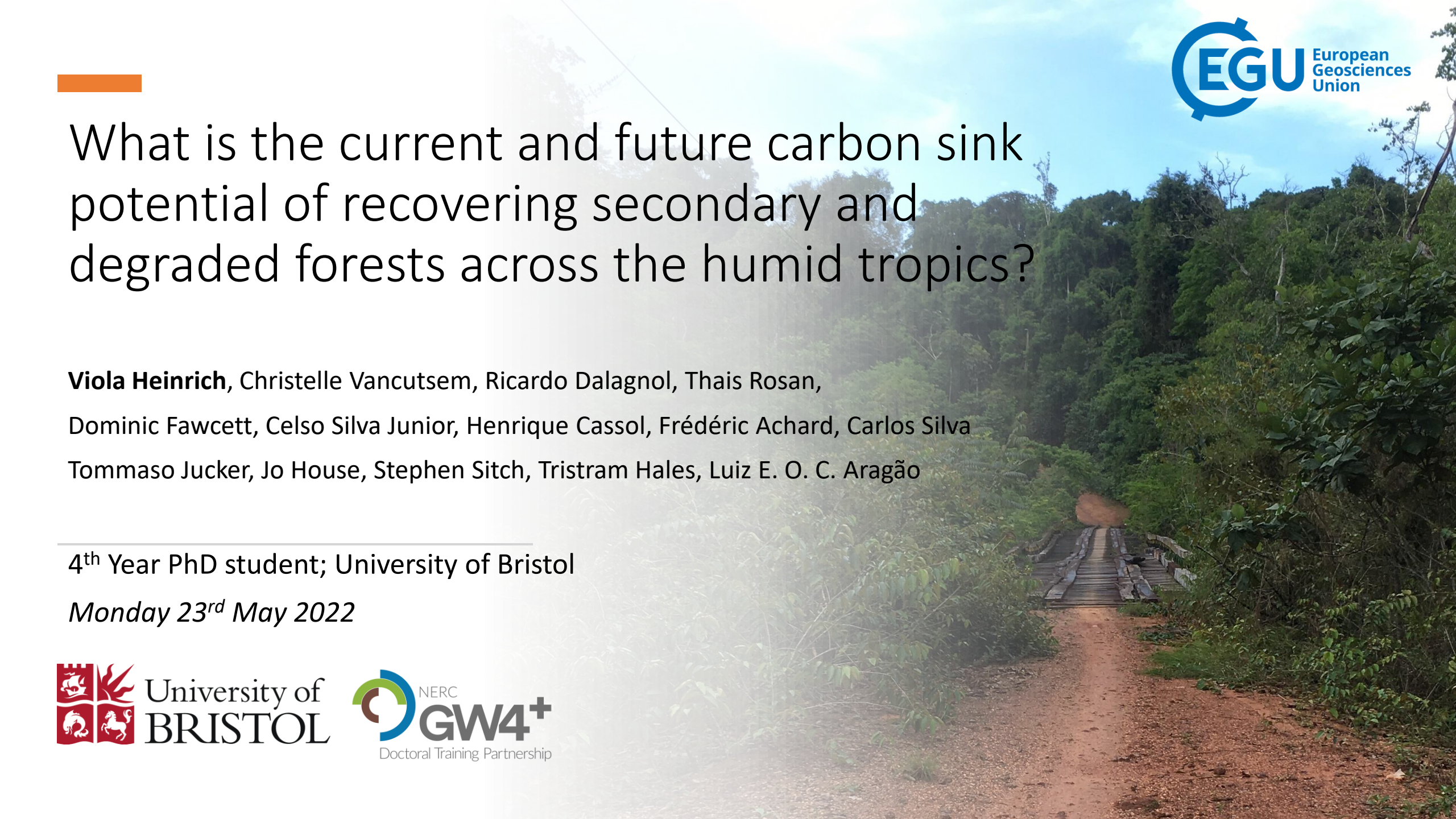
What is the current and future carbon sink potential of recovering secondary and degraded forests across the humid tropics?

Viola Heinrich, Christelle Vancutsem, Ricardo Dalagnol, Thais Rosan,
Dominic Fawcett, Celso Silva Junior, Henrique Cassol, Frédéric Achard, Carlos Silva
Tommaso Jucker, Jo House, Stephen Sitch, Tristram Hales, Luiz E. O. C. Aragão

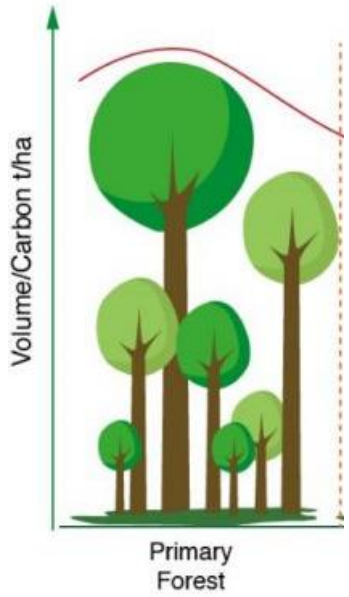
4th Year PhD student; University of Bristol

Monday 23rd May 2022



Tropical forest are a patchwork of…

Old-growth: experienced little/no detectable disturbances in recent past

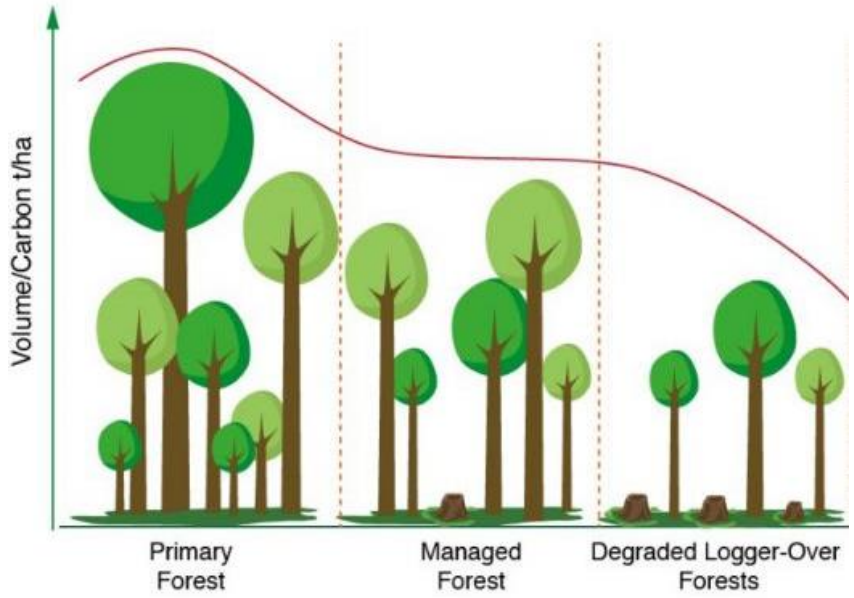


https://www.forestryandclimate.com/impact/the-potential-of-secondary-forests/;
https://news.mongabay.com/2014/08/how-do-we-save-the-worlds-vanishing-old-growth-forests/

Tropical forest are a patchwork of…

Old-growth: experienced little/no detectable disturbances in recent past

Degraded forest: experienced detectable disturbances such as fire and/or logging but not enough to class as deforestation.



