

Exploratory analysis of Recurrent deforestation warnings in the Brazilian Amazon

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Amazon deforestation and degradation

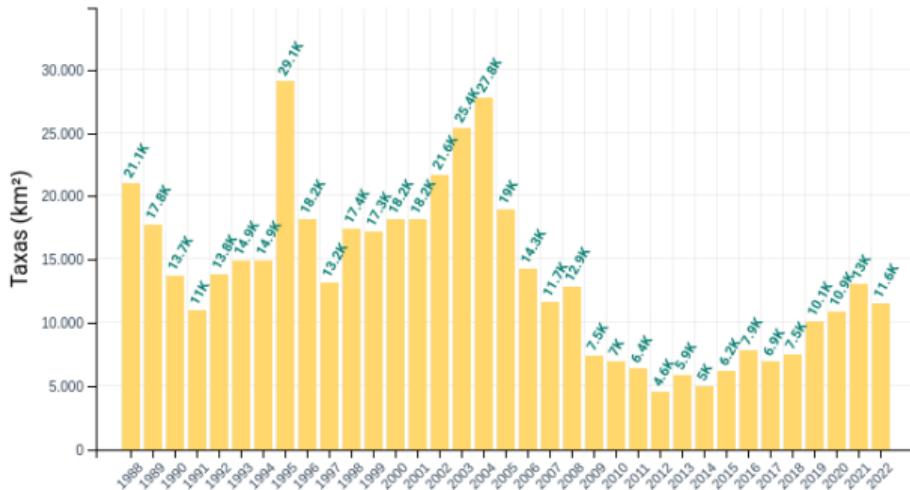
- ▶ cause warming up to 100 km away [BBBS23].
- ▶ reduce precipitation [SBS23].
- ▶ convert the forest into a savanna [FH21].
- ▶ turn the forest, a Carbon sink, into a Carbon source [GBM⁺21].
- ▶ It could flip a planetary tipping point [LRG⁺19].



Fire aftermath. Source: Globo news.

Deforestation in the Brazilian Amazon

- ▶ Current efforts are not producing the desired effect.
- ▶ 2021 had the highest deforestation rate since 2006 (13000 km²).



Deforestation in the Brazilian Amazon (km²). Source: TerraBrasilis

Brazil international commitments

- ▶ Reduce Greenhouse Gas emission 50% (respect to 2005) until 2030.
- ▶ Zero Carbon emissions by 2050.
- ▶ Zero illegal deforestation by 2028.



Brazil international commitments

- ▶ A maximum deforestation of 3925 km²/year in the Brazilian Legal Amazon, starting on 2020 (decree 9578 2018).
- ▶ This is similar to deforestation in 2012 (4571 km²).

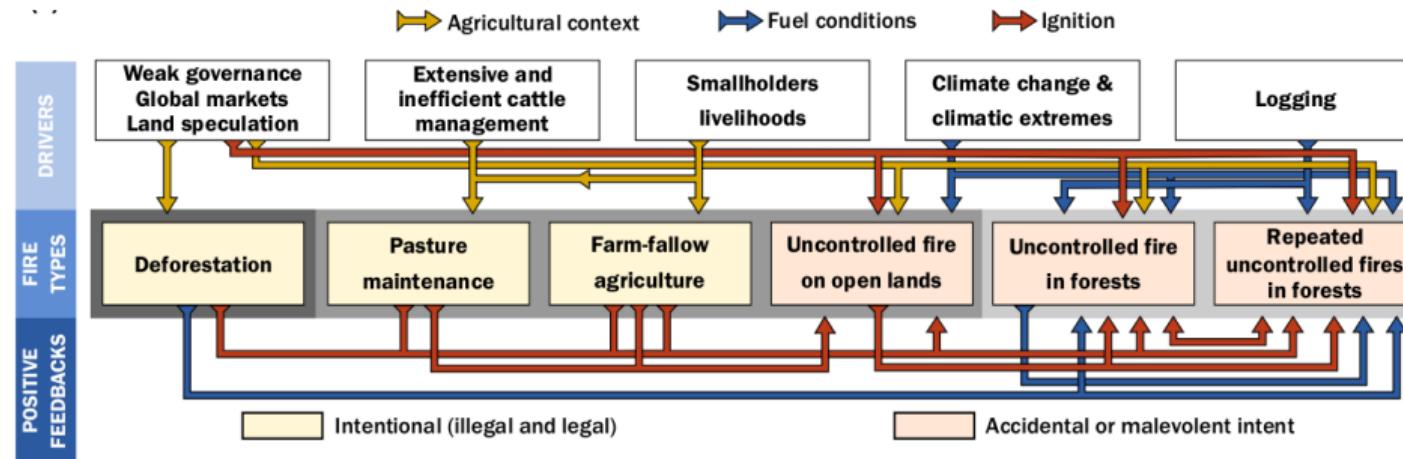
However,

- ▶ Deforestation in 2021 was 271% of this commitment.



