Geospatial forest patterns in Northwestern Amazon forests affected by wind disturbances

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Max Planck Institute for Biogeochemistry

IMPRS gBGC International Max Planck Research School for Global Biogeochemical Cycles

UNAP

BERKELEY LAB Lawrence Berkeley National Laboratory

FRIEDRICH-SCHILLER-UNIVERSITÄT JENA

DAAD Deutscher Akademischer Austauschdienst German Academic Exchange Service

BACKGROUND

- An important driver of tree mortality in Amazonia are strong descending winds (downbursts) produced by convective storms (1-3) that create gaps of uprooted or broken trees (windthrows) (4), producing variation in floristic composition, structural and architectural attributes (5-8). The geographic distributions of windthrows agrees with the pattern of rainfall, with the highest rainfall amounts found in Northwestern Amazonia (9, 10). An interesting detail emerging from these studies is that we don't know about the spatial forests patters in the Northwestern Amazon after wind disturbances than and how this differences in responses/resilience and recovery area moderated by vegetation structure, composition (5-7) (11-12,19,22-24), geospatial landscape attributes, and ecosystem processes (12, 13) including regional patterns of productivity, and biomass storage (14-18).
- To study the mechanisms driving the differences in forest recovery and composition in the Amazon we will use observed and remote sensing data on disturbance and recovery encompassing a chronosequence of 20 years.

- **This study expands the knowledge on how Amazon forests respond in structure and composition to extreme wind disturbances and how resilient they are to processes/events resulting from climate change.**

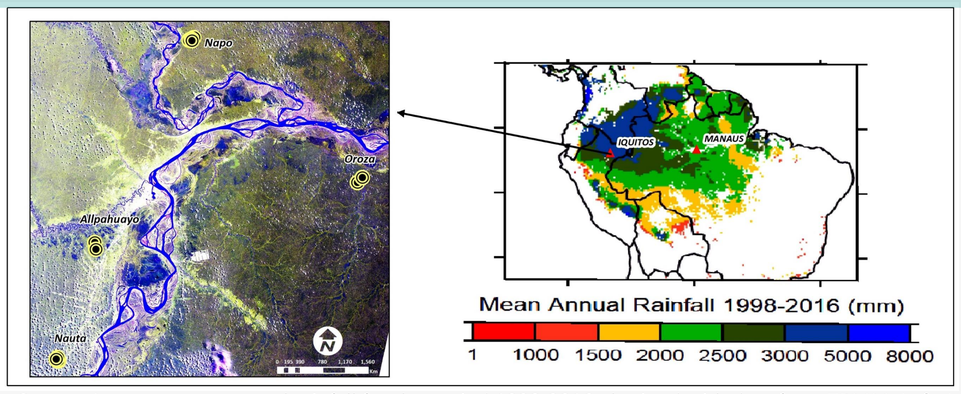


Figure 1 Project Location. Center: Amazon mean annual rainfall for the period 1998-2016 obtained with data from TRMM. Left: Location plots around Iquitos-Perú (NASA - Project 08-BIODIV-10. Dots indicate the location of the 3ha plots.

AIMS

- To assess the spatial distribution of windthrow tree mortality in the North western Amazon
- To test the effects of wind disturbances on the spatial variability of height/diameter relationships
- To test the effects of the relative slope position of trees as a moderator of windthrow tree mortality
- To determine how windthrow tree-mortality affect forest structure and species composition

METHODS

- Each tree in each of the plots are in a geographic coordinate, calculated by geometry using just one GPS point to reduce the error in the position and combined with rangefinder field measure.
- Mortality was calculate using Landsat time series to estimate ΔNPV by Google earth engine. This method was developed and validated in previous studies (2,5-10,16,21-23).
- Relative slope position and others topography indexes was calculated from digital elevation model - DEM (ALOS PALSAR 12m of spatial resolution) by R-QGIS(26-27)
- Using a combination of Geocomputation techniques (QGIS, R & Google Earth Engine)(24-27) the spatial data for mortality and topography was extracted and correlated to each tree and subplot.

RESULTS

Research Question:

how do landscape attributes and their interactions with windthrow tree-mortality affect forest structure and species composition?