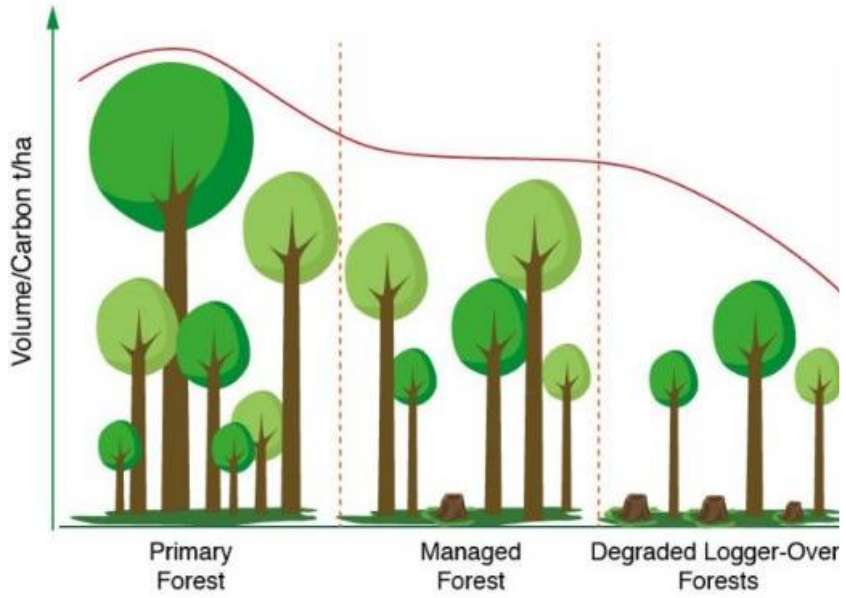
https://www.forestryandclimate.com/impact/the-potential-of-secondary-forests/;
https://rainforests.mongabay.com/kids/lesson_plans/lisa_algee/logging.html

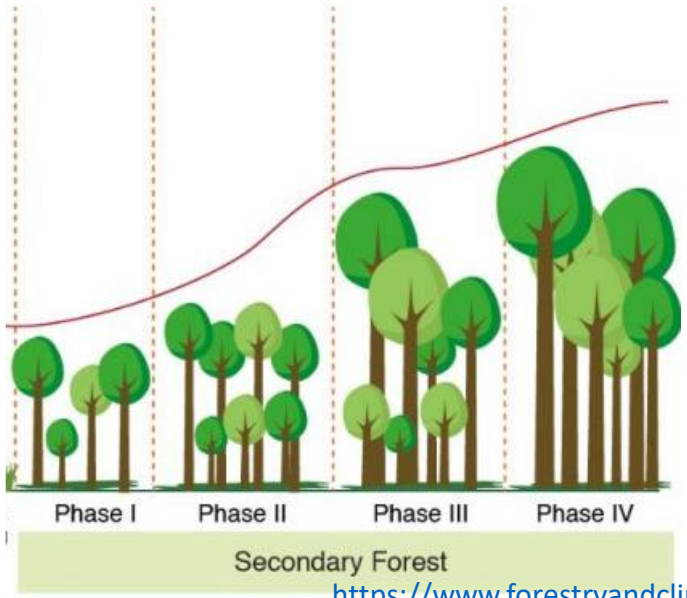
Tropical forest are a patchwork of…

Old-growth: experienced little/no detectable disturbances in recent past

Degraded forest: experienced detectable disturbances such as fire and/or logging but not enough to class as deforestation.

Secondary forest: areas of land that regrow on deforested, now abandoned land.





https://www.forestryandclimate.com/impact/the-potential-of-secondary-forests/;
Secondary Forest Photo credit :Celso Silva Junior

