



Overview of degradation monitoring options in the context of REDD+

07-11 May 2018 | Phnom Penh

Objectives

Definition(s) of degradation

Use of proxies for monitoring degradation (indirect approach)

Use of remote sensing for detection of degradation (direct approach)

Definition(s): in terms of carbon biomass



deforestation



degradation



enhancement

$$\Delta C = \sum \Delta S \cdot B \cdot E_{def} + \sum S \cdot \Delta B \cdot E_{deg} + \sum S \cdot \Delta B \cdot R_{reg}$$

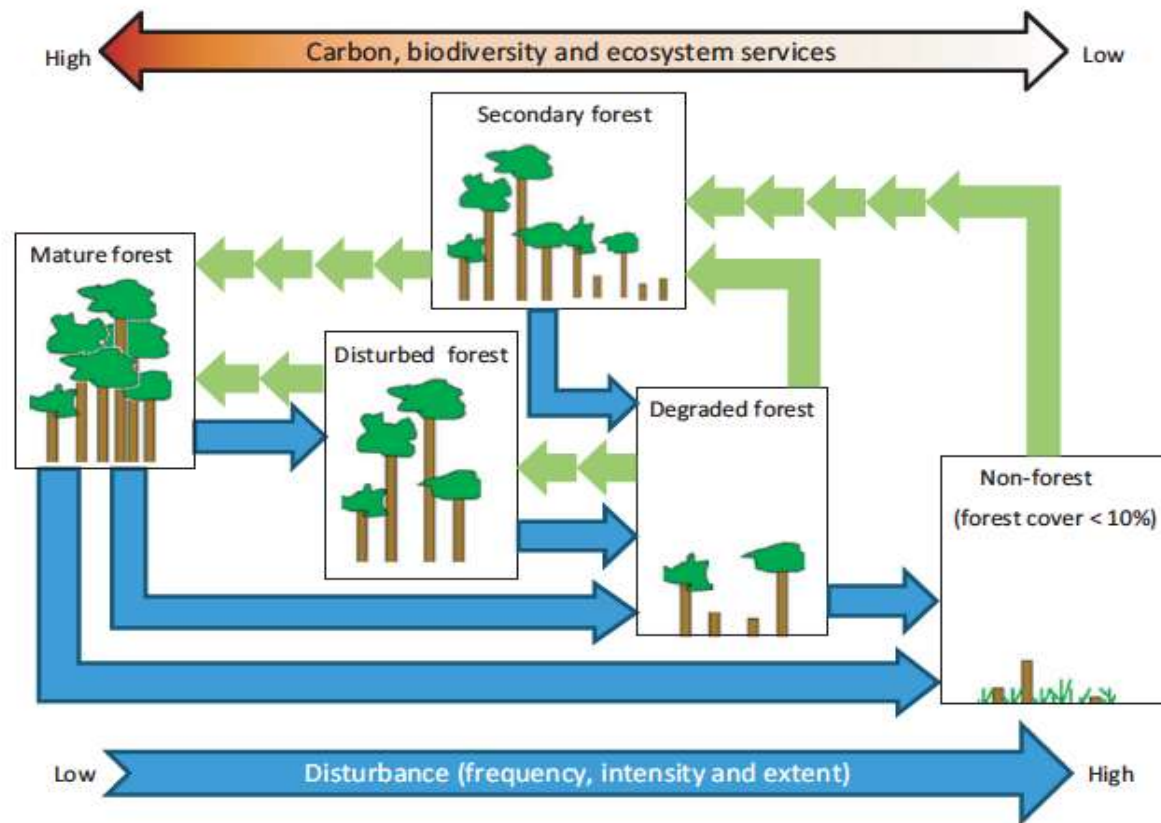
Definition(s): in terms of ecosystem services

Table 1. A suggested framework of criteria and indicators for defining and delineating areas of degraded forest. A suggested minimum set of seven indicators is indicated by an asterisk (*).

| Criterion | Indicator(s) | Variable(s) | General methods |
|----------------------|---------------------------------|--|---|
| Production | Growing stock* | m ³ /ha of wood | Satellite imagery, LiDAR, ground plots |
| | Nontimber forest products | Monetary value, number/yr | Country reporting, questionnaires by management unit |
| Biodiversity | Ecosystem state* | Area of specific forest type | Satellite imagery |
| | Fragmentation* | Area fragmented | Satellite imagery, aerial photography |
| | Species | Presence/absence, population density, relative abundance, indicator of abundance | Aerial or ground surveys |
| Unusual disturbances | Invasive species* | Population density, area affected | Satellite imagery, aerial photography, ground surveys |
| Protective function | Fire* | Area affected | Satellite imagery, aerial photography |
| | Soil erosion* | Area affected | Satellite imagery, aerial photography |
| | Water volume or flow | Flow rate | River or stream flow meters |
| Carbon storage | Stored carbon* | Biomass/ha | Satellite imagery, ground plots |
| | High wood-density trees species | Tree density, relative abundance | Ground plots, aerial photography |