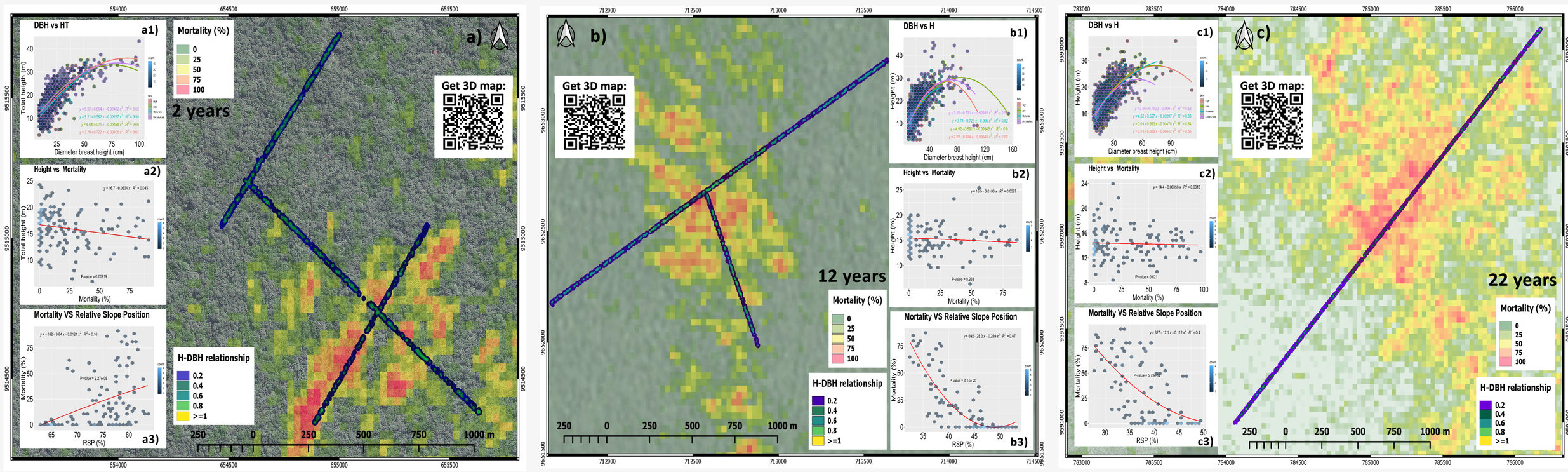
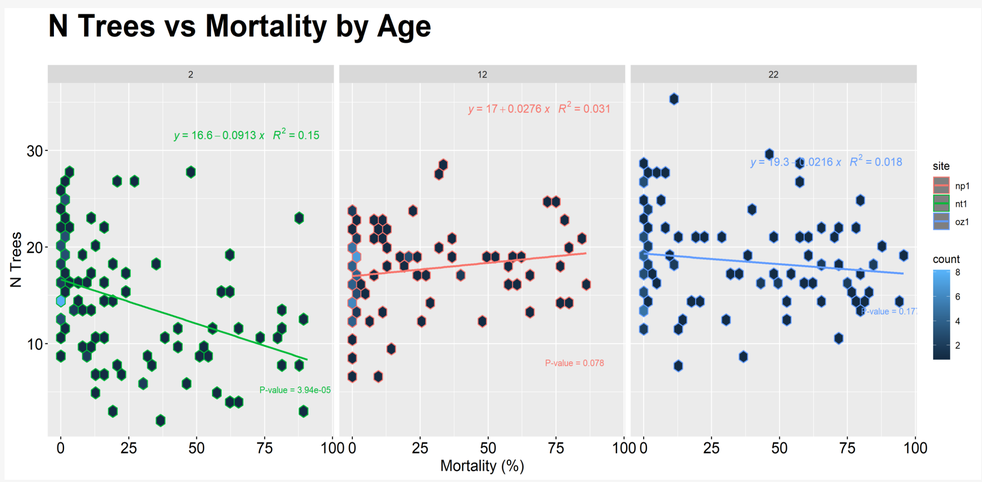


Figure 2. Spatial height - diameter relationship and Mortality Distribution. a) Nauta plot - 2 years after the event, b) Napo Pot – 12 years after de event, c) Oroza plot – 22 years after de event.

a) , b), c): Spatial distribution of H-DBH relationship. a1), b1), c1): Height and diameter relationship across the windthrow severity. a2), b1) c1): Average height by subplot across tree mortality. a3), b3), c3): Relationship between RSP and tree mortality.



Structural Change

- In the fig. a2), LM showing a reduction average of ~4m height by subplot the mortality is in the most higher value, after 12 and 22 years from the disturbance these are a not significant (fig. b2 and c2).
- LM on fig 3 show how the amount of trees have significant reduction (max. ~8 trees are lost) across mortality gradient. In the next years are not significant. In the same context the figure 4, show a significant reduction of volume estimation (~0.5m³) in the just in the first years after disturbance.

