Report for COST Action – STSM Grant

Title: Development of methodology for identification and mapping of marginal niches lying within the natural distribution of Greek Fir aiming towards the identification of MaP populations

By

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1. INTRODUCTION

Marginal/peripheral (MaP) forest tree populations are a focus of attention because of their potentially high genetic and adaptive value, as well as due to the risk of decline and loss they may face due to climate change. Identification of marginal populations geographically, ecologically and altitudinally is of outmost importance as specific management and conservation strategies might need to be followed to secure their sustainability and persistence. In this framework, forest managers are challenged to undertake conservation and management measures aiming towards the conservation of valuable genetic resources of marginal/peripheral populations of forest tree species. To facilitate and reinforce the implementation of such actions, information regarding the spatial distribution of the MaP forest populations, and especially the ecologically marginal ones, is additionally required.

2. PURPOSE OF THE STSM

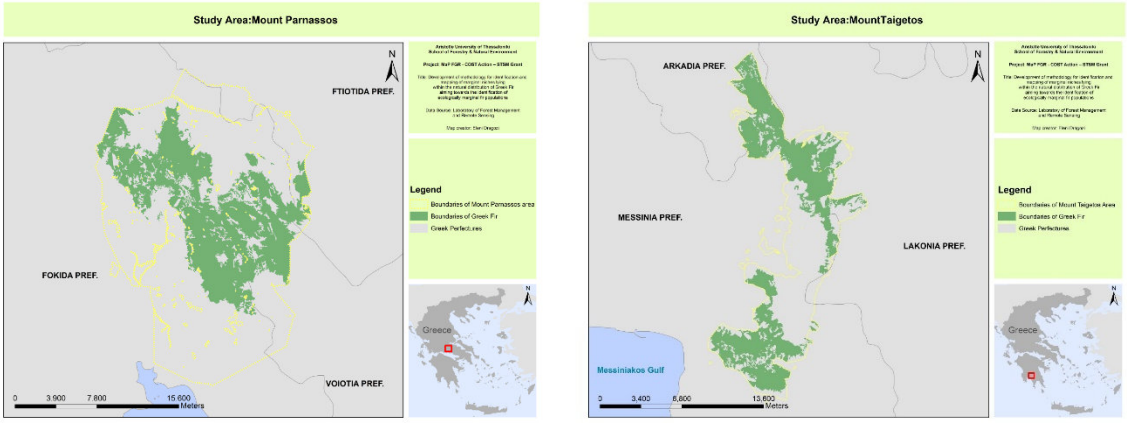
The specific work aimed to develop a methodology for detecting and mapping the areas that represent ecological and geographical marginal niches for populations of forest tree species.
The specific objectives were:

- to develop a methodology, based on the use of GIS and remote sensing, for locating areas in which (ecological and geographical) marginal populations of Greek fir exist in Greece, and
- to apply the methodology in two diverse case studies, namely, a geographically marginal area (Peloponnese - Mount Taygetos) and a potentially ecologically marginal area of (Central Greece - Mount Parnassos). Criterion for the selection of the two sites is the previously recorded extensive dieback of fir trees after experiencing extreme xerothermic (hot and dry) environmental cues.

3. DESCRIPTION OF THE WORK CARRIED OUT DURING THE STSM

During the STSM a methodology was developed and applied for detecting and mapping areas that represent ecological and geographical marginal niches for populations of Greek fir. The proposed methodology was tested in two study areas, namely, Mt.Parnassos and Mt. Taygetos. The first study area, Mt. Parnassos (Figure 1a), is located in the central part of Greece .The second study area, Mount Taigetos (Figure 1b), is located in the Peloponnese peninsula in Southern Greece.

Figure 1. Location of the study areas for MaP Greek fir populations. (a) First study area Mt, Parnassos, Greece (left image) (b) Second study area Mt.Taigetos, Peloponnese, Greece (right image).



In the framework of this study, an analysis of the phenomena occurring at each study area was performed. More specifically, we have performed an analysis of a series of meteorological data, which were provided

by the National Meteorological Services of Greece and evaluated the climate of the two study areas. Analysis of the past and current trends of the annual climate in both areas indicated that fir populations in both areas experienced severe drought during the year 2000. The effects of dieback due to drought in Greek fir forests are demonstrated 2 or 3 years after the drought event. For this reason we tried to evaluate the potential shrinkage of the two Greek fir populations using satellite image analysis. For the purposes of the analysis we used three Landsat images per case. Satellite data were selected based on the analysis of the meteorological data. The methodological steps for detecting and mapping the marginal areas of the Greek Fir include:

Step: 1 Data organization: This step involved all the procedures related to the organization of the data. More specifically, the acquired satellite and ancillary GIS data were organized and stored in a Geodatabase.

Step: 2 Preprocessing of the satellite data: A prerequisite step before the analysis of the satellite data is the radiometric correction of the satellite images. Therefore the Landsat images (3 images per case) were at first calibrated and then corrected for possible atmospheric effects.

Step: 3 NDVI extraction and isolation of areas covered by Greek fir: According to literature (Maselli 2004) (Eitel et al. 2011) the use of Spectral Vegetation Indexes (SVIs) using visible bands such as the Normalized Difference Vegetation Index (Tucker, 1979) can be possible indicators of vegetation stress. For this reason we have decided to utilize NDVI for identifying the dieback areas of Greek Fir.