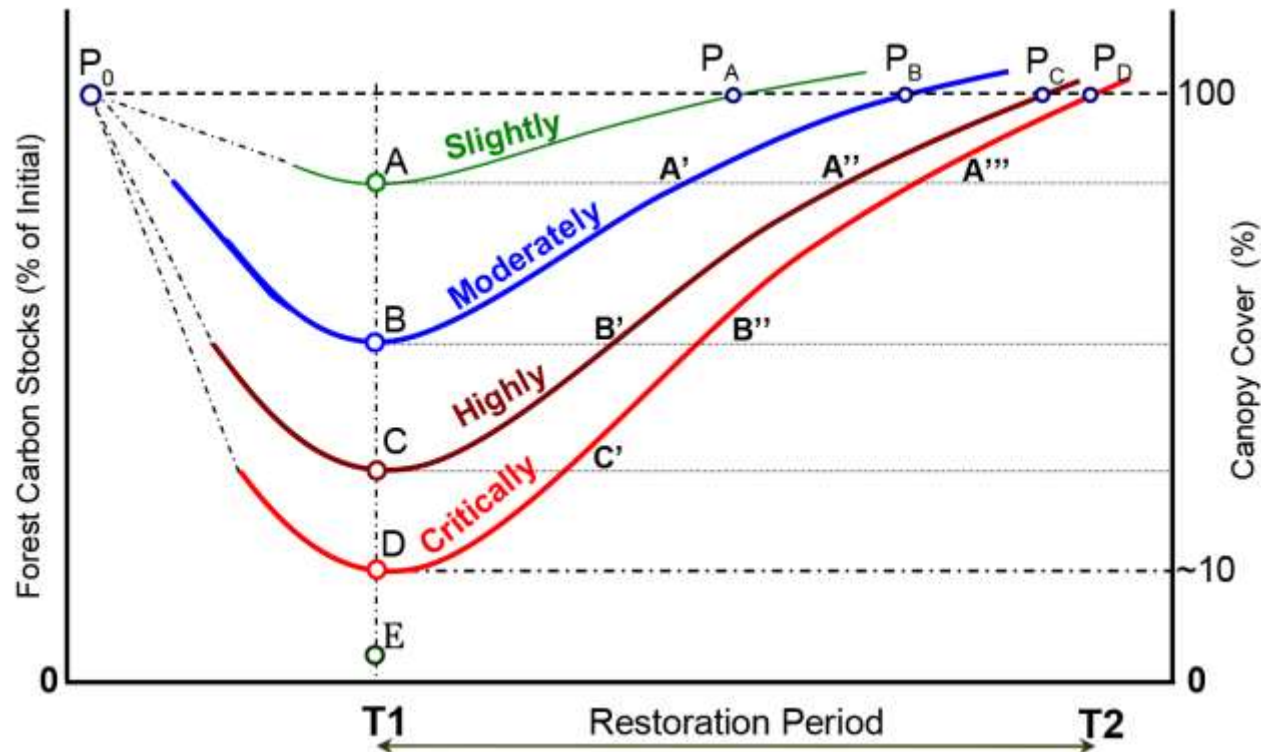
Thompson, I. D., M. R. Guariguata, K. Okabe, C. Bahamondez, R. Nasi, V. Heymell, and C. Sabogal. 2013. An operational framework for defining and monitoring forest degradation. *Ecology and Society* 18(2): 20.

Definition(s): in terms of carbon, biodiversity and ES



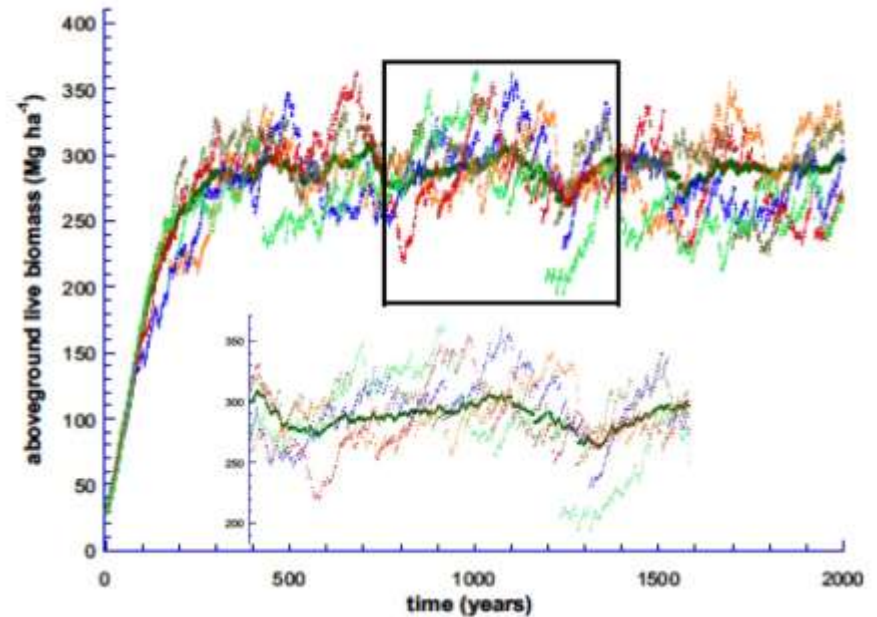
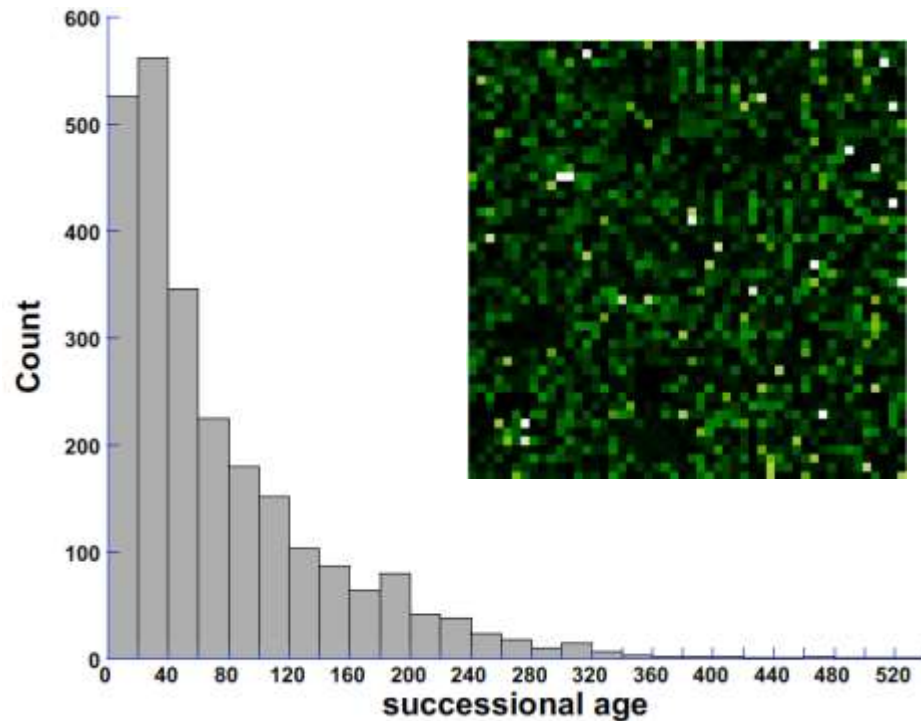
Bustamante et al. (2016), Toward an integrated monitoring framework to assess the effects of tropical forest degradation and recovery on carbon stocks and biodiversity. *Global Change Biol*, 22: 92–109.
doi:10.1111/gcb.13087

