B2p: ABIOTIC STRESSORS AND THEIR INTERACTIVE IMPACTS ON FORESTS

Centenarian Brazilian pines may enter into decline due to climate change effect

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Forest health needs to be considered in the in situ conservation strategies for *Araucaria angustifolia*, and climate changes anomalies may be influencing drought-induced tree mortality in the mature trees, with low recovery power. We present a phytosanitary assessment for a native forest in Palmas (State of Paraná), with centenarian trees, for future comparisons over the dead ones. It was verified the behavior of meteorological variables between 2008 and 2018. The data series were organized by ANOVA and by average tests. A Grouping Analysis was performed, using the Euclidean distance as a similarity pattern, obtaining the groups. A Principal Component Analysis was performed to order the variables. The changes reported here were for the winter months, where in southern Brazil, rainfall is mainly caused by the interaction between the polar air masses, with the continental masses conditioned to ENSO events. The changes were cyclical and standards were verified. Air heat and dryness needs long-term monitoring for climatic warming statement, but, it was verified that overconcentrated rainfall in short periods may have influenced the devitalization and conditioned trees to wilt by dryness, due to hydraulic failure, which would increase mortality in the long term. There are indications that 2009 and 2015 winters were stressful to the Brazilian pine, due to the irregular distribution of the rains and the droughts periods. Still, that a next prolonged drought could be verified until the winter of 2021.

Is climate change adaptation in alpine mountain forests constrained by forest seed production and its climatic triggers?

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Climate change (CC) will considerably alter environmental conditions like temperature and precipitation patterns affecting Central European tree species, especially in alpine regions. To reduce CC-related risks for forests, the planting of different tree species and provenances better adapted to the expected climate has been suggested. However, the amount of seeds produced by temperate tree species varies between years and depends on numerous factors including site and weather conditions during and preceding the year of seed maturation. This study aims to identify the most important climate factors affecting variable seed production in order to estimate the need for forest plantations of key tree species in Austria under different adaptation strategies. Historical data on mast seeding and seed harvest from 1960 to 2016 were collected and analyzed for the currently main tree species. The main climatic conditions and regimes affecting their reproductive features were determined and the occurrence of mast fruiting in each species clustered and mapped at the district level to allow the application of predictive models for all Austrian regions. The results show that the climatic variables affecting masting vary between species and geographical areas and that elevation likewise influences seed production. A heterogeneous distribution of mast fruiting clusters was found for all key tree species. Forest seed producers and forest nurseries are key stakeholders for the implementation of adaptation measures to reliably meet forest seed & seedling demand. Results of this study can support the development of a transnational CC adaptation management strategy in Austria and Central Europe.

Responses of photosynthesis and component processes to temperature: are Mediterranean trees fit for climate change?

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Global warming is raising concerns about the acclimatory capacity of trees and forests, especially in Mediterranean-type ecosystems. The sensitivity of photosynthesis to temperature is a key uncertainty for projecting the magnitude of terrestrial feedbacks on future climate change. While boreal, temperate and tropical species have been comparatively well investigated less attention has been paid to the Mediterranean trees. We quantified seasonal changes in the responses of net photosynthesis (Anet), stomatal conductance (gs), mesophyllic conductance (gm), and electron-transport rate (Jcf) and investigated their sensitivity to drought and thermal stress in sunlit and shaded leaves of Quercus ilex, *Q. pubescens*, Pinus halepensis, and Arbutus unedo. All four species showed a remarkably dynamic acclimation of Topt characterised by high thermal tolerance. Seasonal changes in Topt were consistent in all four species, whereas the shape of the response curves was highly species-specific. Surprisingly, severe drought decreased Topt (similar to winter) accompanied by narrower response curves above all in *P. halepensis*, reducing the optimal range for photosynthesis to the cooler morning/evening periods. In contrast, less strict stomatal control under severe drought led to leaf shedding in *Q. ilex* and *Q. pubescens* and additionally branch dieback in *A. unedo*. Water availability was thus a key factor, in addition to growth temperature to explain acclimation of photosynthetic responses to temperature. More frequent and severe drought periods as predicted by climate change may disrupt the acclimatory capacity of Mediterranean trees, which could lead to reduced growth and, for some species such as *A. unedo*, increased mortality risk.

Climate, genetic variability and natural distribution of yerba mate in Southern Brazil

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It is believed that very little of the genetic variability of yerba mate (*Ilex paraguariensis* S. T. Hill) is being explored in breeding programs and in commercial plantations. It is also believed that climate affects the phenotype of plants and models the genetic variation among populations. The aim of this work was to determine differences between specific climates where yerba mate naturally occurs in southern Brazil. A database of 195 natural occurrences of mate (one of the largest databases of yerba mate in Brazil) was set up. These data was applied to multivariate analysis, georeferencing and modelling. As a result, four climatic groups had being obtained using eleven climatic parameters in addition to altitude. Although these groups feature spatial geographic contiguity, it has being found that yerba mate occurs in several lithologic substrates, in different ecosystems (Mixed Ombrophylous Forest, Ombrophylous Dense Montana Forest, Deciduous and Semidecidual Seasonal Forest), and in Atlantic Forest biome and in Pampa biome. Such a distribution indicates great adaptive plasticity of

yerba mate, greater than those of *Araucaria*, a symbol species of the Mixed Ombrophilous Forest. The group located in the most temperate climate of Brazil was isolated from the others. This isolated group can be verified in genetic studies that aim to know whether the populations are also genetically different. The output of this study may be used to support further improvement in breeding and conservation of species programs, currently and future use, considering the climatic changes and the anthropic pressures.