Source: INPE

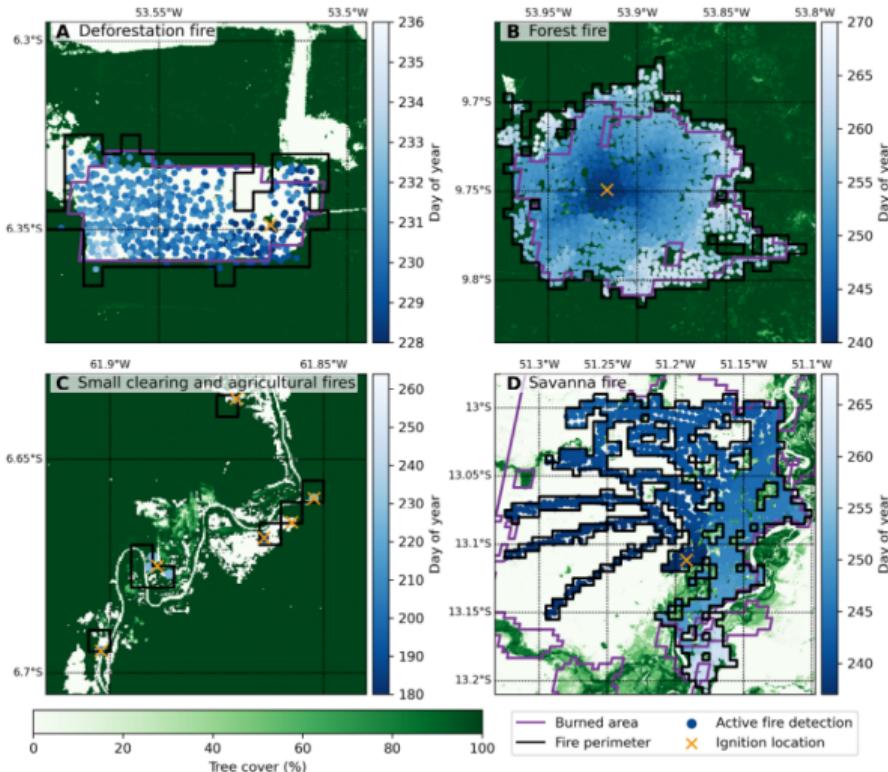
Fire in the Amazon



Overview of fire drivers, types and feedbacks. Source: [BBCF20]

Types of fire

- ▶ Deforestation fire.
- ▶ Understory forest fire.
- ▶ Clearing & Agricultural fire.
- ▶ Savanna fire.



Dominant fire types in the Amazon. Source [AMS⁺22]. ↗ ↘ ↙ ↘

Biomass burning

- ▶ plays a role in the biosphere-atmosphere interaction.
- ▶ harms the human health.
- ▶ leads to economic losses.
- ▶ contributes to climate change [TRH⁺18].