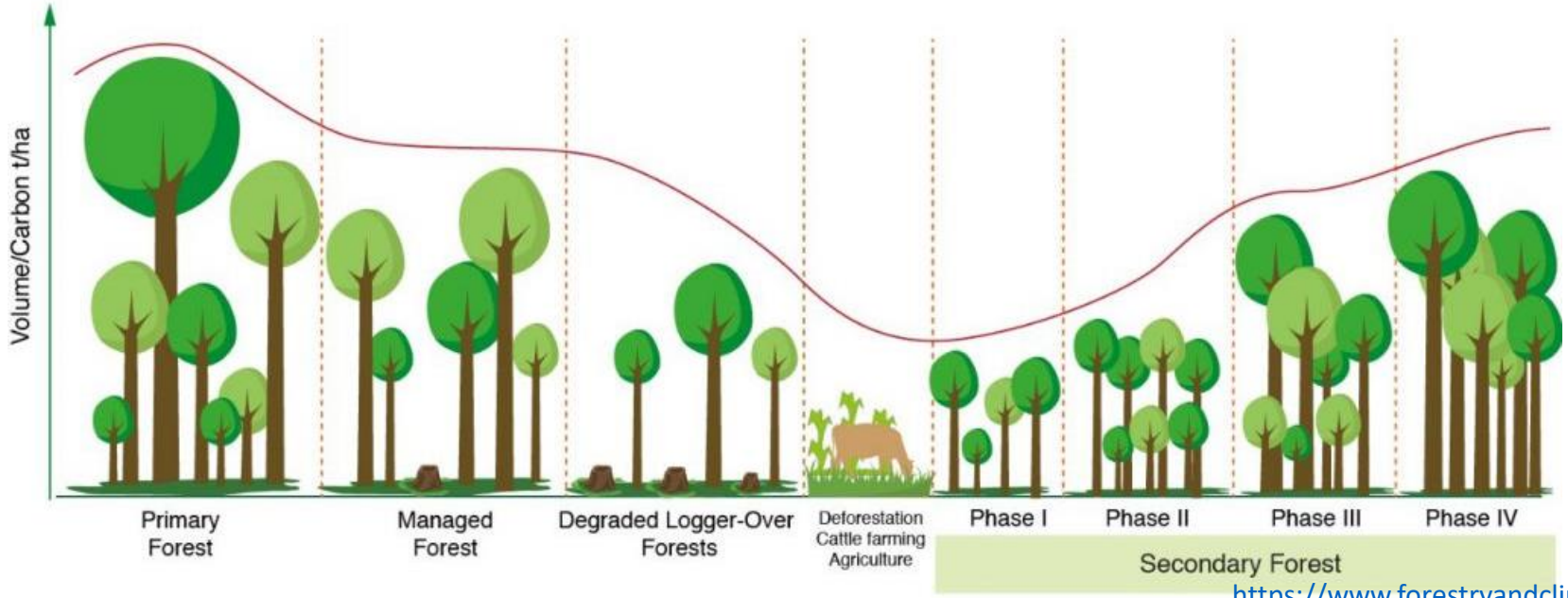
Tropical forest are a patchwork of…

Old-growth: experienced little/no detectable disturbances in recent past

Degraded forest: experienced detectable disturbances such as fire and/or logging but not enough to class as deforestation.

Secondary forest: areas of land that regrow on deforested, now abandoned land.

Non-forest land: Deforested areas no longer classed as forest (including plantations)



https://www.forestryandclimate.com/impact/the-potential-of-secondary-forests/;

Protecting the remaining forests is the most effective way to limit land-based emissions

But…

…In the already disturbed regions we need to know how much carbon these regions can store

2023
Global
Stocktake

REDD+ WEB PLATFORM

REDUCING EMISSIONS FROM DEFORESTATION AND FOREST DEGRADATION IN DEVELOPING COUNTRIES

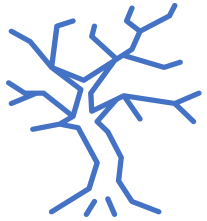
Secondary and Degraded Forest recovery

Secondary Forest

Numerous studies have estimated the regrowth rates

We know:

- Absorb Carbon x11 faster than old-growth forests[1]
- Enable biodiversity to recover[2]
- Fire and repeated land clearing reduce the regrowth rates[3]



Degraded Forest

Studies of recovery limited to **small in-situ analysis**

We know:

- They can recover Carbon levels[4]
- They can suffer long-term mortalities[5]
- Climate and human disturbance impact forest dynamics[6,7]

Where are the gaps?

1. There has been no pan-tropical assessment of the recovery of degraded forests compared to secondary forest.
2. How recovery of degraded forest various across the tropics.
3. What is the carbon stock potential of these forests now and in the future.

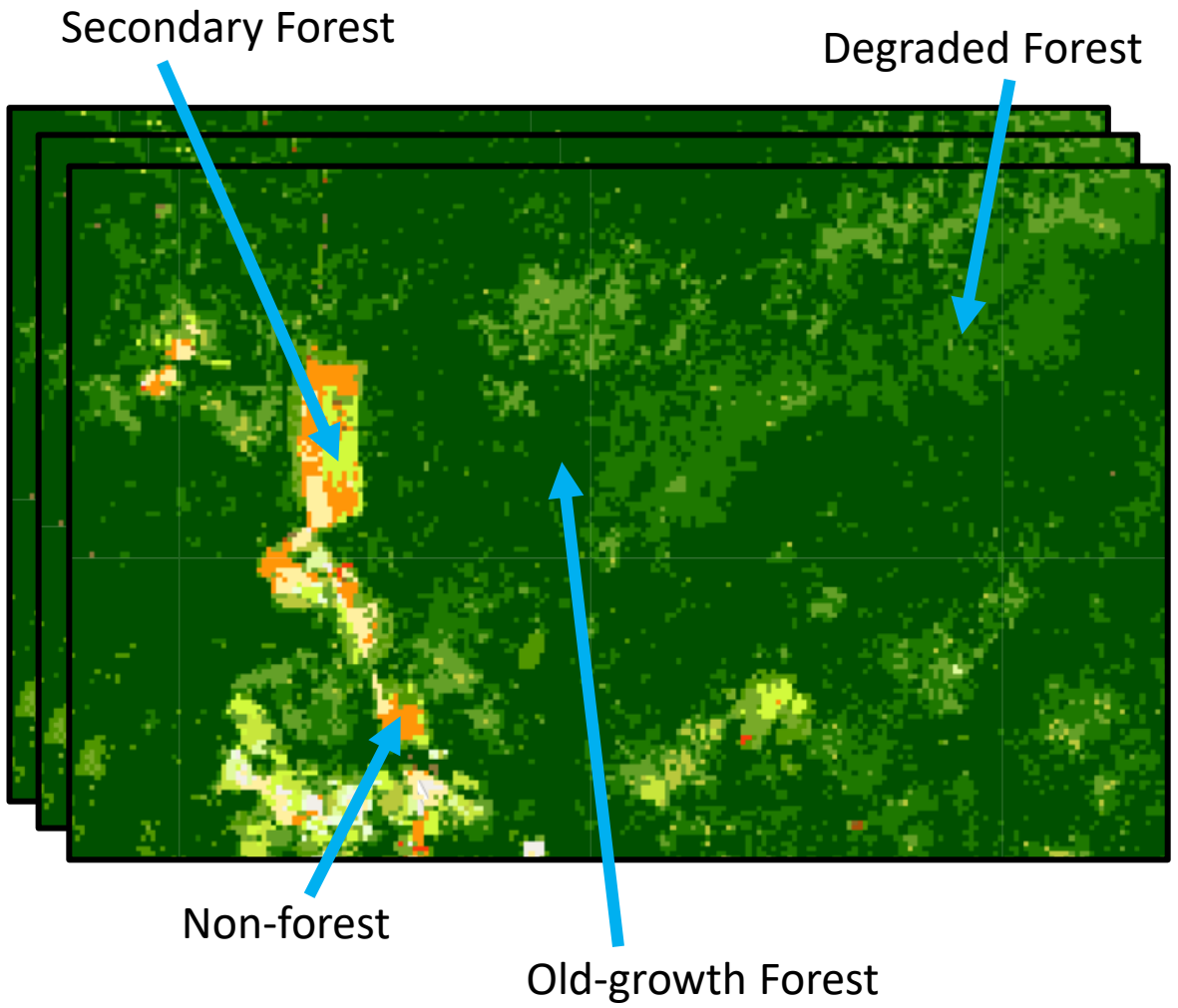
1 Poorter et al., 2016. *Nature*; 2 Lennox et al., 2018 *Glob. Chang. Biol.*; 3 Heinrich et al., 2021*. Nature Commun;* 4 Philipson et al*., 2020. Sci Adv.;* 5 Silva et al., 2020. *Environ. Res. Lett.*; 6 Rappaport et al. 2018. *Environ. Res. Lett.*; 7 Sullivan et al., 2020. *Sci*.