Tree-ring and response to climate variability and carbon sequestration using dendrochronology in the Sahelian Agroforestry of Niger

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Agroforestry Parklands are the predominant agro-ecosystems in West Africa where Prosopis africana and Faidherbia albida are some of key species for rural population. While these trees are resistant to external stress, their growth and regeneration depend strongly on local conditions. Meanwhile, characterizing tree response to climate variability and carbon sequestration is limited in the Sahelian Agroforestry Parklands. This study was carried out in two agroforestry parklands in the South Central Niger and purports at characterizing the response to climate variability and carbon sequestration of *P. africana* and *F. albida* trees using modern dendrochronology methods. The methodological approach consisted of sampling discs using standard dendrochronology techniques, LINTAB 6 system for ring width measurements, COFFECHA and ASTAN for respectively crossdating and standardization of chronological series. There was no significant difference in mean ring-width between the two tree species ($P \geq 0.05$). However the dynamic of cambial growth varied with tree age for both species indicating strong influence of environmental factors. *P. africana* (r1 = 0.50) expresses more dependence on annual rainfall than *F. albida* (r2 = 0.63). There was a significant difference in carbon sequestration between the two species ($P \leq 0.05$). These results can guide policy makers in the choice of adapted species to climate variability and other anthropogenic pressures in the Sahelian belt of Niger.

Estimating the impact of climate change on Brazil's planted forests sector

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Brazil has 9.85 million hectares of planted forests, grown mainly in the South and Southeast regions. These forests have species of the genera *Eucalyptus* and *Pinus*, which represent 93% of the total. In 2017, 139.83 million cubic meters of log wood for paper, cellulose and other purposes were produced, with a production value of several billions of US dollars. However, projected advances of the planted forests sector in Brazil can be directly impacted by climate change and resulting biophysical effects. Here, we quantify these impacts using GLOBIOM-Brazil, a global bottom-up partial equilibrium model of competition for land use between agriculture, forestry, and bioenergy sectors, which includes various refinements reflecting Brazil's specificities. It computes consumption and trade for 30 regions of the world; and production and land use at a 50 km grid resolution in Brazil and 250 km in other regions for the most important crops, wood, and animal products. Land use change depends on the feedback between agricultural demand and biophysical and regulatory constraints on land. Climate change impacts are incorporated in the model by climate shocks on future crop, grass and biomass productivities as projected by Global Gridded Crop Growth Models simulated for five Global Climate Models (HadGEM-ES, MIROC-ESM-CHEM, IPSL-CM5A-LR, GFDL-ESM2M, NorESM1-M) and two climate change scenarios (RCP 2.6 and RCP 8.5). Simulations through the year 2050 indicate a slight decrease of the biomass of planted forests in all Brazilian biomes but the Pampa, where the conditions for planted forests are projected to improve.

Dry of Brazil nut trees at Resex Cajari: new evidence that climate anomalies are affecting Amazonian biodiversity

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The Brazil nut (*Bertholletia excelsa* Bonp.) is among the largest trees in the Amazon. It has big canopy area, and is a deciduous species, indicating high water dependence. In order to investigate Brazil nut trees dry, after strong "2015 el nino", we evaluated occurrence and possible explanations of this drought, and relationships with climatic anomalies and nut production. We conduct semi-structured interviews with agroextractivists, and we analyzed leaves and soil near at 15 trees, with and without symptoms of dry. In the years 2015/2016, was registered the strongest El Niño in the Amazon, with an increase of more than 2 °C in the average temperature, reduction of precipitation and prolongation of the dry period. Probably, the water deficit and temperature stress caused the dry (burn) of the leaves and thin branches of the higher Brazil nut trees, observed in the Santa Rosa region, Resex Cajari-Amapá, Eastern Amazonia. The same did not occur in the young trees, in other species and in other regions. There was a drastic fall in fruit production in 2017, and negative correlation of the production with positive anomalies in the Pacific temperature, demonstrating that this species has sensitivity to climate change. Brazil nut trees can recover and sprout new leaves, but the next harvest is it impaired. The nutritional variables did not present significant relationships with trees dry. The hypothesis raised is that this may be related with hydraulic conductance problems, when occurs cavitation and loss of water molecules adhesion, after physiological stress in large trees.

For the assessment of ozone and climate change impacts on southern European forests: MITIMPACT PROJECT

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Climate change and air pollution are two significant stressors affecting forest health and vitality of European forests. Mediterranean area has been identified as one of the most prominent "Hot-Spots" in future climate change projections and is seriously affected by air pollution, in particular ozone (O_3). The MITIMPACT ALCOTRA project aims to quantify ozone impacts on forest test sites distributed in South East France and Northwest Italy, by evaluating ecosystem health and ecosystem services. The project area can be considered as a case study for the assessment of global change impacts in Mediterranean forests. This innovative aspect of the project can be useful to provide cost-effective measures for forest management in preparation to future climate conditions. Here we will introduce a new monitoring station to measure in real time O_3 concentrations together with meteorological parameters in MITIMPACT project. Based on the data obtained here, calculated several O_3 indices, especieally the effective dose of O_3 entering into the stomata so called phytotoxic ozone dose with a threshold Y (PODy), will be shown. We will discuss new appropriate thresholds to protect Mediterranean forest against the negative effect of O_3 for future climate change.