The Mediterranean Forests in Transition (MEDIT) Project:

Integrating plant functional traits with vegetation dynamics models to understand forest response to climate change.

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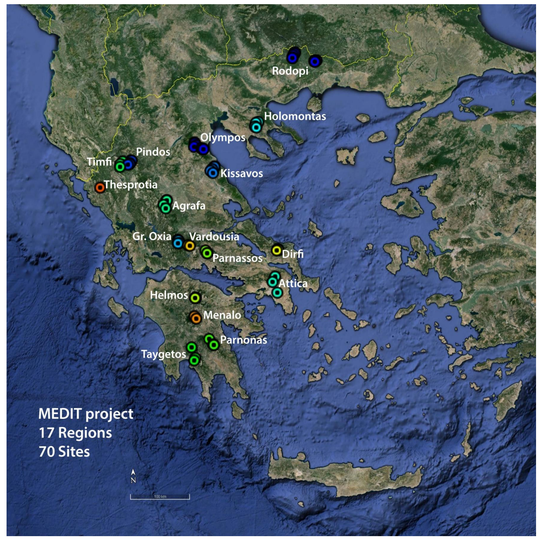
Introduction

The MEDIT project aimed to integrate an extensive database of forest plot measurements made across Greece with models of vegetation dynamics, in order to understand the future of Mediterranean forest types. A field and laboratory protocol was systematically applied at 70 plots, covering a range of environmental conditions from ca 350m to ca 1650m asl.

All major forest types have been monitored including Evergreen Broadleaved (MEB), Lowland Conifer (MLC), Deciduous Broadleaved (MDB) and Mountainous Conifer (MMC) Forests.

The developed dataset was used to constrain two vegetation dynamics models. Simulations were performed at the local and regional scale under baseline and climate change conditions. Forest vulnerability to climate change in terms of species composition and primary production was quantified.



Materials & Methods

We measured/quantified plant and stand level properties including:

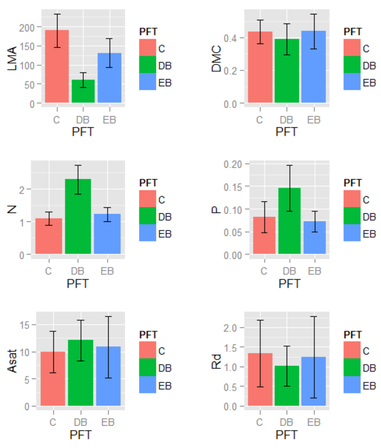
- leaf structural & chemical traits (L_A, L_t, DMC, LMA, C, N, P, Ca, K, Mg) & WD in ~ 700 trees
- leaf photosynthesis (A_{sat}) and dark respiration (R_{dark}) in ~ 400 trees
- tree diameter and tree height in ~ 9000 trees, long-term tree growth in ~280 individuals
- stand structure/synthesis, including LAI, recruitment & species area curves in 40 plots
- soil mechanical and chemical properties (texture, soil depth, pH, ECEC, SOM, C, N, P, Ca, K, Mg and WHC) in 70 plots

We developed a database to integrate these measurements. Our analyses included the functional description of the major forest tree species in Greece, the identification of functional plasticity and trait interrelationships, and the application of these data within vegetation dynamics in order to understand current forest dynamics and project their future under climate change conditions. Baseline climatic conditions were extracted from the ECAD-EOBs data base and Climate Change conditions were based on the IPCC A1B emissions scenario.

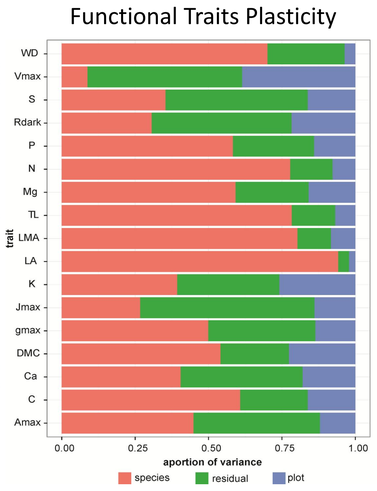
Results: Ecophysiology

Conifer species presented the highest LMA and Deciduous Broadleaved species the highest nutrient concentrations and area based A_{sat}. For most traits, intraspecific variation was greater than between plots variation, indicating that the taxonomy and the within stand hierarchical position of an individual could be a strong predictor of its functional characteristics.

