**(Esquivel-Muelbert et al., 2018)⁠ - Compositional response of Amazon forests to climate change**

**argumentos:**

**-** Changes in biodiversity attributed to climate change have already been documented in a wide variety of ecosystems (e.g. Bowler et al., 2017; Chen et al., 2009), including in some tropical locations, but so far there is remarkably little evidence of widespread impacts of cli- mate change on the composition of tropical ecosystems which har- bour much of the planet's diversity (Duque, Stevenson, & Feeley, 2015; Fauset et al., 2012; Van Der Sande et al., 2016).

- if sufficient high‐quality, long‐term floristic moni- toring is available, then the approach of analysing shifts in a suite of functional traits to describe how communities change over time can be used to link floristic changes to their drivers (McGill, Enquist, Weiher, & Westoby, 2006; Violle, Reich, Pacala, Enquist, & Kattge, 2014).

-Most notably, with more extended or intense periods of soil water deficit, large trees and those with low wood density may be at greatest risk of hydraulic failure due to cavitation (McDowell & Allen, 2015; Rowland et al., 2015). Large trees have been shown to be particularly affected by artificially‐imposed drought (McDowell & Allen, 2015; Nepstad, Tohver, Ray, Moutinho, & Cardinot, 2007; Rowland et al., 2015) and drought events (Bennett, Mcdowell, Allen, & Anderson‐Teixeira, 2015; Phillips et al., 2010). On the other hand, several observations from tropical forests show a decline of small understory taxa associated with increases in soil water deficit (e.g. Condit, Hubbell, & Foster, 1996; Enquist & Enquist, 2011; Fauset et al., 2012; Feeley, Davies, Perez, Hubbell, & Foster, 2011).

-The spatial distribution of tree taxa over precipitation gradi- ents has been shown to provide a valuable proxy for drought tolerance in observational studies and experiments (Engelbrecht et al., 2007; Esquivel‐Muelbert, Galbraith, et al., 2017). If drought is increasingly affecting Amazonian forests, we might therefore expect concerted shifts in tree communities towards more dry‐affiliated components. A compositional shift towards more dry‐tolerant taxa as a consequence of an increase in moisture stress has been reported locally for sites in southern Ghana (Fauset et al., 2012), Central America (Enquist & Enquist, 2011; Feeley, Davies, et al., 2011), and parts of the Amazon (Butt et al., 2014)

-Based on predictions from plant physiology supported by experimental studies, we expect increases in dry season duration or intensity to shift floristic compo- sition towards dry affiliated and smaller‐statured genera with high wood density (McDowell & Allen, 2015; Rowland et al., 2015).

**objetivo:** investigate whether the floristic and functional composition of intact lowland Amazonian forests have been changing in response to different environmental drivers (increase in moisture stress and atmospheric CO2 concentrations)

**método:**

**-**evaluating records from 106 long term inventory plots spanning 30 years

-traits:maximum tree size, biogeographic water deficit affiliation and wood density

-we examine trends in abundance for individual genera, which allows us to understand which taxa dominate the changes in functional composition.

-We describe Amazonian tree genera in terms of the three basic traits to represent largely independent axes of funda- mental plant characteristics and each potentially responsive to environmental change

-The diversity of Amazonian flora hinders us from performing

consistent species‐level analyses as comprehensive trait data are still missing for the large majority of Amazonian tree species. Therefore, our analyses were performed at the genus level, and the mean trait value of the genus was assigned to each individual.

-Then, to obtain a census‐level value for each of the three traits,

we scaled the genus‐level traits to the community level by calculat- ing the community‐weighted mean (CWM sensu Diaz et al., 2007) for each trait in each census. For each of the 743 censuses across 106 plots, the CWM of each of these components was calculated as the mean trait value across the genera of the community, weighted by (a) the number of stems; and (b) the total basal area occupied by each genus.