Definition(s): quantification of degradation degrees



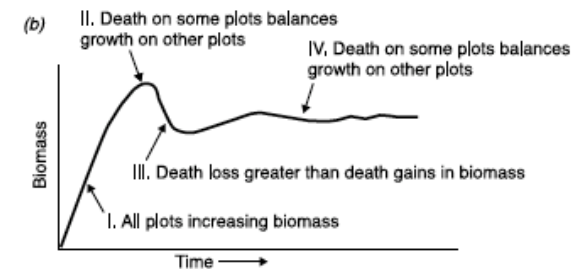
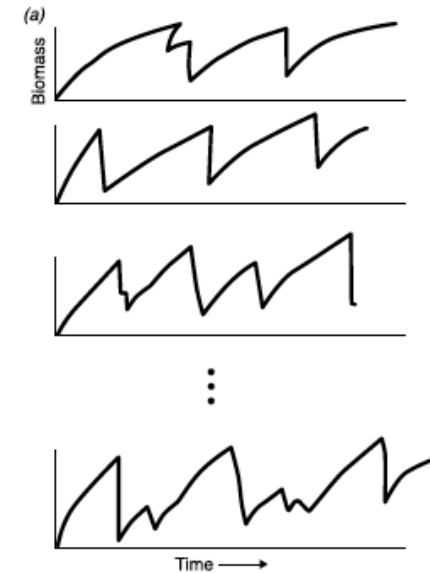
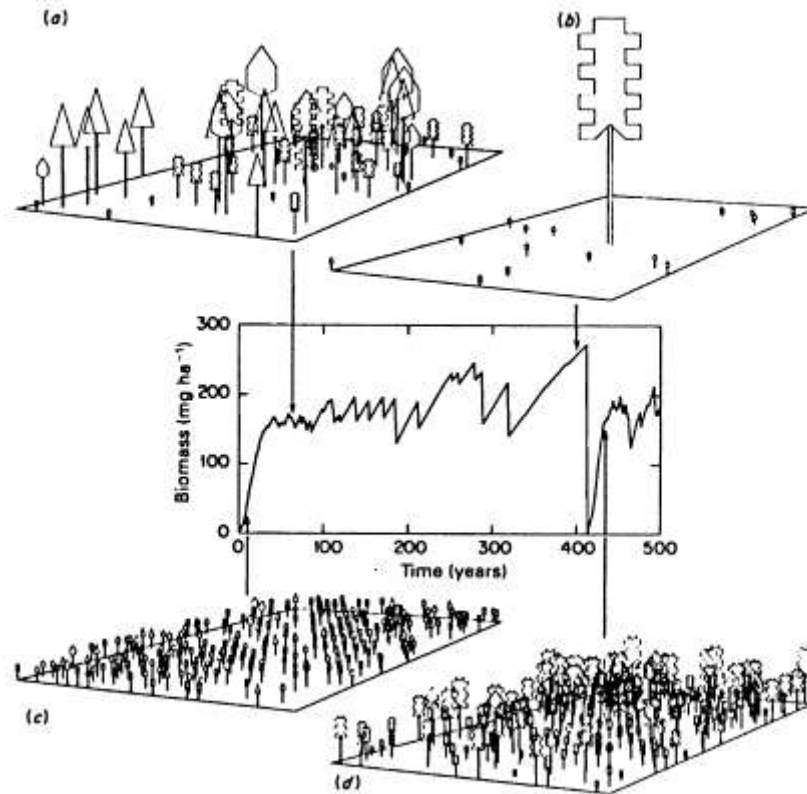
Sasaki et al., 2011. Approaches to classifying and restoring degraded tropical forests for the anticipated REDD+ climate change mitigation mechanism. *Biogeosciences and Forestry*, vol. 4, pp. 1-6, 2011

Definition(s): complex structure of natural forests



Chambers et al., 2013. The steady-state mosaic of disturbance and succession across an old-growth Central Amazon forest landscape. PNAS