Source: INPE

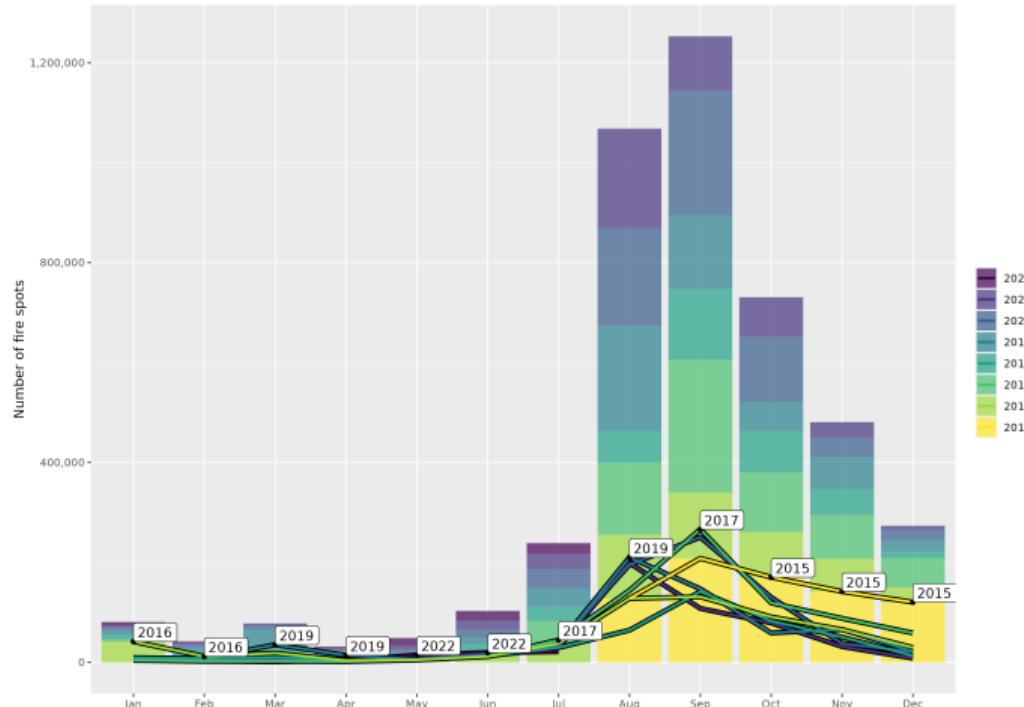
Biomass burning emissions in Brazil

- ▶ BB emissions by deforestation in the tropics account for 15% of annual emissions and are increasing (GFED 4.1s).
- ▶ 15% of the Carbon emitted from 1997 to 2019 occurred in South America (GFED 4.1s).
- ▶ 60% of the South American BB emissions occur in the Brazilian territory [SPC⁺²¹].
- ▶ Concentrated in the Amazon and Cerrado biomes.
- ▶ Mostly driven by land use and land cover change.



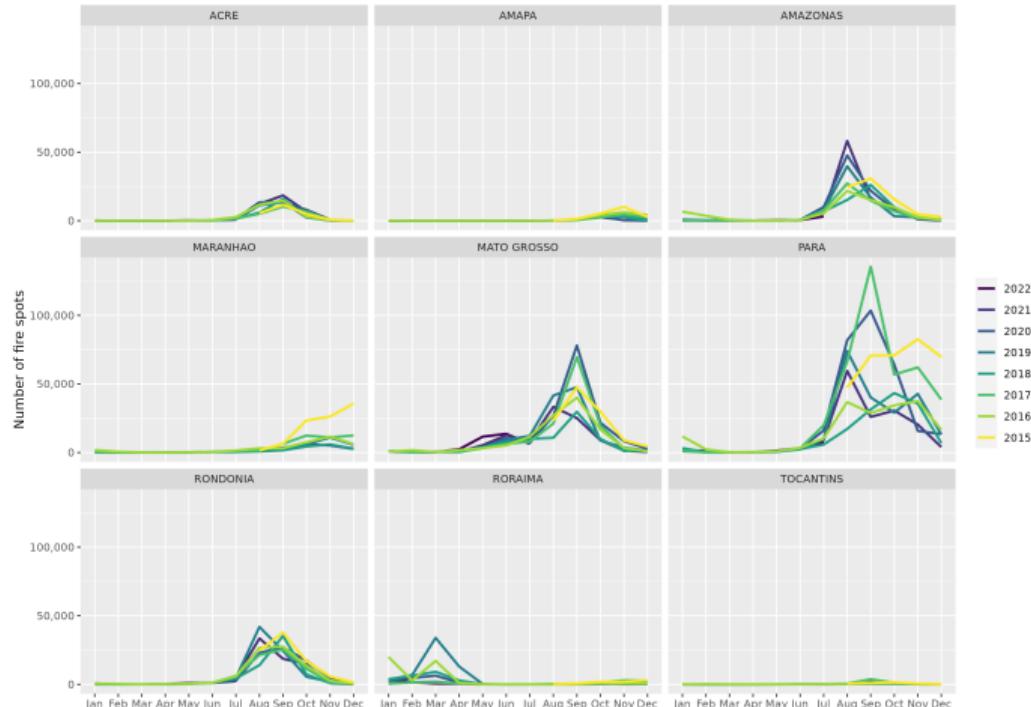
Monthly active fires detected by MODIS-Aqua in January 2022. Source: INPE

Fire spots by month (VIIRS satellite)



Aug (2019) & Sep (2017) top fire spots. Note 2015's last trimester.

Fire spots by month and state



Note the increasing trend in Amazonas and its move towards August.

INPE's information systems

- ▶ PRODES: Deforestation accounting.
- ▶ DETER: Issue deforestation warnings.
- ▶ TerraClass: Deforestation follow-up.