Satellite datasets can provide continuous information on forest type and their carbon storage

1. **Identify** areas and Years since last disturbance event using a pan-tropical remote sensing dataset 1982-2018 (TMF) (Vancutsem et al 2021).

2. **Estimate** the Aboveground Carbon of forests derived from ESA-CCI Biomass product (100m resolution) Santoro and Cartus (2019).

3. **Model** the carbon accumulation and carbon stock potential



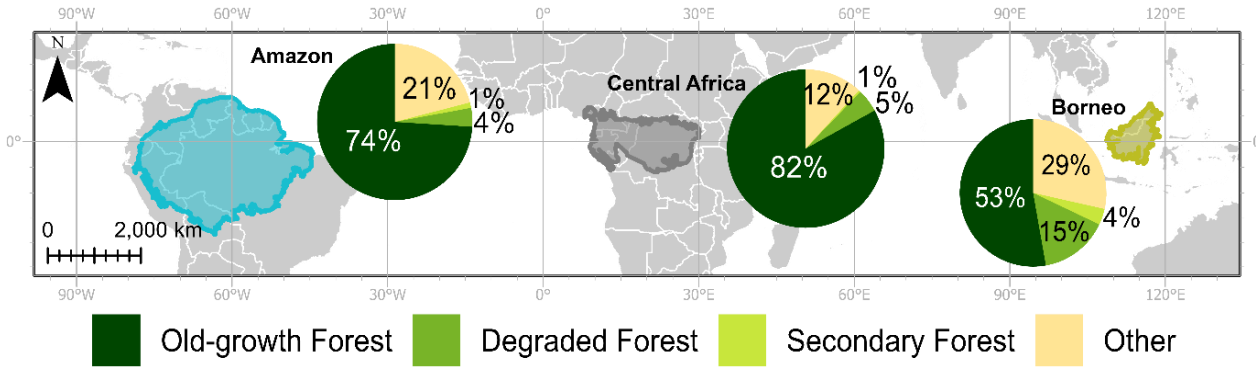
Satellite datasets can provide continuous information on forest type and their carbon storage

1. **Identify** areas and Years since last disturbance event using a pan-tropical remote sensing dataset 1982-2018 (TMF) (Vancutsem et al 2021).

2. **Estimate** the Aboveground Carbon of forests derived from ESA-CCI Biomass product (100m resolution) Santoro and Cartus (2019).

3. **Estimate** the carbon stock potential

1.



2.

3	0	3
0	0	2
0	0	1

Years since last disturbance event

Satellite datasets can provide continuous information on forest type and their carbon storage

1. **Identify** areas and Years since last disturbance event using a pan-tropical remote sensing dataset 1982-2018 (TMF) (Vancutsem et al 2021).

2. **Estimate** the Aboveground Carbon of forests derived from ESA-CCI Biomass product (100m resolution) Santoro and Cartus (2019).

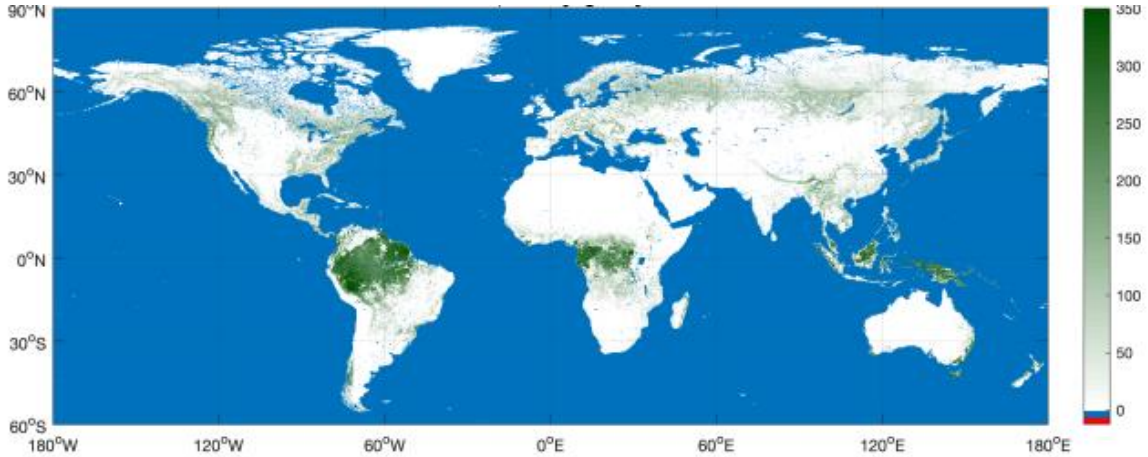
3. **Model** the carbon accumulation and carbon stock potential

Space for time substitution method:

Years since last disturbance event

3	0	3
0	0	2
0	0	1

+



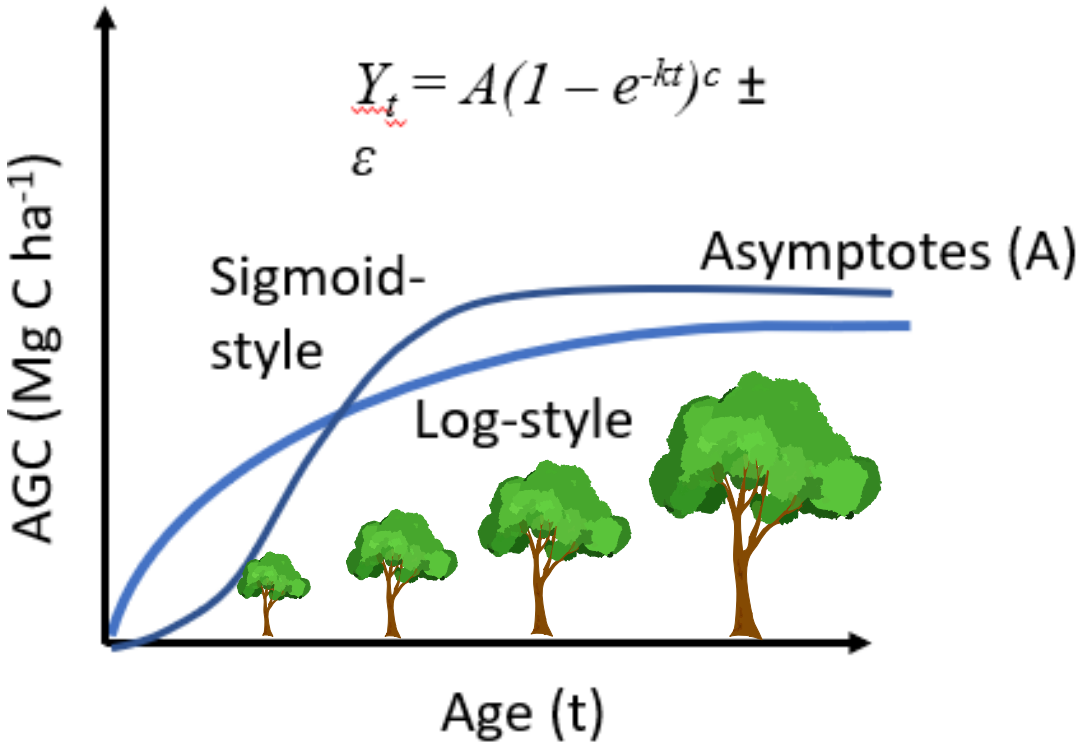
Satellite datasets can provide continuous information on forest type and their carbon storage

1. **Identify** areas and Years since last disturbance event using a pan-tropical remote sensing dataset 1982-2018 (TMF) (Vancutsem et al 2021).

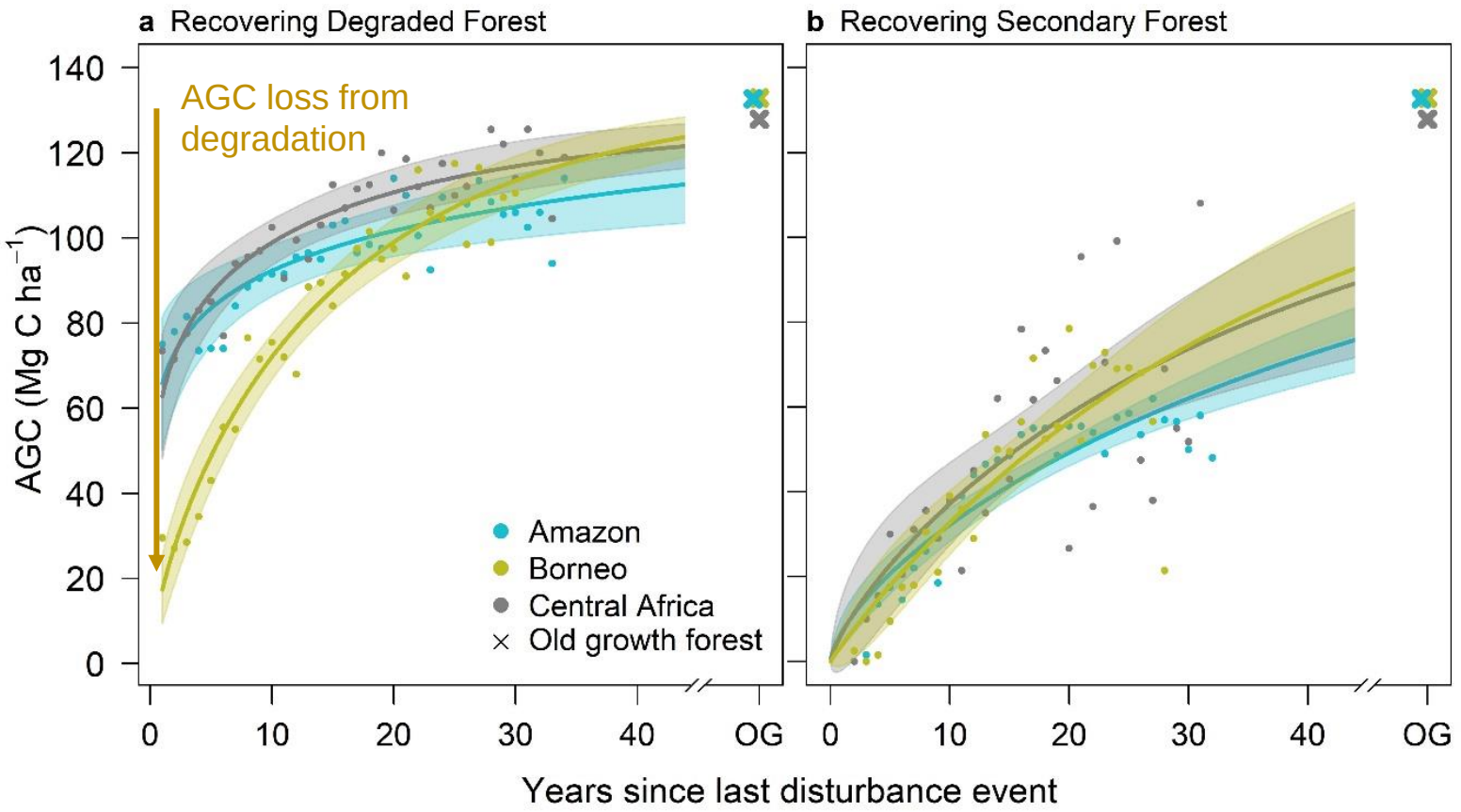
2. **Estimate** the Aboveground Carbon of forests derived from ESA-CCI Biomass product (100m resolution) Santoro and Cartus (2019).