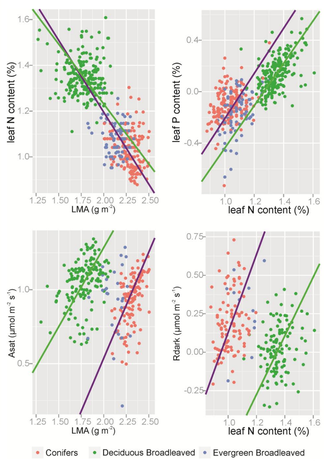
Functional Traits and PFTs



Functional Traits Plasticity



Functional Traits Scaling



Strong associations have been identified for the key traits that reflect the global leaf economic spectrum. A fast to slow trade-off seems to exist at both the leaf and the stem level.

However distinct scaling equations exist for different leaf habits. These relationships can be used to predict some key functional traits and to constrain vegetation dynamics models.

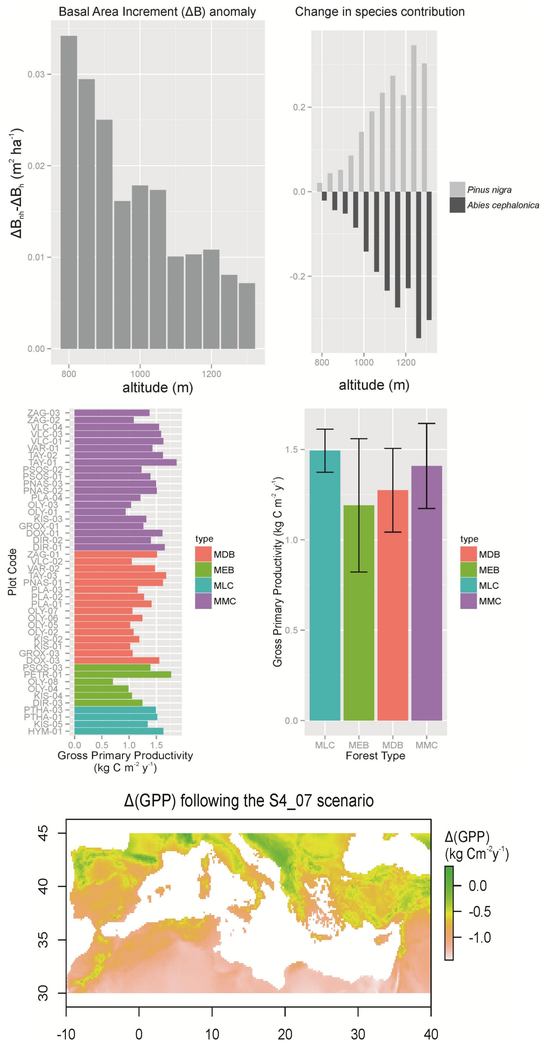
Results: Modeling

Small and larger scale simulations were performed using two different models. At the local scale the re-parameterised GREFOS model adequately simulated biomass and species dominance patterns in 5 Mountainous Mediterranean regions, under baseline climatic conditions. Following the A1B climate change scenario, elevational shifts of more drought tolerant taxa were simulated. Warmer conditions lead to a decreased forest productivity at lower altitudes as an effect of drought stress on species growth and a strong species composition shift at higher altitudes. At the national scale, the TFS – MEDIT constrained model accurately simulated forest productivity across different forest types. MLC and MMC forests illustrated the highest gross (GPP) and net (NPP) primary productivity. Under climate change conditions simulations suggest changes in the functional composition of the study sites which are associated with changes in forest productivity.

At the Mediterranean scale, TFS adequately captured the patterns of GPP and NPP. Forced with the climate change scenario significant changes in GPP were simulated along the basin, and particularly at low altitudes highlighting their vulnerability.

Conclusions

An extensive database of functional traits was developed during the MEDIT project. This database was used to constrain simulations of forest dynamics at both the local and regional level. Following scenarios of climate change significant shifts in forest structure and function were simulated. Low altitude forest are likely to present a lower efficiency to store C, while high altitude forest are expected to experience significant shifts in species composition.



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