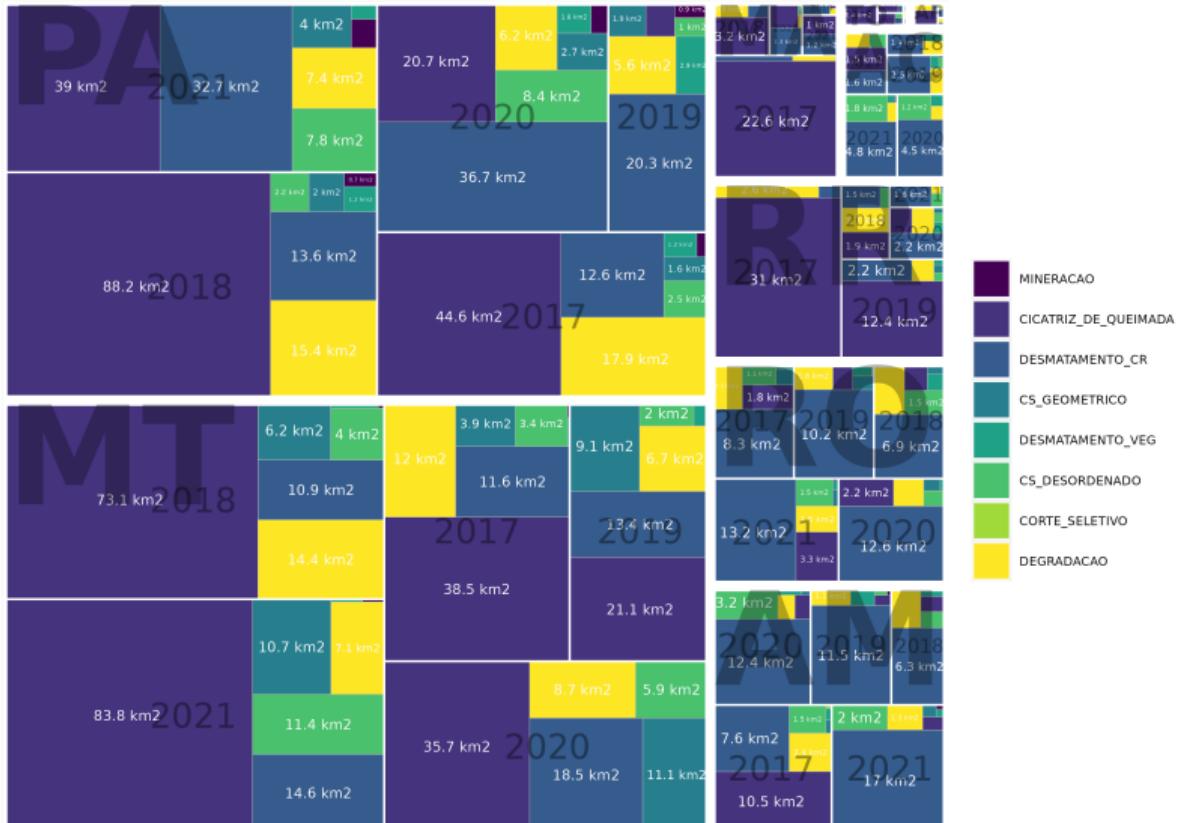


DETER

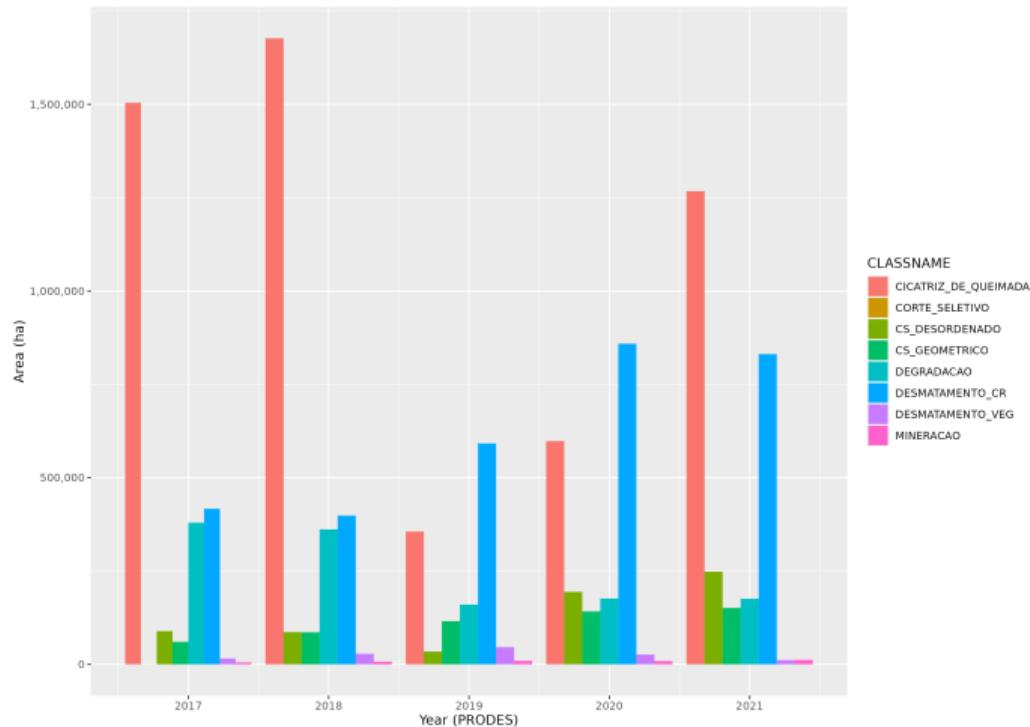
- ▶ DETER is a GIS which produces a fast assessment of deforestation and forest degradation in the Brazilian Amazon [SDA⁺06].
- ▶ DETER employs Linear Mixture Models of CBERS imagery and human experts to deter and issue warnings of deforested (or degraded) areas larger than 3 ha [DAMV⁺22].