**resultados:**

- Tree communities have become increasingly dominated by large statured taxa

- but to date there has been no detectable change in mean wood density or water deficit affiliation at the community level, despite most forest plots having experienced an intensification of the dry season

-However, among newly recruited trees, dry affiliated genera have become more abundant, while the mortality of wet affiliated genera has increased in those plots where the dry season has intensified most.

-Thus, a slow shift to a more dry affiliated Amazonia is underway, with changes in compositional dynamics (recruits and mortality) consistent with climate change drivers, but yet to signifi- cantly impact whole community composition.

-Here we report the first Amazon wide analyses of temporal trends in functional and floristic composition of lowland tree communities across 106 Amazonian inventory plots analysed over three decades.

**(Esquivel-Muelbert et al., 2017)⁠ - Biogeographic distributions of neotropical trees reflect their directly measured drought tolerances**

**argumentos:**

-In the tropics, water availability is a leading driver of the diversity and distribution of tree species, suggesting that many tropical taxa may be physiologically incapable of tolerating dry conditions, and that their distributions along moisture gradients can be used to predict their drought tolerance.

-The future composition and structure of tropical forests may be substantially altered by periods of high mois- ture stress, such as droughts. Well-known macroecological diversity patterns of tropical trees and lianas strongly suggest that water supply, particularly the length and severity of the dry season, is a major constraint on plant survivorship: woody plant diversity is greatest where seasonal moisture deficits are lowest1, 2. This implies that many tropical woody taxa are ultimately limited by physiological constraints related to water supply, and that the distribution of individual taxa over biogeographical gradients of moisture availability could predict their vulnera- bility to droughts.

-Given the predictions of drier conditions, better delimitation of the drought vulnerability of different tree taxa would improve our understanding of how tropical forest communities will respond to future changes in climate.

**Objetivo:**

-Here we investigate the relationship between the large-scale bioclimatic distribution of genera and their tol-

erance to droughts at different life-history stages. We use information on water deficit affiliation (WDA) from ref. 39, which quantifies the affiliations of genera to different precipitation conditions across a wide precipitation gradient (500–3500 mm y−1).

**método:**

-To quantify drought tolerance, we assessed five drought events, both experimental and natural, spanning different life-history stages and distinct regions within the Neotropics (Table 1). These include two through-fall exclusion (TFE) experiments conducted in the Brazilian Amazon, at (1) Tapajós40 and (2) Caxiuanã41, (3) one observational study conducted over the 1982 drought in a 50 ha tree inventory plot on Barro Colorado Island in Panama17, hereafter referred to as BCI, and the results from two shade house experi- ments testing drought sensitivity on transplanted seedlings, in (4) Panama4 and (5) Bolivia12.

-our approach was to examine responses, to the extent possible, across all genera, combining available experimental and observational data on drought-induced mortality. We hypothesize that biogeographically wet-affiliated neotropical tree genera will prove to be more sensitive to drought conditions. We predict that drought-related traits should be more important for trees in their adult phase; thus, dry-affiliated genera should have a greater advantage as adults than as seedling and saplings.

**resultados:**

-Across the different experiments, genera affiliated to wetter climatic regimes show higher drought-induced mortality than dry-affiliated ones, even after controlling for phylogenetic relationships.

-Overall, our analysis of experimental, observational, and bioclimatic data across neotropical forests suggests that increasing moisture-stress is indeed likely to drive significant changes in floristic composition.

-Overall, the water deficit affiliations (WDA) of neotropical tree genera, which display more strongly negative values for genera that occur in drier conditions, are significantly associated with their tolerances to drought.

-Our results allowed us to identify the vulnerability of particular taxa. Drought-mortality was greater than base-

line mortality across more than one experiment for 22 of the 51 genera that occur in at least two different studies (Supplementary Table S5). Among these vulnerable genera, we highlight Inga and Hymenaea (Leguminosae), Pouteria (Sapotaceae), Casearia (Salicaceae), Guarea (Meliaceae), Virola (Myristicaceae), Licaria (Lauraceae) and Eschweilera (Lecythidaceae). Only five genera (Capparidastrum [Capparaceae], Faramea [Rubiaceae], Garcinia [Clusiaceae], Socratea [Arecaceae] and Miconia [Melastomataceae]) were consistently resistant, with drought treatment mortality rates lower than or equal to the baseline mortality.