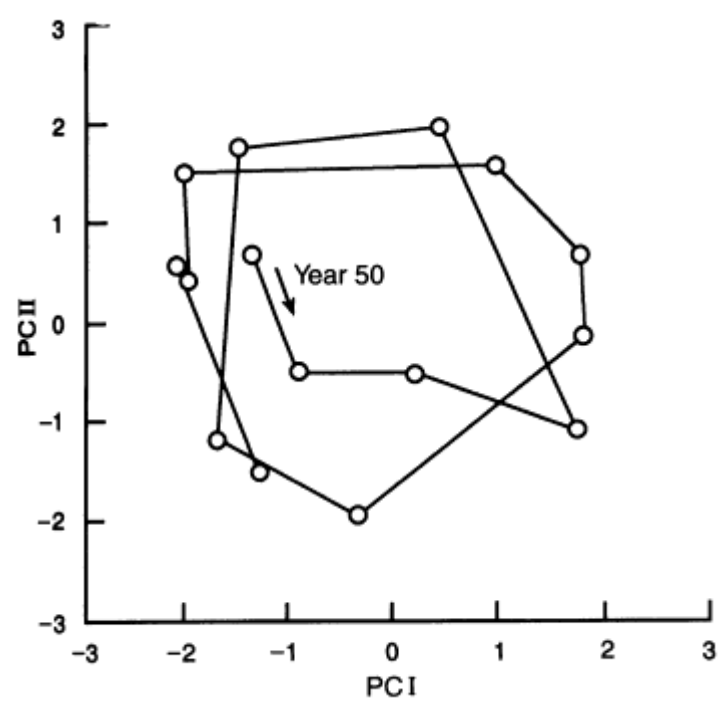
Definition(s): Importance of the MMU



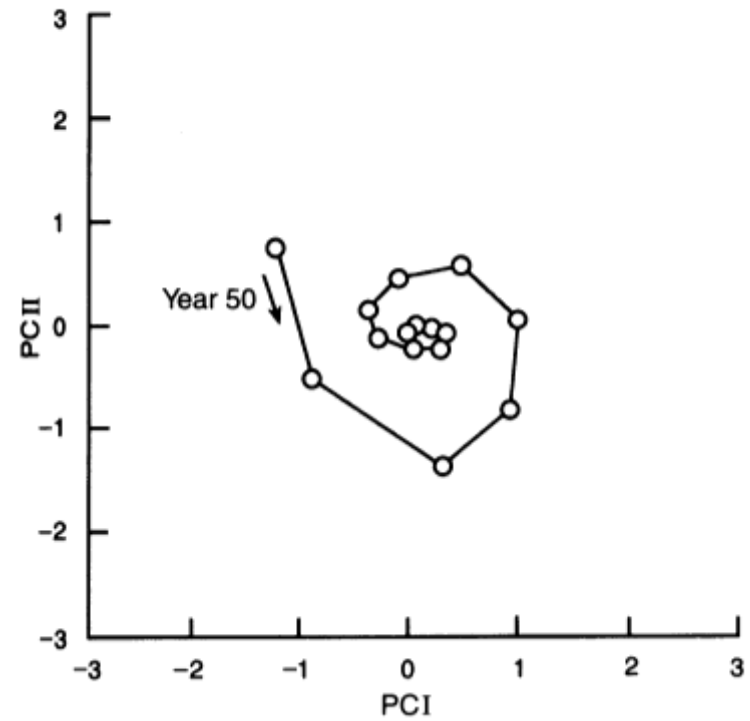
Shugart, H. H., S. Saatchi, and F. G. Hall (2010), Importance of structure and its measurement in quantifying function of forest ecosystems, J. Geophys. Res., 115, G00E13, doi:10.1029/2009JG000993.