DETER warnings

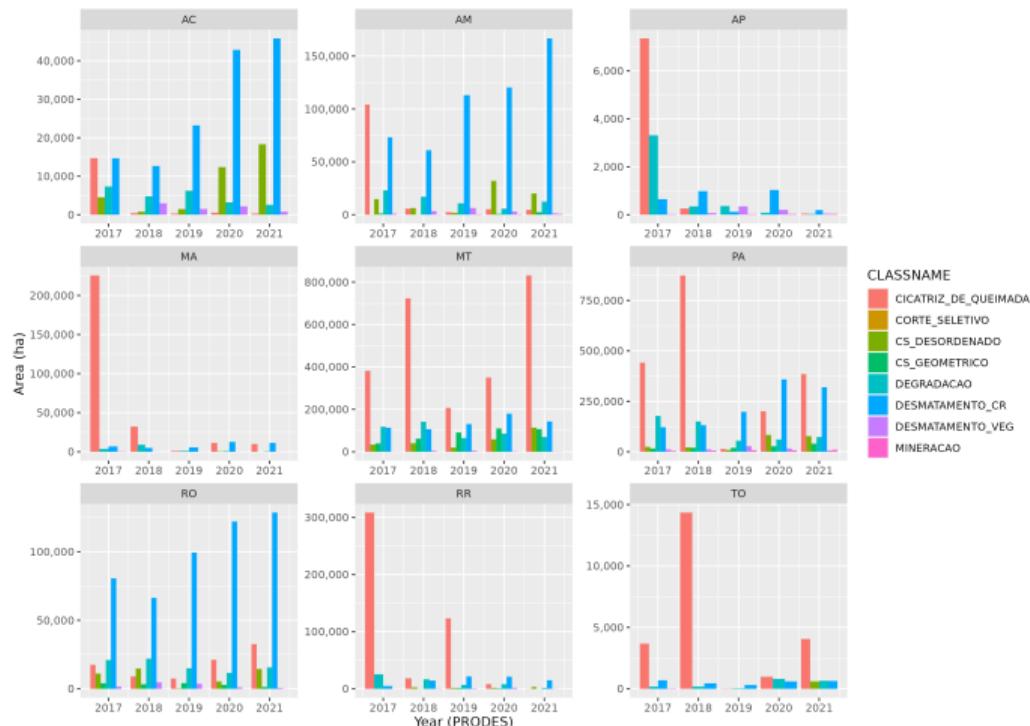


DETER warnings by class



Burn scars and clear cut are the most common warnings.

DETER warnings by class and state

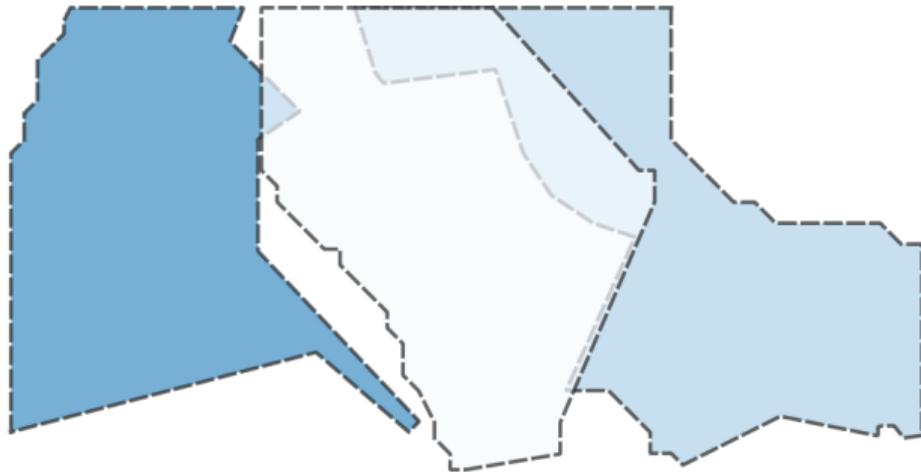


Burn scars and clear cut are the most common warnings.

DETER warnings and time

- ▶ The spatial properties of DETER warning are inconsistent along time (shape, size, position, orientation).

