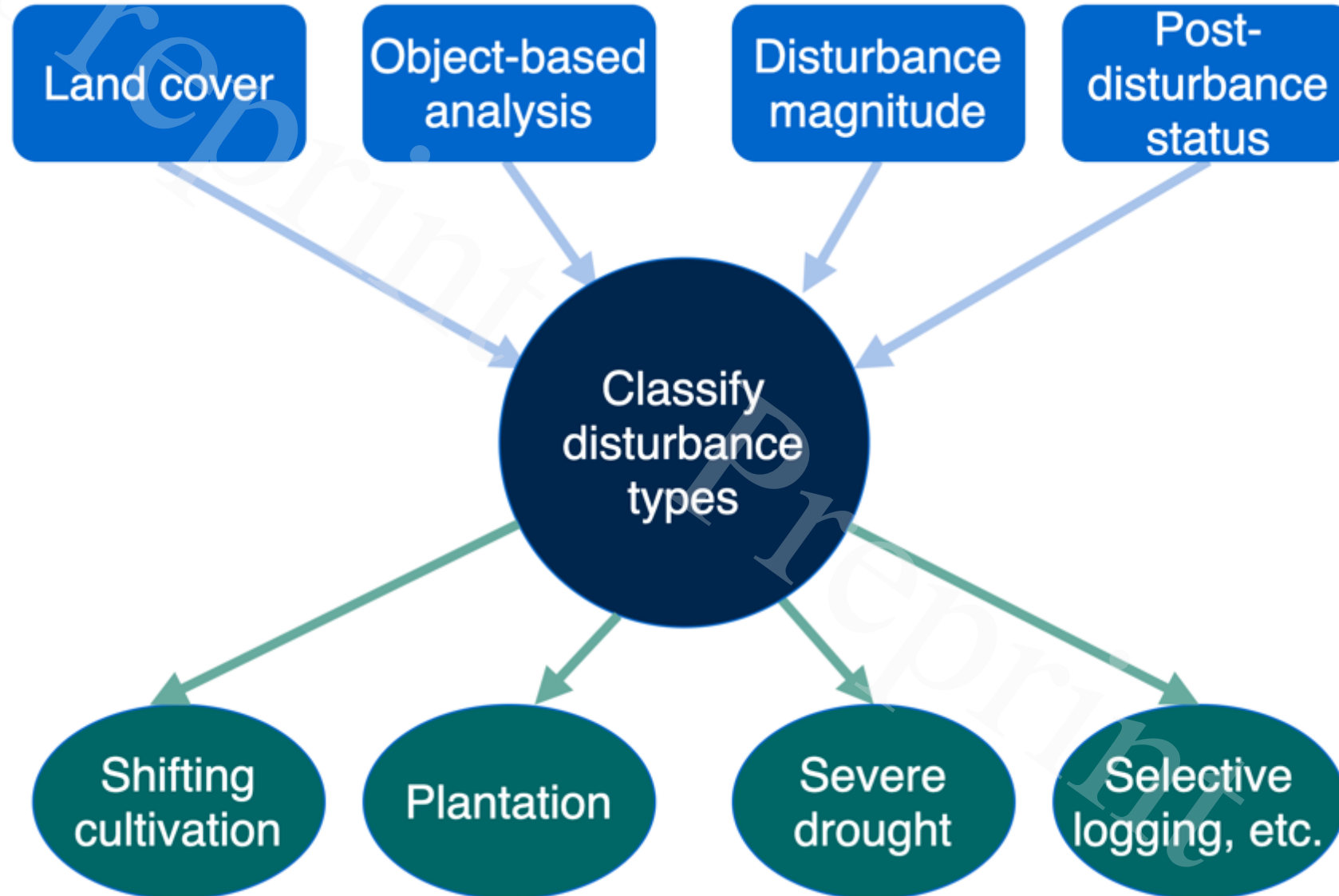


(a)



(b)