Definition(s): Scale of observations: micro vs macro

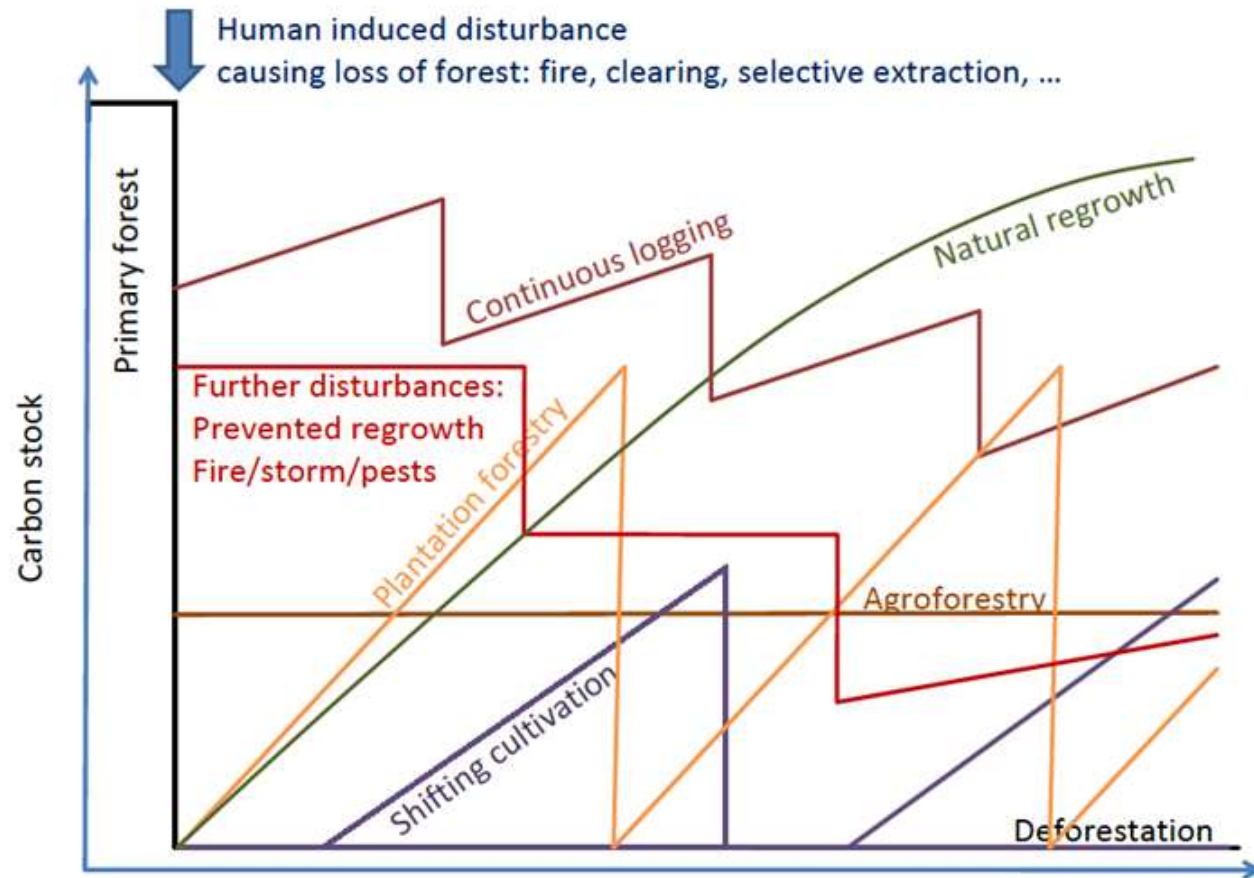
No convergence at micro scale



Convergence at macro scale



Definition(s): A lot of possible processes



GFOI (2016), Methods and Guidance Document V2

www.reddcompass.org

Technical approaches to degradation

Indirect approaches

Combination of existing data as proxies

- national forest inventories
- forestry statistics (volumes, exploited areas, road lengths),
- field survey (woodfuel, shifting cultivation)

Direct approaches

- Specific indices
- Dense time series
- Fragmentation
- Spatial synthesis

FREL submission of Congo (2016)

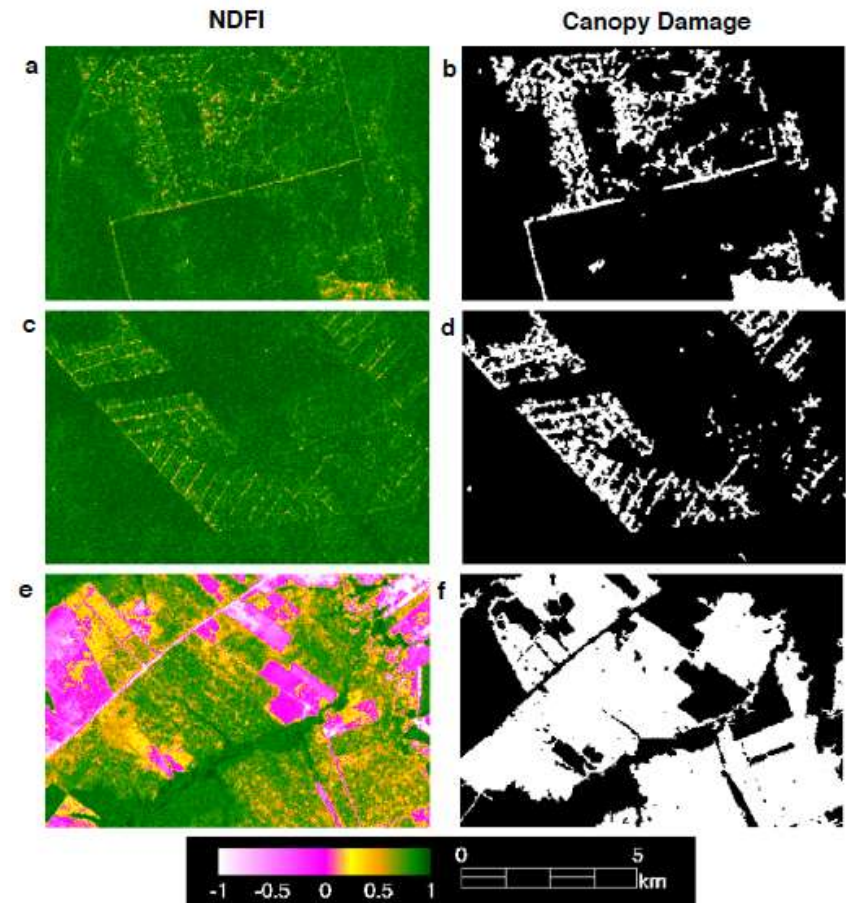
| | | |
|---|-------------------|-----------------|
| Emission liée à l'extraction de bois conventionnelle_Biomasse aerienne | 3,250,870 | teCO2/an |
| Emission liée à l'extraction de bois certifiée_Biomass aerienne | 1,166,595 | teCO2/an |
| Emission liée à l'extraction de bois conventionnelle_Biomasse souterrain | 1,202,822 | teCO2/an |
| Emission liée à l'extraction de bois certifiée_Biomass souterrain | 431,640 | teCO2/an |
| Emission liée au dommage d'extraction conventionnelle_Biomasse aerienne | 7,157,185 | teCO2/an |
| Emission liée au dommage d'extraction certifiée_Biomass aerienne | 1,284,200 | teCO2/an |
| Emission liée au dommage d'extraction conventionnelle_Biomasse so | 2,648,158 | teCO2/an |
| Emission liée au dommage d'extraction certifiée_Biomass souterrain | 475,154 | teCO2/an |
| <i>Emissions Historiques bruts liées à la Dégradation Planifiée (EH-DEG-PL)</i> | <i>17,616,624</i> | <i>teCO2/an</i> |