Warnings are inconsistent along time

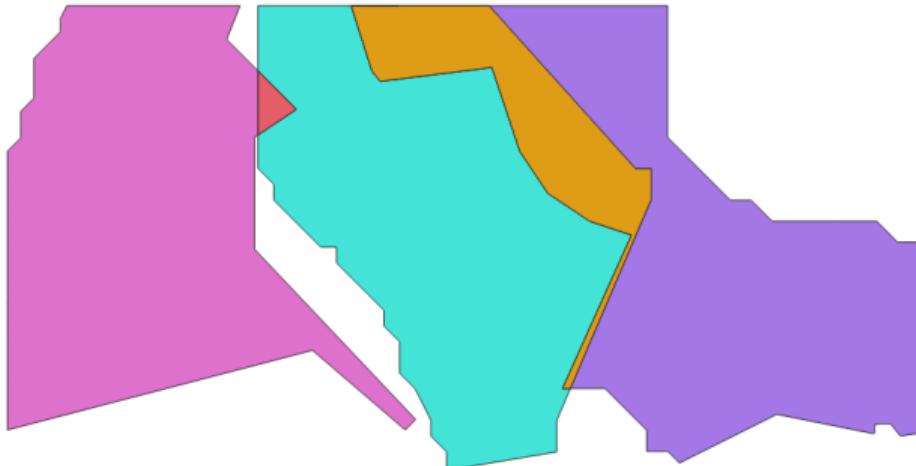


DETER warnings don't fit along time.

DETER subareas

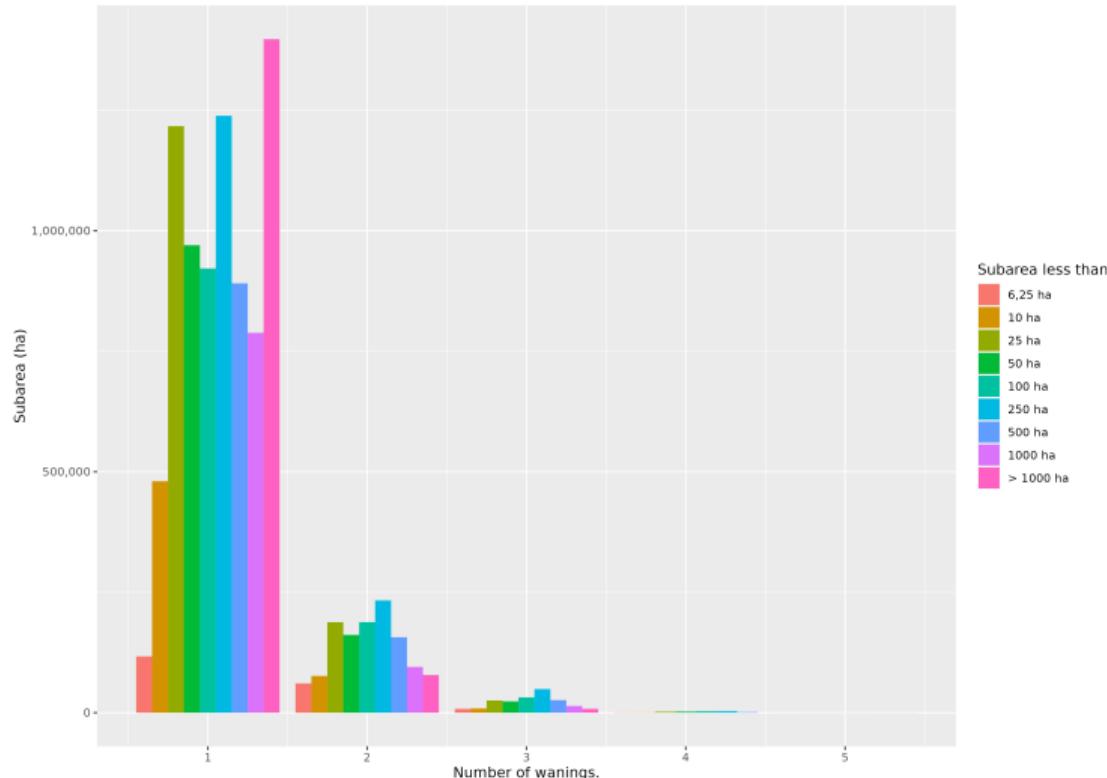
- ▶ The spatial properties of DETER warning are inconsistent along time (shape, size, position, orientation).
- ▶ DETER subareas maintain their spatial properties along time.