# Method – Classify disturbance types

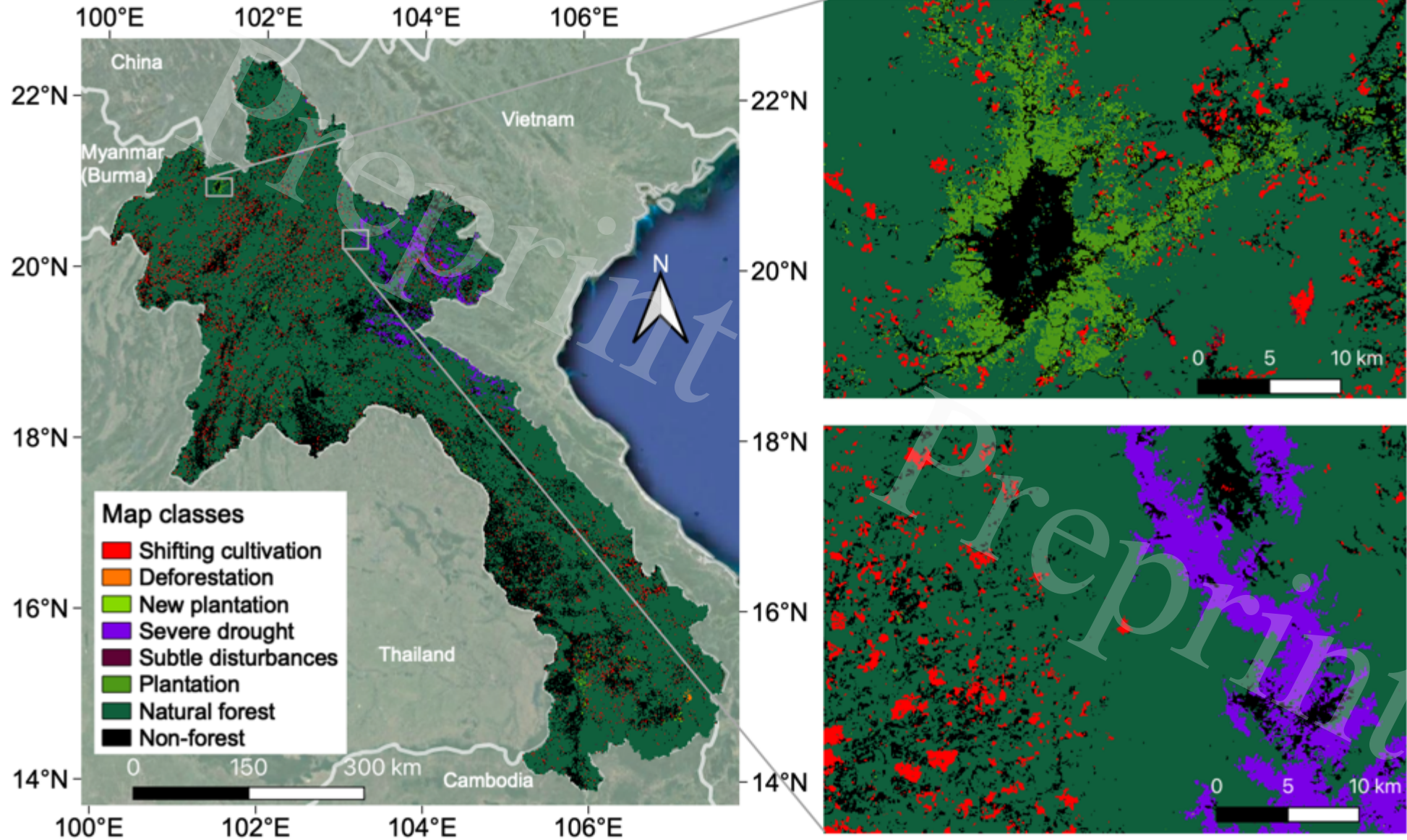




# Preliminary results

## Annual maps of disturbance type (1991-2020)

2016 as an example





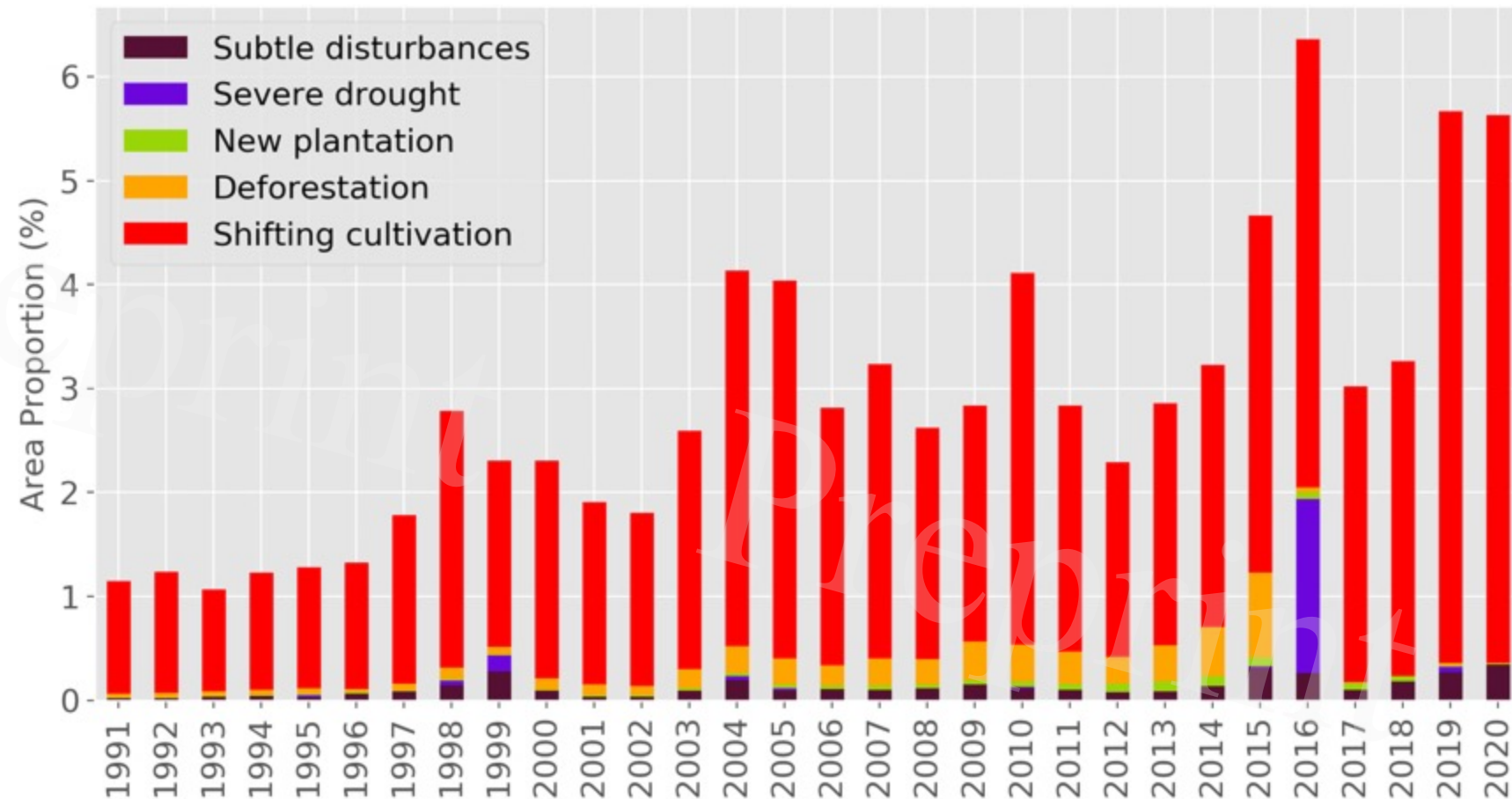
**Preliminary result: Year of slash-and-burn activities**