3. **Model** the carbon accumulation and carbon stock potential

Applied the Chapman-Richard model of regrowth:



Biome wide recovery models

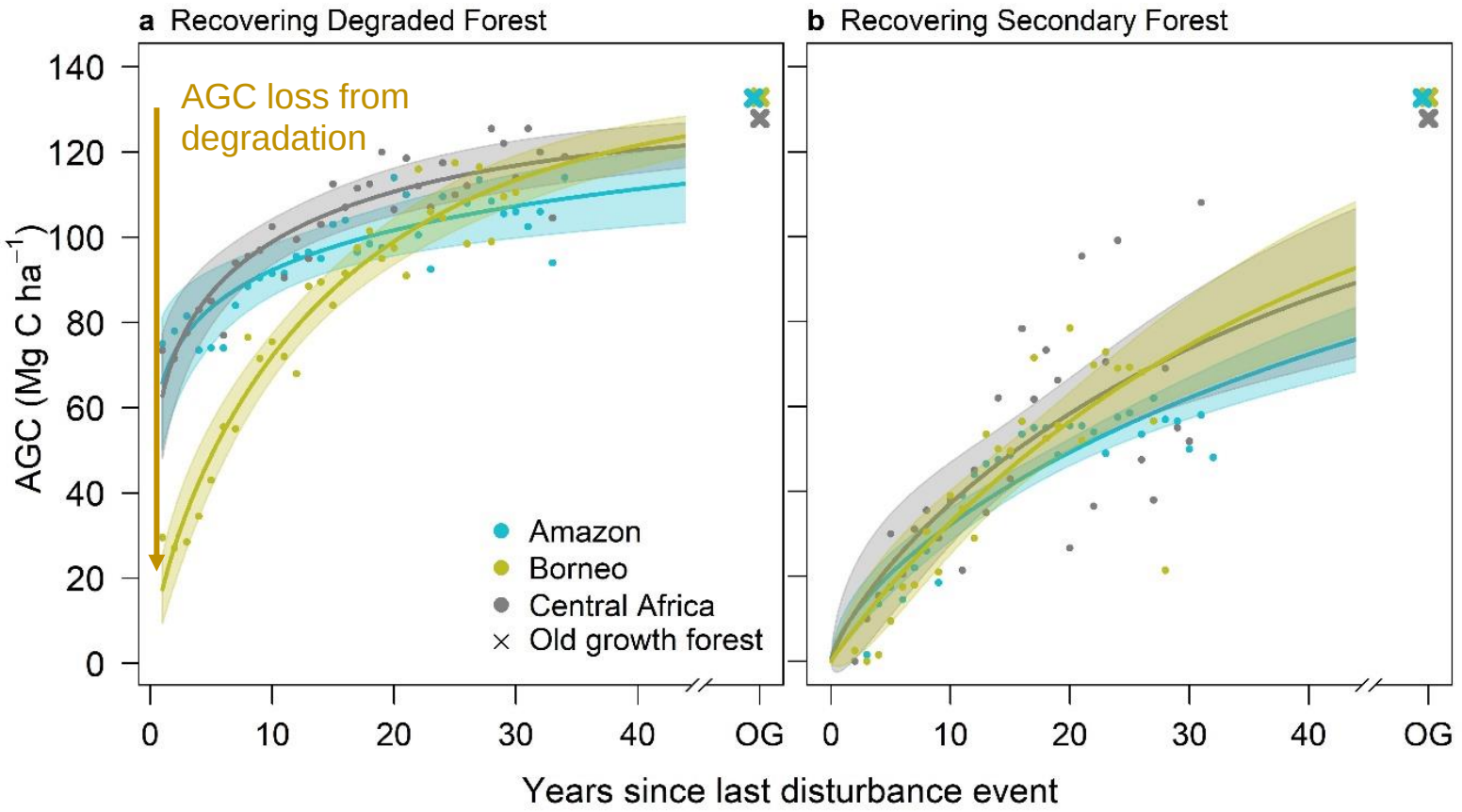


Heinrich et al. (in review)

- Borneo has highest loss of absolute carbon
  - (87% of old-growth forest AGC)

  Periodic selective logging of carbon-rich Dipterocarp tree
  - Recovery rates are also up to 60% higher in Borneo (3.95 Mg C ha^{-1} yr^{-1})
- Amazon and Central Africa are subject to frequent, lower impact disturbances and have similar patterns of recovery
  - In Amazon, degradation by fire can cause post-disturbance mortalities
  - In Central Africa, small-scale, manual forest felling impacts overall AGC identified in remote sensing product.

Biome wide recovery models



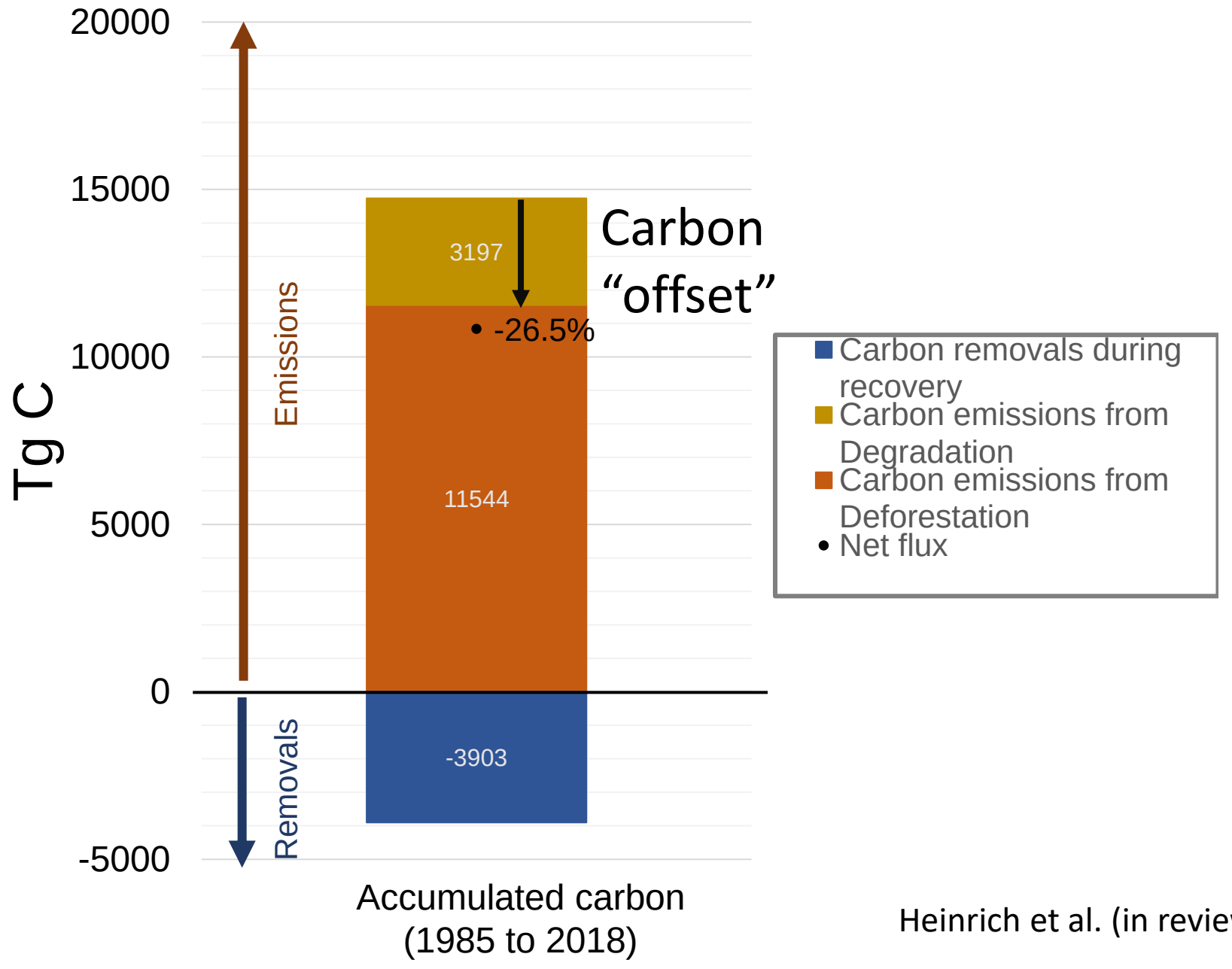
Heinrich et al. (in review)