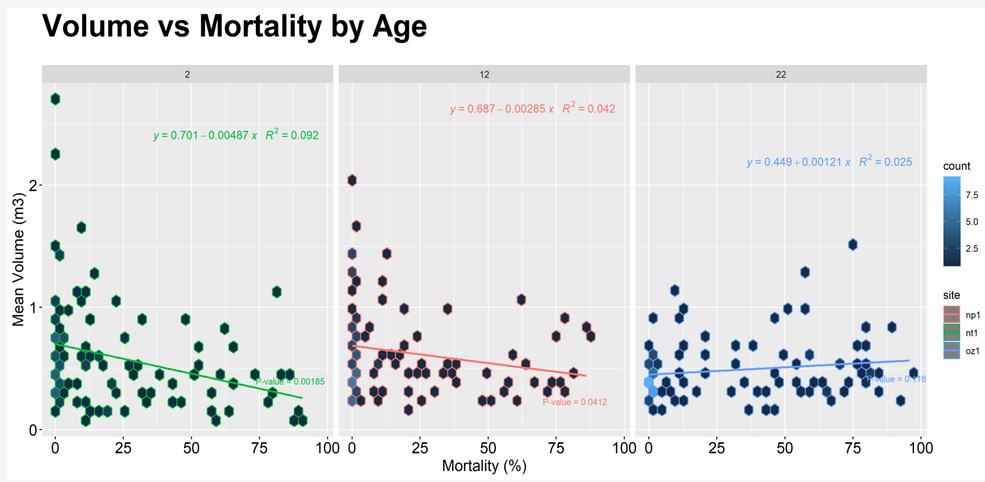
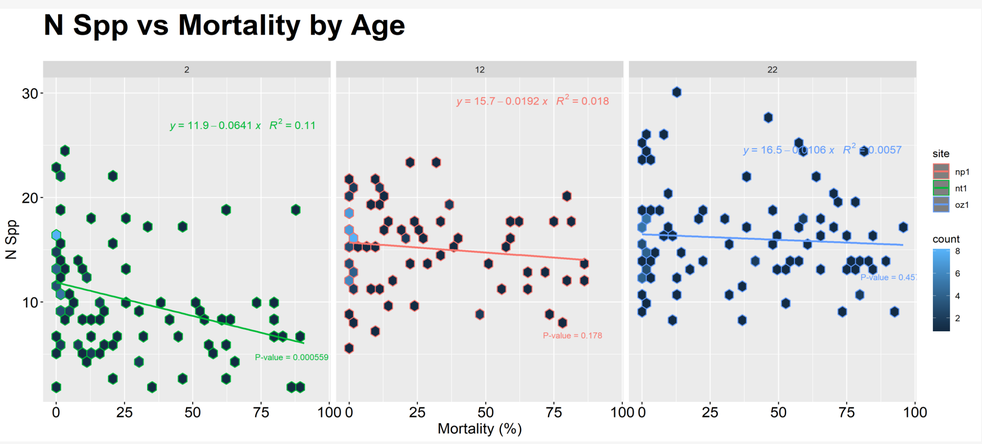


Figure 3. Variation of amount trees

Figure 4. Variation of Volume estimations



Composition Change

- Fig. 4, LM showing a reduction of ~5 spp when the mortality is in the most higher value, after 12 and 22 years from the disturbance these are a not significant.
- The fig. 5 show how some pioneer spp like Cecropias appear 12 years after the disturbance and even are the most dominant spp. And how species of genus *Eschweilera*, *Virola,* are resilient in time and dominance.

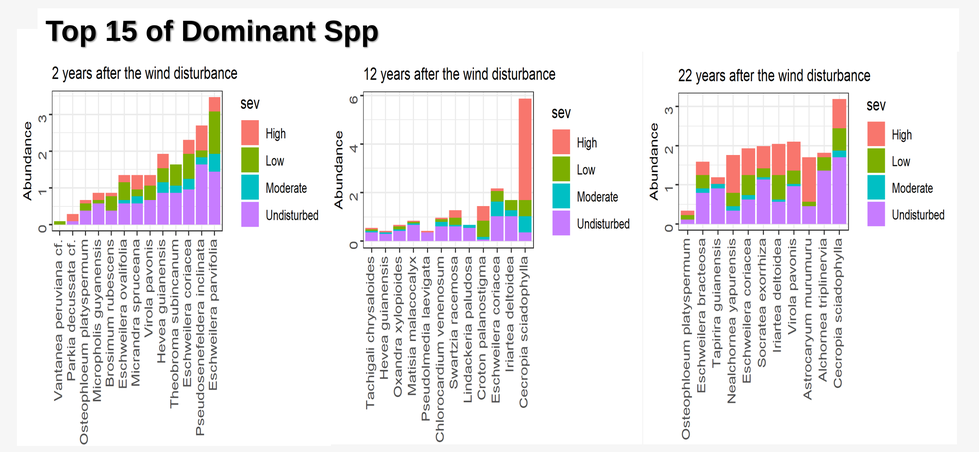


Figure 5. Variation of amount of Spp

Figure 5. Forest composition Change

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