Step 4: Method for mapping the Greek fir MaP populations: An essential first step in mapping the marginal populations of Greek Fir was to locate the areas of the Greek fir dieback. More specifically, to locate the areas were the image (pixels) exhibits lower NDVI values compared to the NDVI values of the same areas, before the drought event. To identify the areas with the decreased NDVI values, we selected to apply a change detection method implemented within in the ENVI software package. Ultimately, the results were further analyzed in GIS environment using several criteria for identifying the marginal areas of Greek Fir.

Step 4: Method for mapping the dieback of fir trees after experiencing adverse (hot and dry) environmental cues:

The next stage of the methodology was to isolate the areas occupied by fir trees with extreme dieback. To extract those areas, the NDVI differentiation maps resulted from the previous stage were combined in GIS environment. Using the combined information from both maps we were then able to identify the areas of interest.

Step 5. Statistical Analysis

A collateral aim of this work was to examine the correlation of the topographic and climatic parameters with the marginal areas, in order to identify their potential effects on the sustainability level of the two Greek fir populations. At this point, it should be noted, that it was not feasible to obtain spatial climatic datasets for the two study areas. To this end, it was decided to use in the data analysis, only the spatial information which was readily available, from the Forest management plans. In order to detect and examine the relationships between the topographic parameters and the marginal areas of Greek fir, a Multiple Correspondence Analysis (MCA) was carried out (Greenacre 1984) (Greenacre and Pardo 2006).

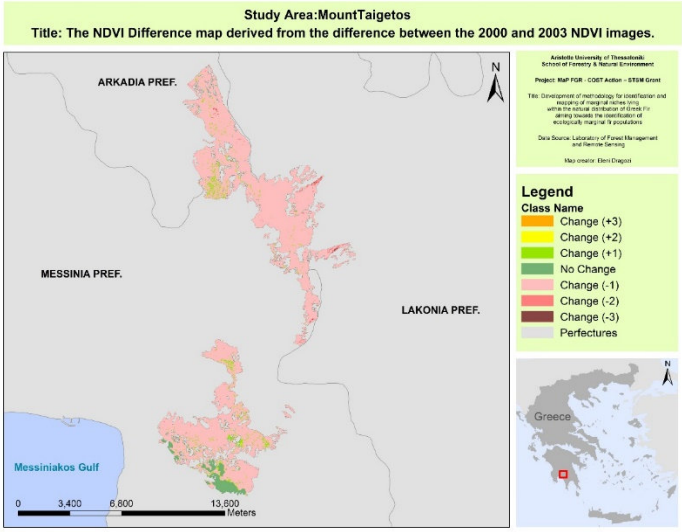
4. DESCRIPTION OF THE MAIN RESULTS OBTAINED

The results of the proposed methodology is (a) a set of maps illustrating the Greek fir marginal population areas for two case studies (Parnassos and Taygetos) - Figure 2 presents an example of the produced maps

and (b) results from the MCA indicating the relation of the several topographic and site quality parameters with fir populations' dieback.

The results obtained from the statistical analysis it was revealed that the quality of the site is closely related with the marginal areas. In both case studies it was found that the fir populations with extensive dieback were located on good or medium quality sites. These findings provide the first indications regarding the potential factors that they may affect the potential response of fir trees, growing at those sites, to xerothermic conditions that challenge their plasticity. However, in order to draw and infer more safe conclusions, we need to repeat the study in other study areas as well.

Figure 2. NDVI difference map between the years of comparison 2000 and 2003. The pink areas represent the areas where the difference between the two NDVI images is negative. This means that the year 2000 NDVI values were higher compared to the year 2003 NDVI values, of the same areas. The pink areas are those which were severely affected by drought. The light green areas depict the areas where the year 2003 NDVI values are higher compared to NDVI values for the year 2000. These two classes are those who dominate on this map. The dark green areas represent the areas where the NDVI differences were zero. Description of the class colors can be found on the map legend.



Foreseen publications

The research findings obtained from the present study are considered good for publishing in a peer reviewed journal. However, we intend to proceed in further analyses to reinforce the findings of this research. We hope that in the foreseeable future we will be able to fulfil this study and proceed with the publication.

Acknowledgements

I would like to personally thank the COST ACTION FP1202 for offering to me through the STSM a great professional and personal experience. I would also like to thank the Institute of CRA for endorsing me during the STMS period and Dr. Sofia Bajocco in who was the responsible CRA scientist during my stay in Italy for all her kind support.

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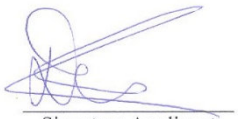

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To the STSM Coordinator,
Dr. Fulvio Ducci

Dear Dr. Ducci,

Mrs. Eleni Dragozi has been hosted to the Research Unit of Climatology and Meteorology applied to Agriculture (CMA) of the Italian Agricultural Research Council (CRA), as an early stage researcher, for a two months period (from September 10th to November 10th 2014).

During her stay in our Institute, Mrs. Eleni Dragozi has successfully fulfilled her work plan for the STSM grant, focusing on the mapping of marginal areas of Greek Fir.

The STSM grant offered the opportunity to both parties to exchange knowledge on the ecology of forest species and especially on the response of marginal populations of pilot forest species when challenged by climate change.

The collaboration with Mrs. Eleni Dragozi has been very fruitful and has opened new perspectives for joint research activities.

I take this opportunity to thank you as STSM Coordinator for the chance given to our research Institute.

Sincerely yours,

Luigi Perini
Director of CRA-CMA

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