Total accumulated carbon (1985 to 2018)

	Amazon	Borneo	Central Africa
Degraded forest recovery (1985 to 2018)	2128 TgC	745 TgC	757 TgC
Secondary forest recovery (1985 to 2018)	201 TgC	55 TgC	17 TgC

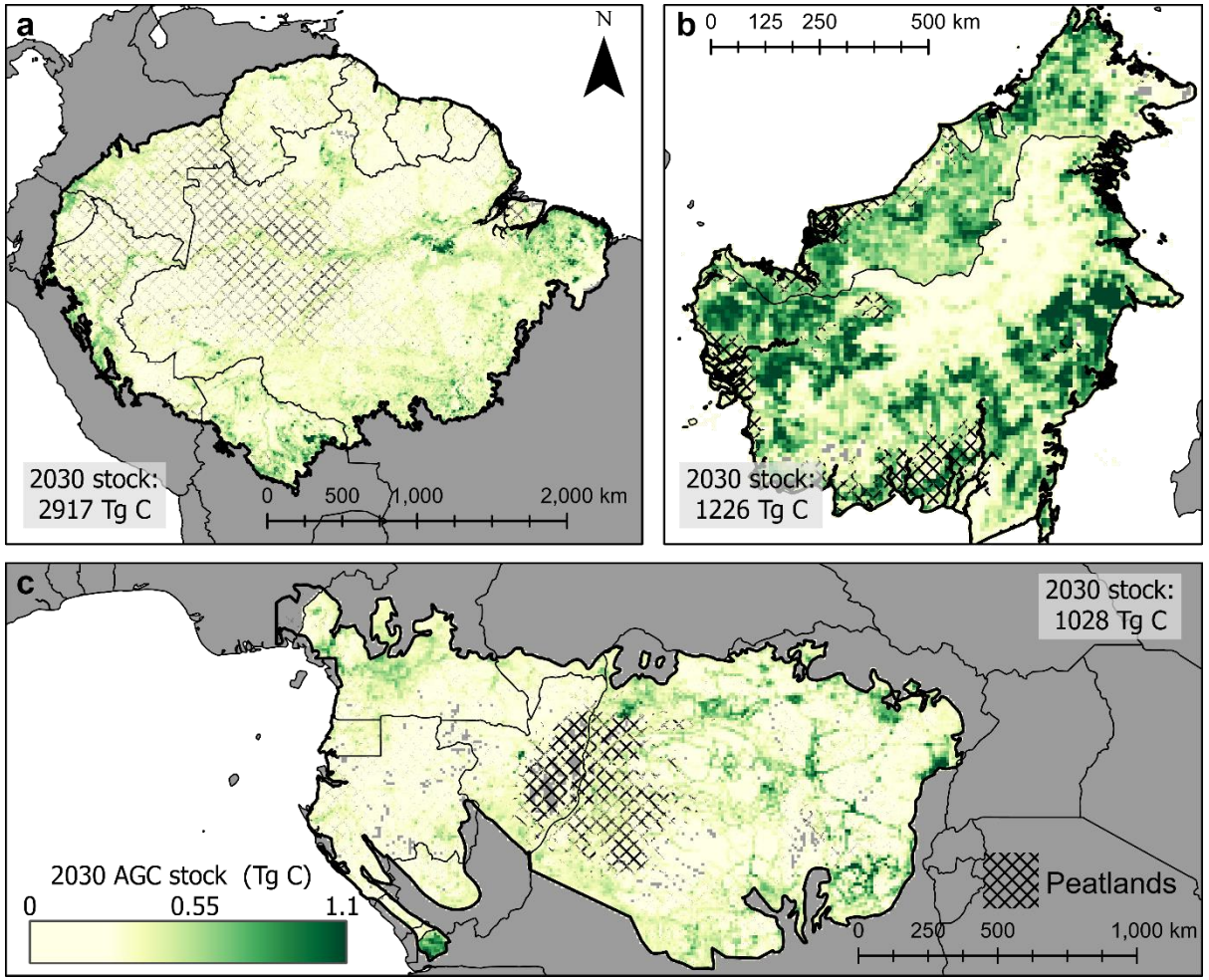
Total stored: 3903 TgC

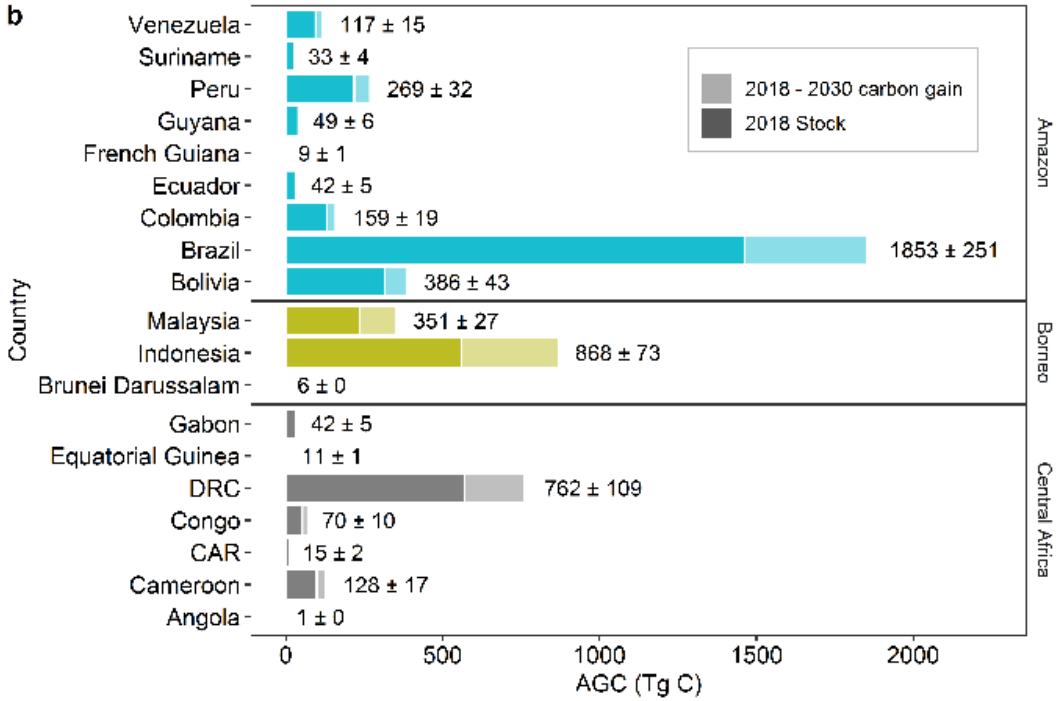
26% of total forest carbon loss was offset by recovery



Heinrich et al. (in review)

Spatial patterns of recovery up to 2030



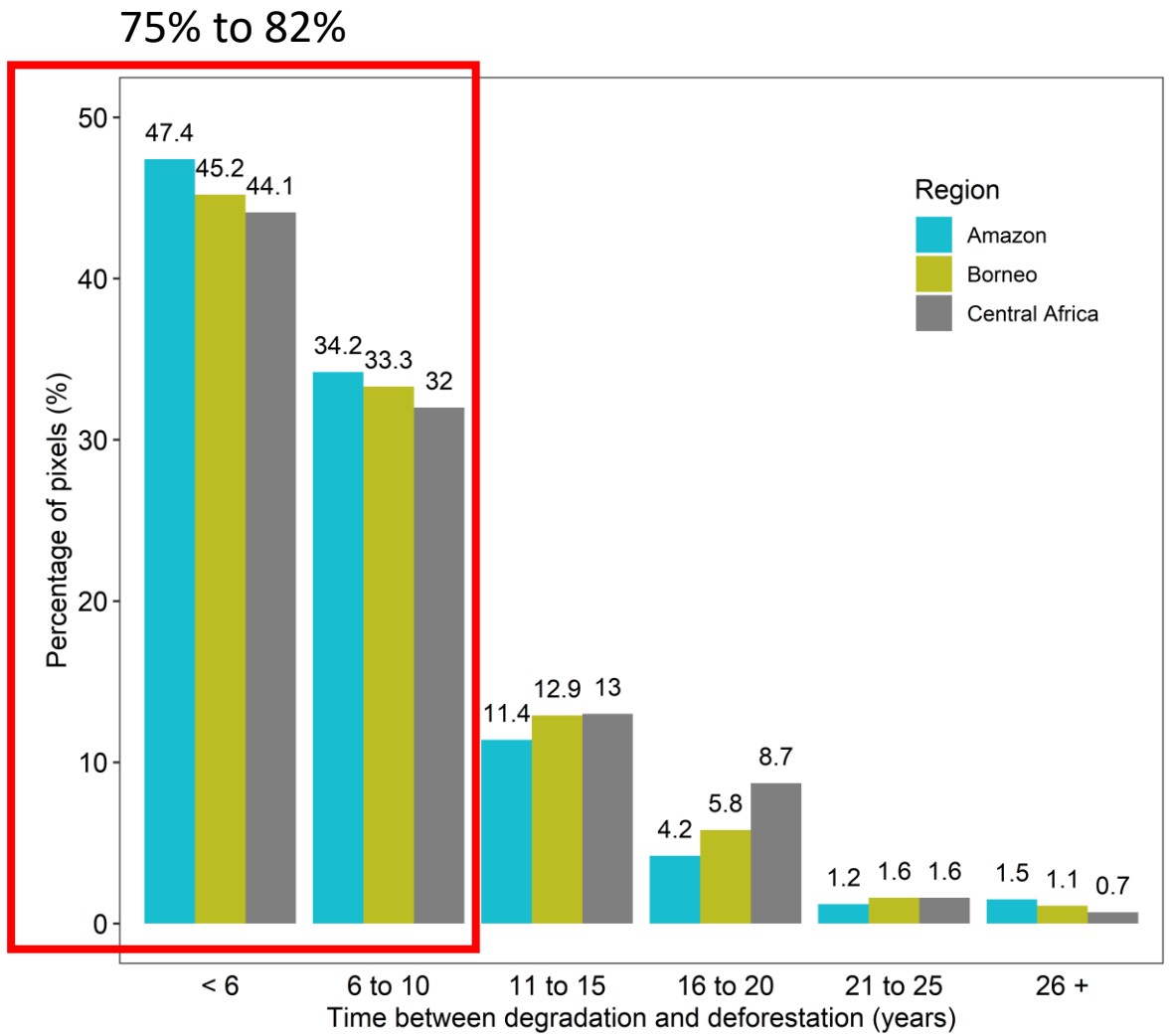


If all recovering forests standing in 2018 still stand in 2030 – their carbon stock ~ **5170 TgC**… but…

Heinrich et al. (in review)

…not all recovering forests are left to stand

- 1/3 of forests that were degraded at some point were deforested by 2018
- Mostly occurred in the first 10 years after they were initially degraded
- If only 10 year+ forests are preserved, the 2030 carbon stock of these forests is 60% lower than if all would be preserved



Heinrich et al. (in review)

We need COP26 pledge – ending forest loss by 2030 – to succeed

- Degraded and Secondary forests are important carbon sinks: (i) degraded forest → large area (ii) secondary forest → fast carbon accumulation
- Regrowth in degraded and secondary forests offset ~1/4 of carbon emission from humid tropical forest loss.
- Future stock in recovering forests would be 60% higher compared to current practices of deforesting young degraded forests.

Heinrich et al. (in review). *One quarter of humid tropical forest emissions offset during recovery.*

University of BRISTOL

Viola Heinrich
Email: viola.heinrich@bristol.ac.uk
Twitter: @vh_trees

NERC GW4+ Doctoral Training Partnership