Specific indices, spectral unmixing

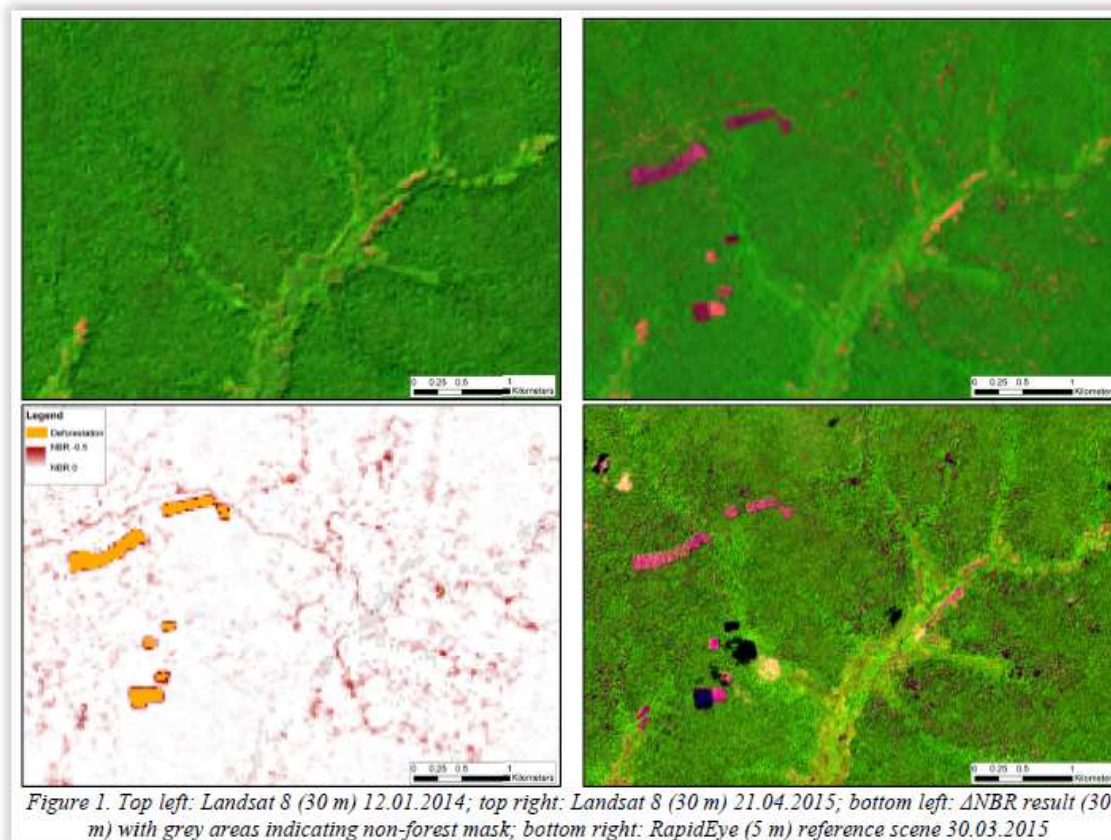
$$NFDI = \frac{GV_{shade} - (NPV + Soil)}{GV_{shade} + (NPV + Soil)}$$

$$GV_{shade} = \frac{GV}{100 - Shade}$$

Souza, C., Roberts D., Cochrane, M., 2005. Combining spectral and spatial information to map canopy damage from selective logging and forest fires. Remote Sensing of Environment 98