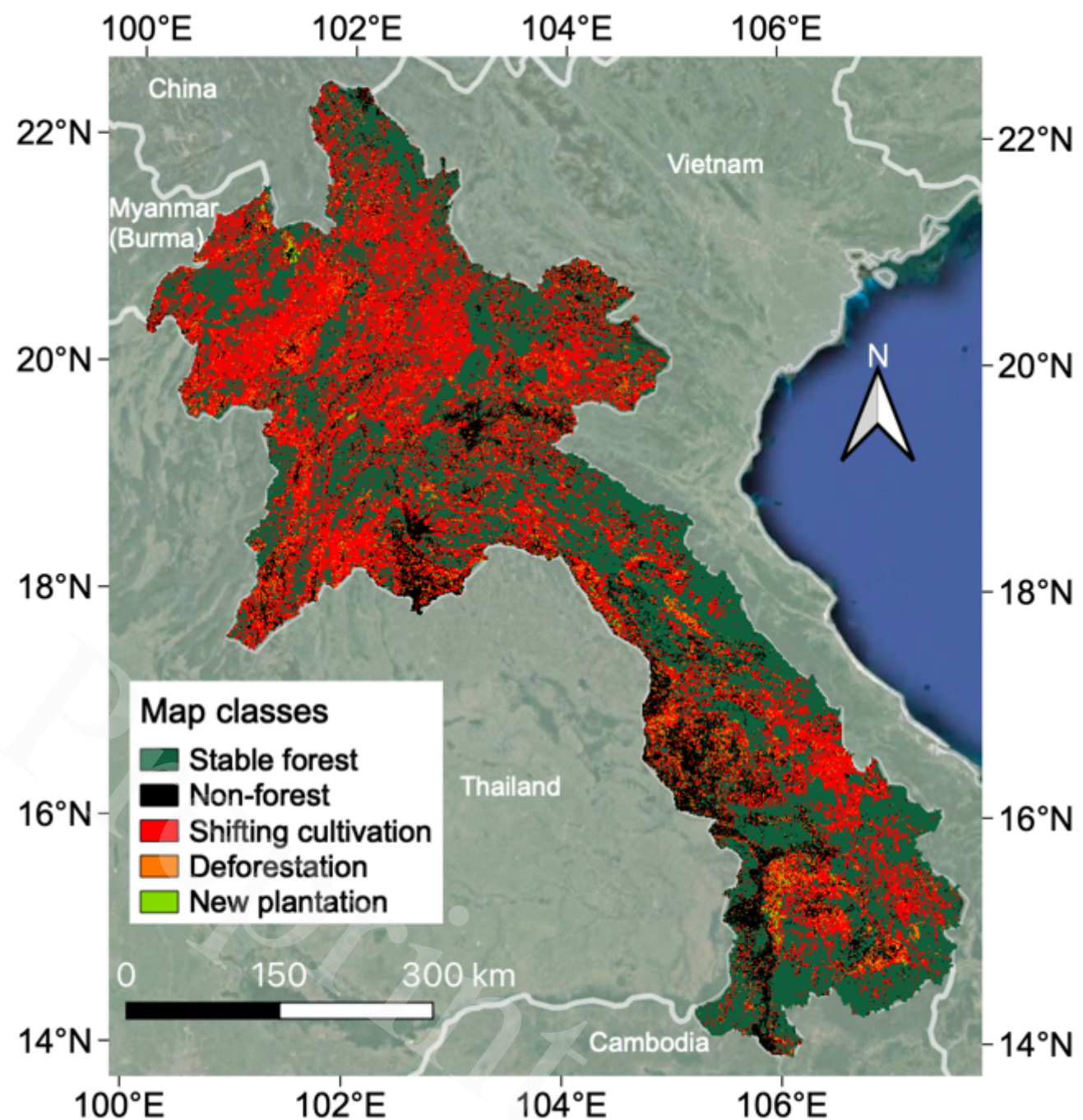


# Annual area proportion of different types of forest disturbance in Laos

- Shifting cultivation is the major disturbance type for every year.
- Area of slash-and-burn activities has an increase trend.