DETER subareas



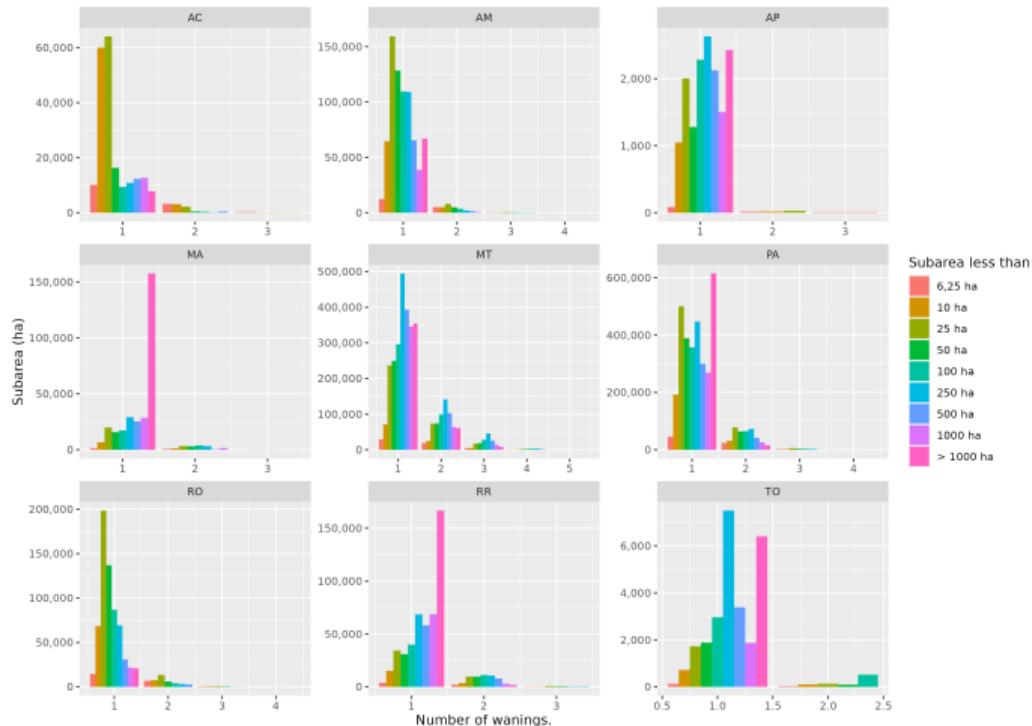
From 3 DETER warnings, we get 7 subareas!

DETER subareas



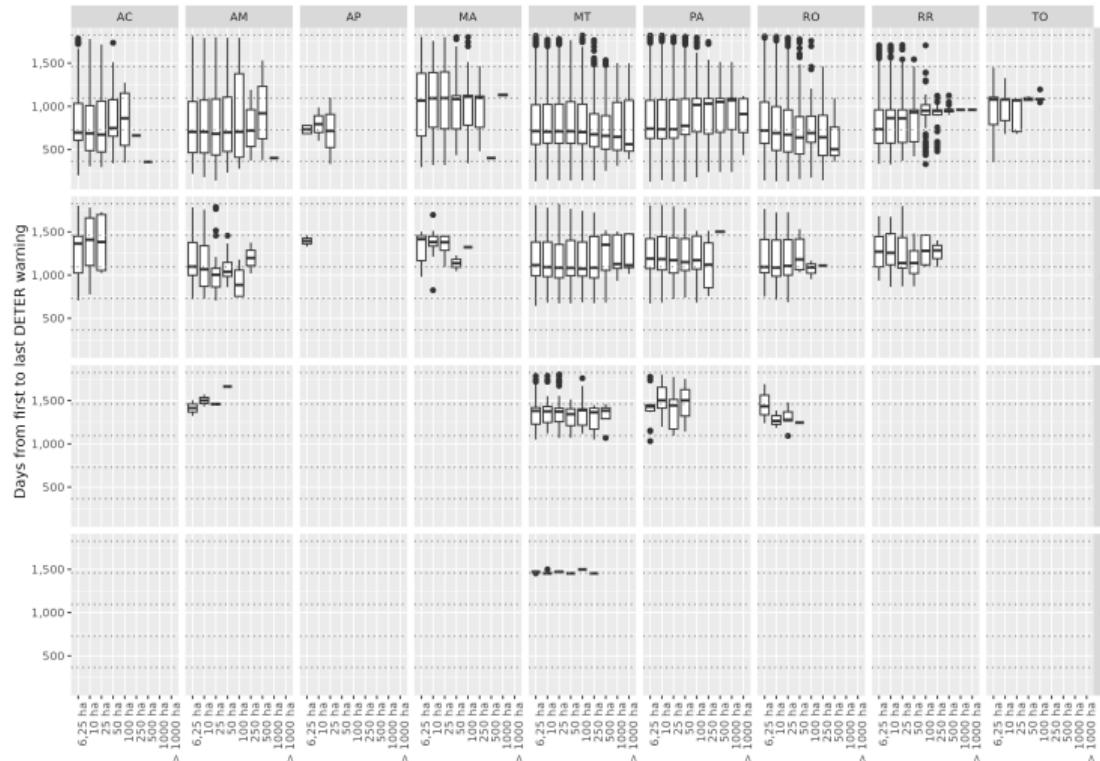
There are subareas with up to 5 recurrent warnings.