-Consequently, our findings suggest that traits related to resistance to hydraulic failure - such as wood density, vessel size and vessel density56, 57 and the capacity to close stomata during dry periods16, 42, 55, 58 - may provide a greater relative advantage in adult trees exposed to high vapour pressure deficits.

-Our results suggest that a reassembly of Amazonian tree communities is likely to take place under drier climate conditions, just as has occurred recently in parts of West Africa23 where dry-affiliated genera have increased in abundance.

**(Nepstad, Tohver, Ray, Moutinho, & Cardinot, 2007) - MORTALITY OF LARGE TREES AND LIANAS FOLLOWING EXPERIMENTAL DROUGHT IN AN AMAZON FOREST**

⁠

**argumentos:**

**-**One of the most important forest responses to severe drought is tree mortality, which alters forest structure, composition, carbon content, and flammability, and which varies widely.

-One explanation for the considerable variation in response of tree mortality to severe drought episodes may be the effects of the drought on the amount of soil water that is available to plants at each site (plant- available soil water, PAW), and the ability of different plant types to access this soil water. None

**Objetivos:**

-This study tests the hypothesis that tree mortality increases abruptly during drought episodes when plant-available soil water (PAW) declines below a critical minimum threshold. It also examines the effect of tree size, plant life form (palm, liana, tree) and potential canopy position (understory, midcanopy, overstory) on drought-induced plant mortality.

**Métodos:**

**-**A severe, four-year drought episode was simulated by excluding 60% of incoming throughfall during each wet season using plastic panels installed in the understory of a 1-ha forest treatment plot, while a 1-ha control plot received normal rainfall.

-We completed an initial survey of stems ?1 cm dbh in

March 2000, including identification to species and measurement of diameter at breast height (dbh ¼ 1.3 m).

**Resultados**

- After 3.2 years, the treatment resulted in a 38% increase in mortality rates across all stems .2 cm dbh. Mortality rates increased 4.5-fold among large trees (.30 cm dbh) and twofold among medium trees (10–30 cm dbh) in response to the treatment, whereas the smallest stems were less responsive.

-Overall, lianas proved more susceptible to drought-induced mortality than trees or palms, and potential overstory tree species were more vulnerable than midcanopy and understory species.

(Aguirre-Gutiérrez et al., 2019)⁠ - **Drier tropical forests are susceptible to functional changes in response to a long-term drought**

**argumentos:**

- Climatic changes have profound effects on the distribution of biodiversity, but untangling the links between climatic change and ecosystem functioning is challenging, particularly in high diver- sity systems such as tropical forests.

-Trait-based approaches provide an opportunity to link func- tional composition, ecosystem function and environmental changes.

-methodological and data availability constraints hamper our ability to monitor both the distributions of spe- cies and ecosystem responses to climate change (Cayuela et al. 2009). These challenges are especially acute in high biodiversity areas such as the tropics (Malhi et al. 2014), for which there is not only greater uncertainty concerning the effects of climate on biodiversity, but also about current species distributions and their taxonomic identity (Cardoso et al. 2017).

-Notably, it is possible that wetter tropical forests, that is those with intrinsically lower water deficits, may be either more sensitive or more resistant to climatic changes than tropical forest found in drier environments (Allen et al. 2017).

-if com- munities respond to temporal environmental changes by shifting their species abundances and trait distributions towards more suitable ranges (Fauset et al. 2012), new domi- nant trait combinations may arise in the community.