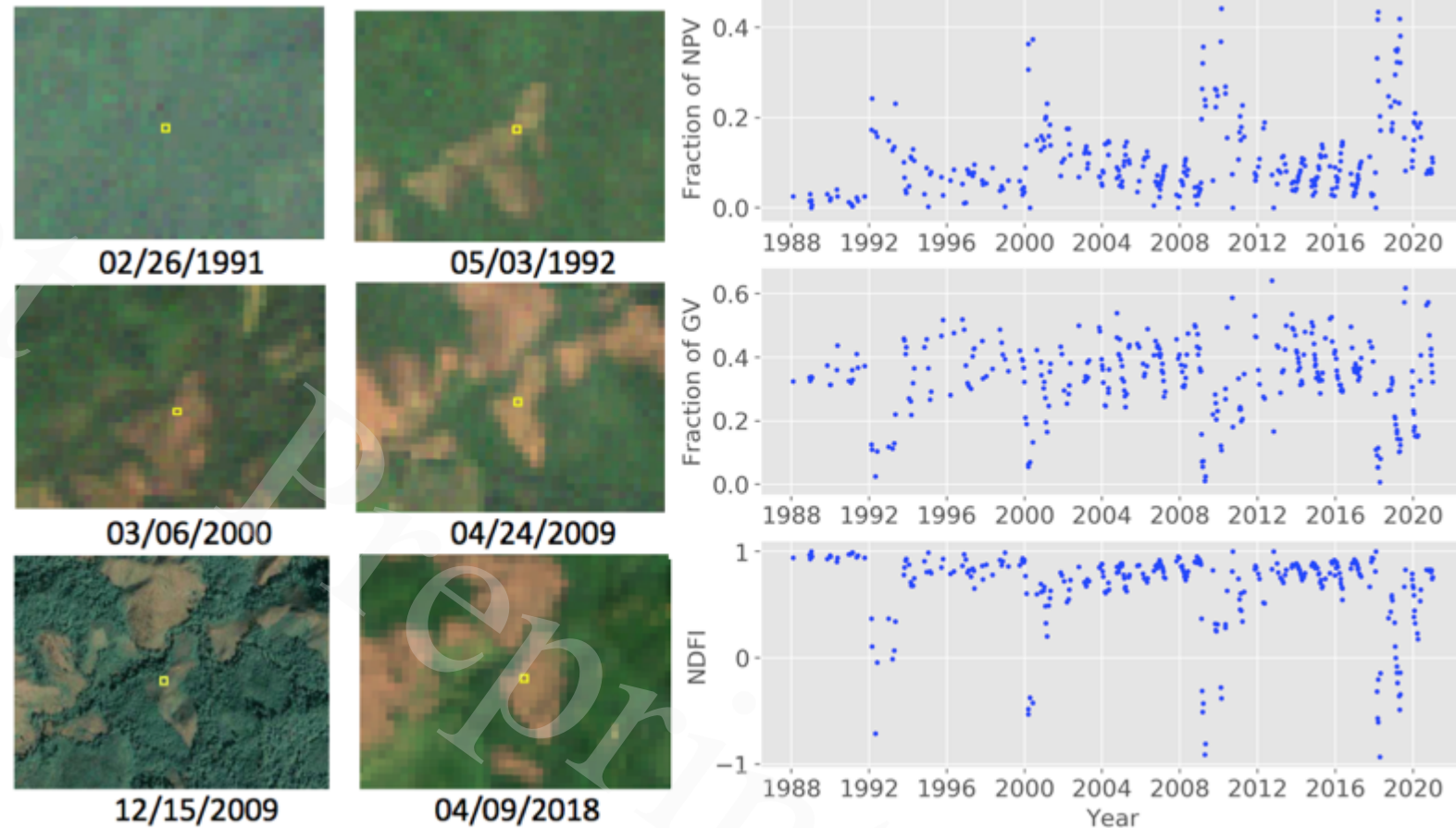
# Aggregated forest disturbance map in Laos (1991-2020)



(Chen et al., 2022)