DETER subareas



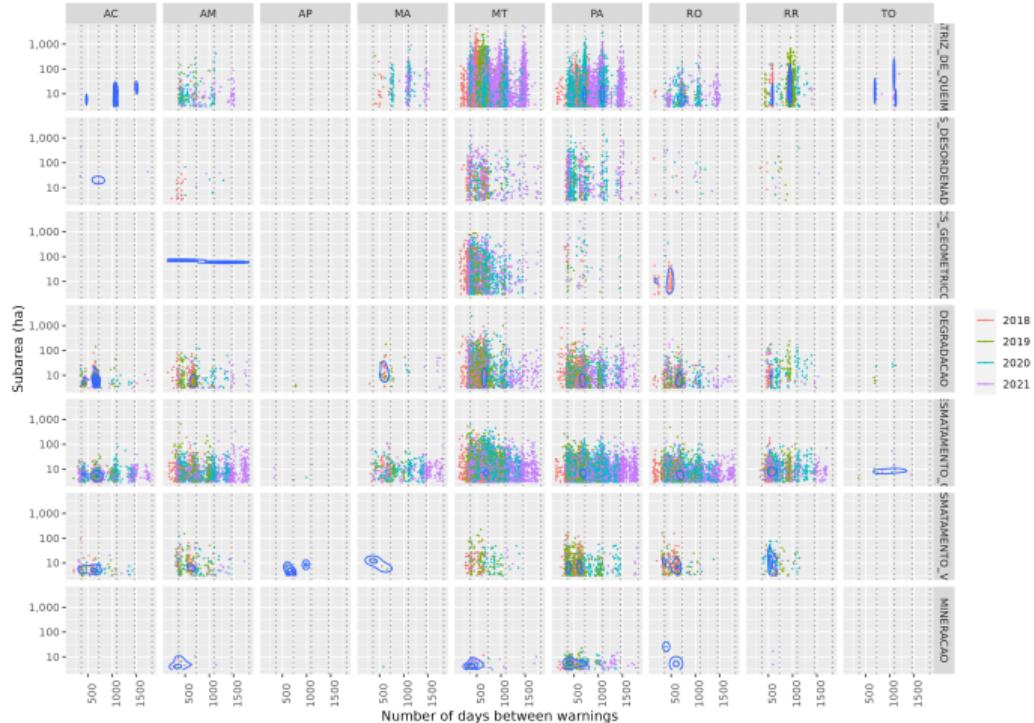
The warning recurrence changes by brazilian state.

DETER subareas



Number of days between first and last warning.

DETER subareas

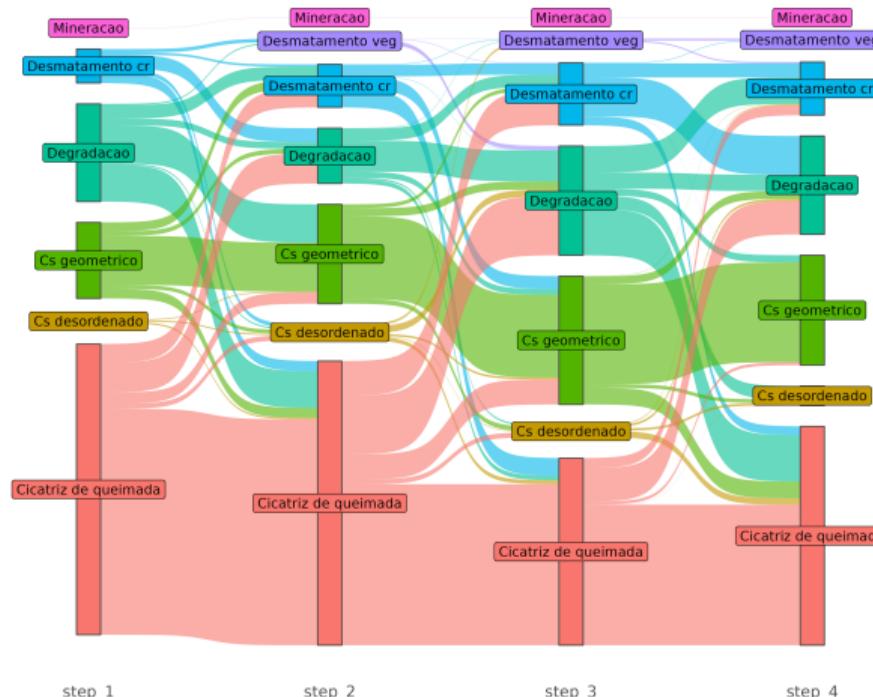


The number of days between warnings behaviour in space and time.

Subarea trajectories

- ▶ Overlaped subareas organized along time describe trajectories of change.

DETER subareas (4 warnings)



Trajectory of subareas with 4 wanings.

Take home message

- ▶ Deforestation and forest degradation threat the Amazon.
- ▶ An important portion of deforestation and degradation are due to fire.
- ▶ We need to take advantage of all available resources and search for answers to the urgent questions post by a fast changing climate.
- ▶ The analysis of DETER warnings could improve the characterization of forest degradation just by switching to a perspective that focus on the time dimension instead of the spatial dimensions.
- ▶ R code available at <https://github.com/albhasan/treesburnareas>

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