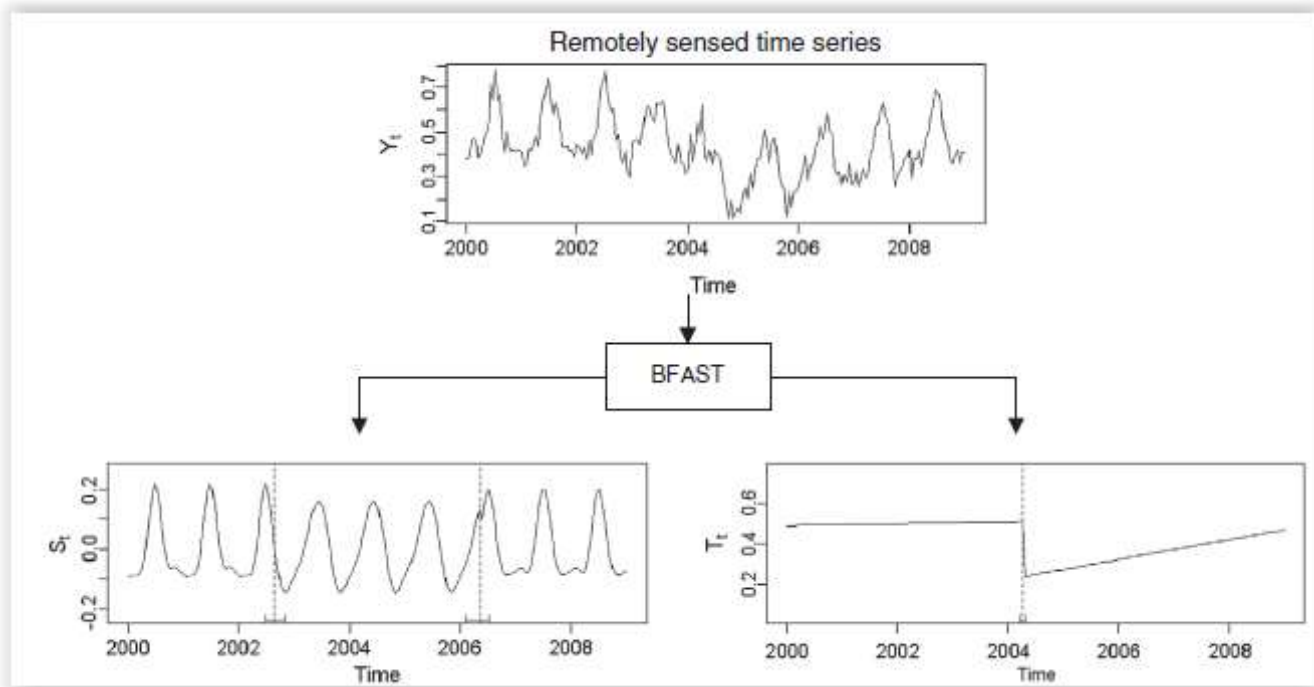


Specific indices, self referenced NBR



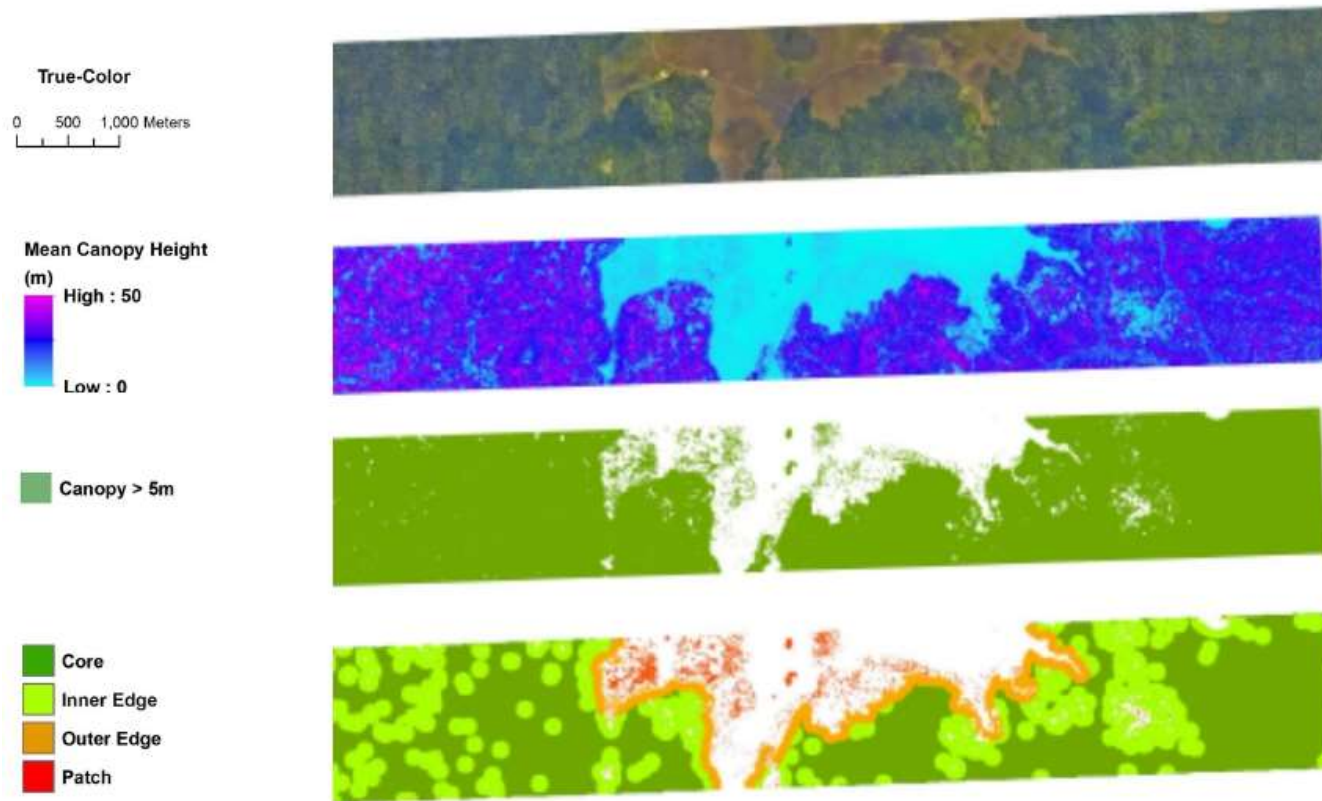
Langner et al., 2018. Towards Operational Monitoring of Forest Canopy Disturbance in Evergreen Rain Forests: A Test Case in Continental Southeast Asia, Remote Sensing