# Accuracy assessment and area estimation

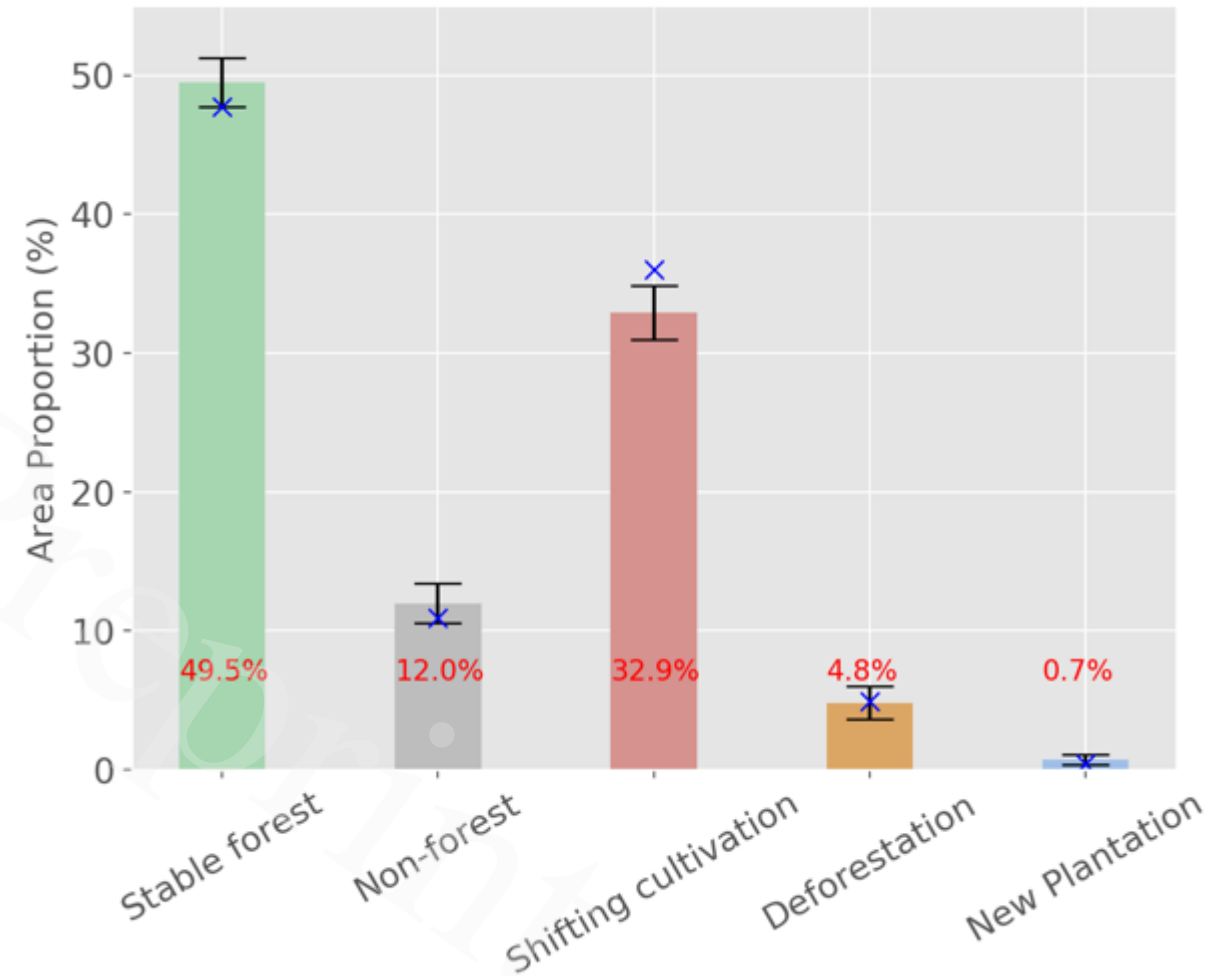
- **1000 simple random sample units in Laos.**
- **At least two interpreters for each sample unit.**
- **Shifting cultivation is mapped at high accuracy.**
  - producer's accuracy: 87.7%
  - user's accuracy: 80.2%



Example of reference data

# Area estimation of disturbance classes (1991-2020)

- **The area of shifting cultivation in Laos is estimated with low uncertainty.**
  - margin of error of the area estimates: 5.9%.
- **Shifting cultivation is the major disturbance in Laos.**
  - $32.9\% \pm 1.9\%$  of Laos over the period 1991-2020.