-Changes in the community functional trait composition may also imply changes in key aspects of ecosystem functioning such as nutri- ent, carbon and water cycling. Therefore, understanding past and current responses of community-level traits has the poten- tial to provide valuable insights into tropical forest resilience against environmental changes and offer a promising avenue for a better understanding of ecosystem functioning (Madani et al. 2018).

-In addition to the challenges associated with monitoring responses of tropical forests across climatic gradients to a dry- ing environment, little is known about the effects of recent changes in climate on community-level trait composition.

-Ana- lysing the precipitation anomaly over the last century, Fauset et al. (2012) have shown there has been a long-term drying trend in tropical Western Africa, which may had led to changes in forest composition and community level leaf phenology. However, there is an overall lack of integrated knowledge on how long-term droughts affect hydraulic, leaf and wood related community traits that are hypothesised to be tightly linked to how different tropical forest may respond to changes in climatic conditions.

-Given a drying trend across West Africa, we hypothesised

that the tropical forest across the climatic gradient have shifted their trait distributions but that the magnitude of the trait shifts may be dependent on the forest type and the past and current climate conditions. Specifically, we hypothesised that forests with usually low water deficits, that is intrinsically wetter for- ests, may be more susceptible to a drying environment as their plant communities may be adapted to high levels of moisture and water availability. These wetter forests are therefore expected to show stronger trait shifts than drier forest.

-Investigating if and how plant communities have shifted their trait composition as a result of a drying climate will increase our understanding on how past climatic conditions have shaped current plant trait distributions and will render insights into how changes in climate may shape future tropical forest communities.

**métodos:**

-We demonstrate the power of such approaches by presenting a novel analysis of long-term responses of different tropical forest to climatic changes along a rainfall gradient.

-Here we coupled a unique combination of intensive plant traits collections together with a wider set of trait data to long-term forest inventories in a West African wet-dry forest gradient and explore if forests exposed to different water deficits show differential responses to a drying climate.

-The study focuses on the forest zone of Ghana, West Africa (Fig. 1a). We obtained vegetation census data for 15 unique 1 ha permanent plots with no signs of fire events or large log- ging actions and with at least two censuses recorded from the African Tropical Rainforest Observation Network (AfriTRON; www.afritron.org)

-In 2015 and 2016, we collected the species traits data at seven permanent 1 ha plots along a rainfall gradient (Fig. S1), as a part of the Global Ecosystems Monitoring campaign (GEM; http://gem.tropicalforests.ox.ac.uk/). The selected traits char- acterise part of the species hydraulics, leaf and wood eco- nomics spectrum (see Table 1 for their description and SI for their relevance).

-We calculated for each of the traits t, and vegetation cen- sus plots, p, their community-level weighted mean (CWM) using the species basal area as the weighting factor

-All analyses of CWM were carried out using the log10 transformed trait values and were carried out with the R package ‘FD’.

**Resultados:**

-Notably, we find that drier tropical forests have increased their deciduous species abundance and generally changed more functionally than forests growing in wetter conditions, suggesting an enhanced ability to adapt ecologically to a drying environment.

-Almost always only plots classified as being at the drier end of the MCWD range, that is ‘Dry’ plots, showed important (most above 92% highest posterior density interval, HPDI) shifts in their CWM trait values (Fig. 3; Table S2), thus we mainly focus on this group of plots.

-Trait composition changed across time and across the precipi- tation gradient. For most traits the long-term climatic water deficit, and not its absolute or relative changes, adequately described changes in trait composition as a possible response to climate changes.

-Community-level traits are changing. Changes in environmental conditions could trigger structural trait changes as an adapta- tion measure when simpler physiological mechanisms, for example stomata opening frequency, are not enough to deal with such environmental changes (Magnani et al. 2002). Here we show that for West African tropical forests, community- level trait structural changes have taken place, likely as a response to a drying environment, leading to large shifts in the community trait composition. Moreover, the increase of decid- uous species abundance in drier locations suggests a direct response to the changing environmental conditions.