Dense time series analysis of indices, BFAST



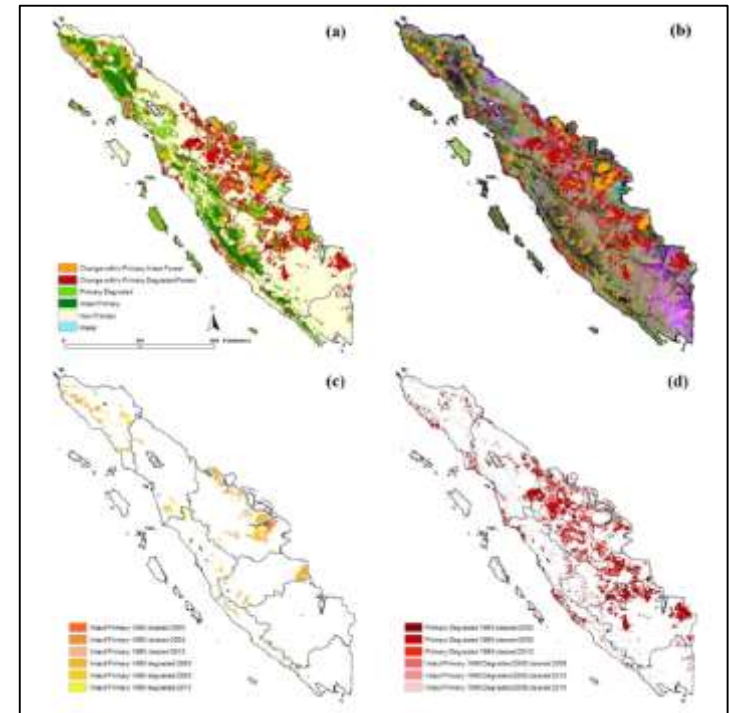
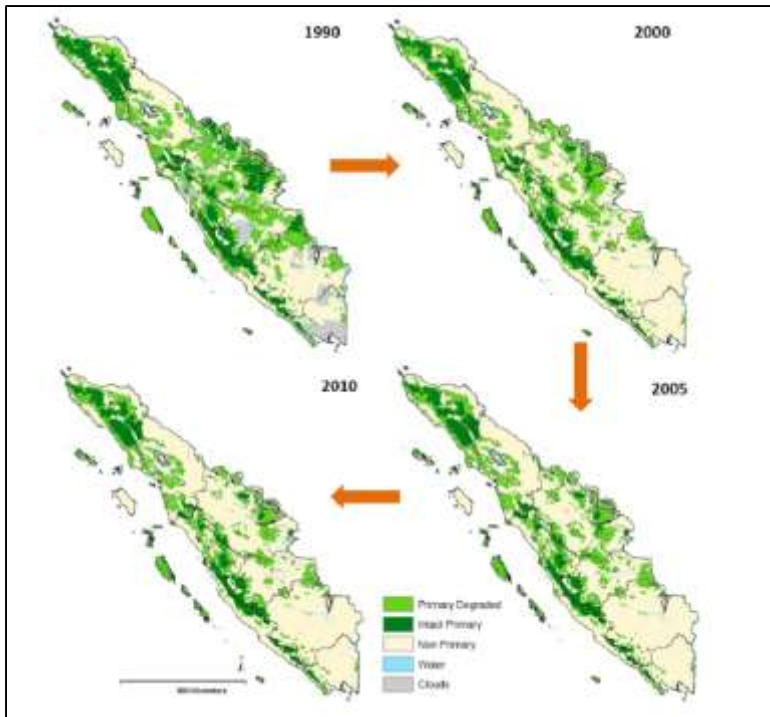
B DeVries, J Verbesselt, L Kooistra, M Herold, 2015. Robust monitoring of small-scale forest disturbances in a tropical montane forest using Landsat time series. Remote Sensing of Environment, 2015

Landscape Fragmentation Tool (LFT)



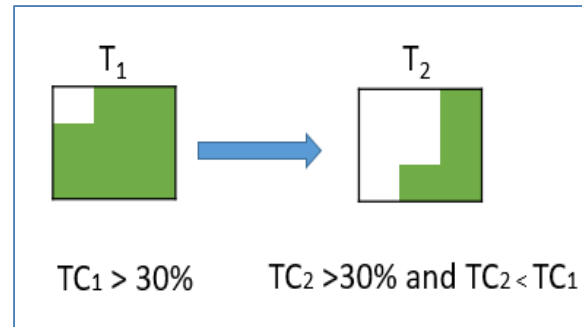
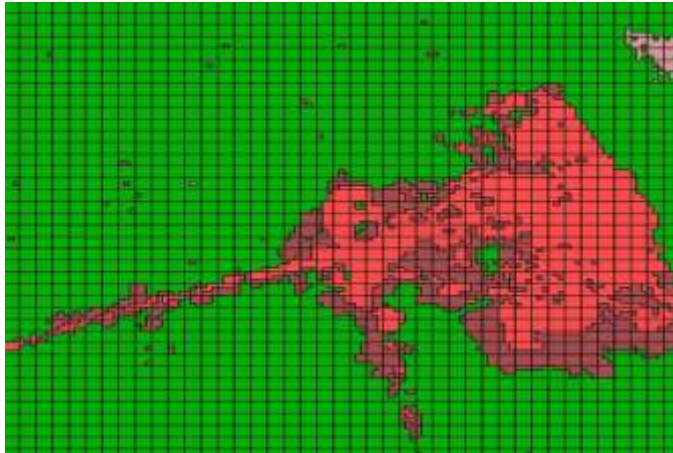
Shapiro et al., (2016) Using fragmentation to assess degradation of forest edges in Democratic Republic of Congo. *Carbon Balance and Management*.

Intact Forest Landscapes



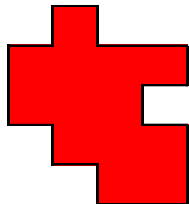
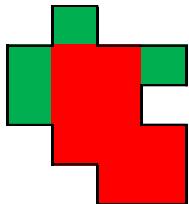
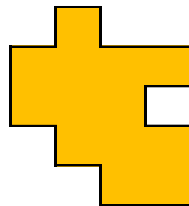
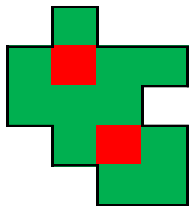
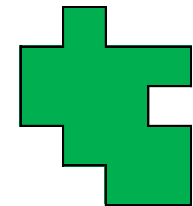
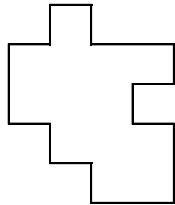
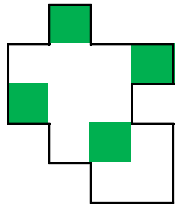
Margono, B.A. et al. Mapping and monitoring deforestation and forest degradation in Sumatra (Indonesia) using Landsat time series data sets from 1990 to 2010. *Environ. Res Letters*

Spatial aggregation on a fixed grid (JRC IMPACT toolbox)



Verhegghen, A., Bodart, C. & Eva, H.; Projet ReCaREDD - Atelier sur le suivi de la dégradation forestière par télédétection – Brazzaville 2016

Spatial aggregation into objects



Requires input data (GFC, roadless, other)

Independent of the resolution of auxillary product

Segmentation may not be relevant in future evaluations



Presentation adapted from S Saatchi (JPL / NASA)

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