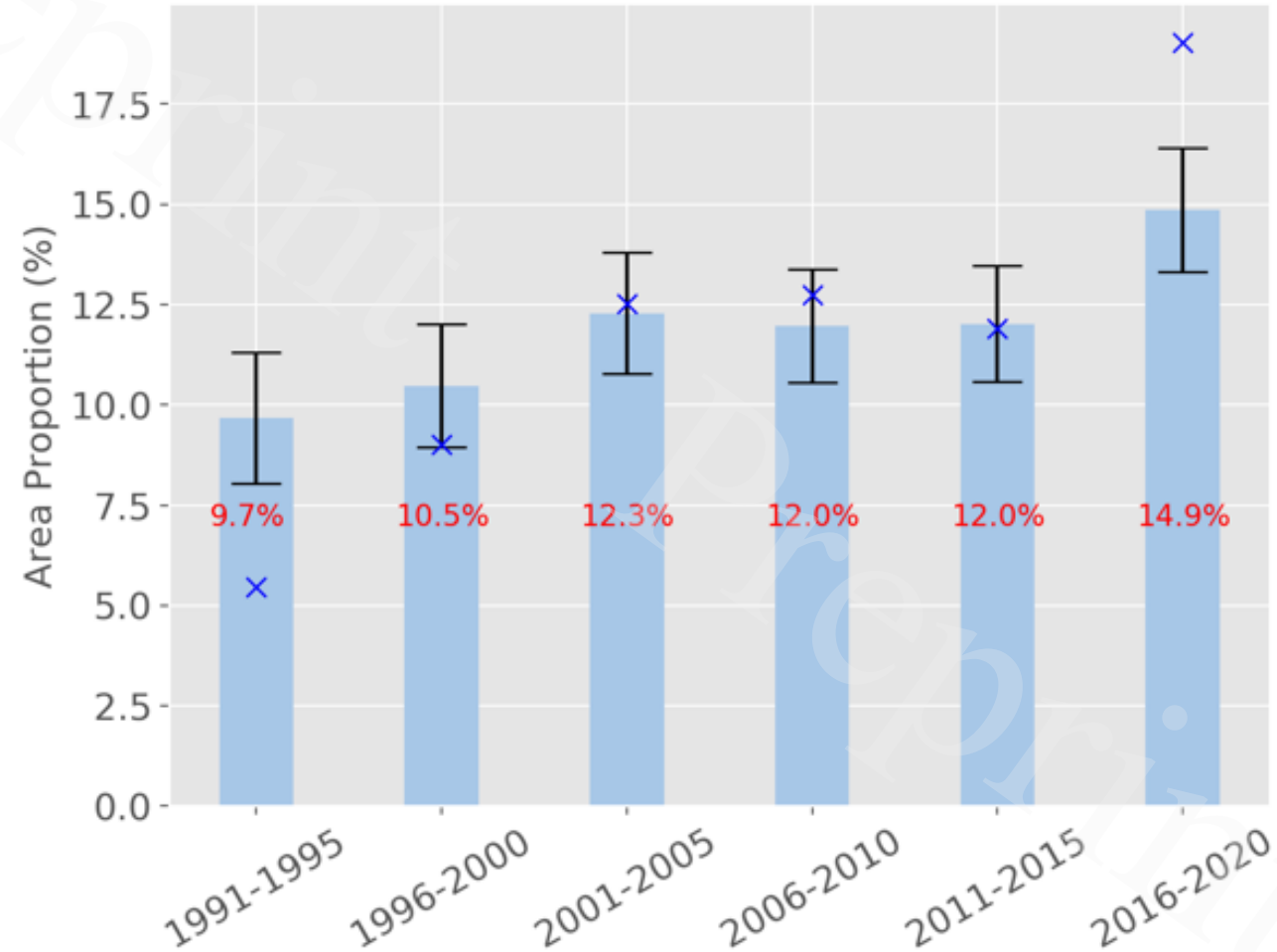


# Area estimates of shifting cultivation by 5-year period

- **The area of slash-and-burn events are estimated with good accuracy by period.**

- All margin of errors of the area estimates < 17%.

- **Slash-and-burn activities have increased in the recent 5 years.**



# Summary

- Dense Landsat time series is effective to monitor shifting cultivation.
- Shifting cultivation is the major disturbance in Laos and mapped at high accuracy.
- Slash-and-burn activities have increased in the recent 5 years.

## Next steps

- Analyze the spatial-temporal patterns of shifting cultivation.
- Quantify carbon dynamics associated with shifting cultivation.
- Expand our study to the whole Southeast Asia.