SESSIONE / *SESSION 1*

ABSTRACTS

COMPOUND-SPECIFIC EFFECT OF VOCS EMISSION IN *BETULA PENDULA*, ROTH UNDER O_3 EXPOSURE AND N FERTILIZATION

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Keywords: *Betula pendula*, BVOC emissions, tropospheric ozone, nitrogen deposition, climate change.

Silver birch (*Betula pendula*) grows in cold climates and its latitudinal distribution is shifting up north due to climate change. This species emits volatile organic compounds (VOCs) into the atmosphere and contributes to the formation of aerosol and ozone. The emission of volatiles from plant leaves changes in response to pollution and environmental stressors although the magnitude of these changes is still unclear. For this reason our main objective was to explore whether Silver birch changes quality and quantity of volatile organic compounds (VOCs) emission when exposed to elevated ozone (O_3) and nitrogen (N) availability. Trees were exposed to three levels of ozone (low, medium, high) in the air and three levels of nitrogen in the soil (10-30-70 kg ha^{-1} yr^{-1}) in solardomes. The emission of monoterpenes decreased as N fertilization increased from 10 to 70 kg ha^{-1} yr^{-1} under low levels of O_3 in the air. In contrast, N reduced the emission of monoterpenes in plants exposed to high O_3 levels. The effects of N emission were found to be compound-specific. These results are discussed in the light of future scenarios involving global climate models and atmospheric VOC budgets.

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IL RUOLO DEI SUOLI FORESTALI NEL SEQUESTRO DEL CARBONIO

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Parole chiave: suoli forestali, sequestro del carbonio, cambiamento climatico, sostanza organica del suolo.
Keywords: forest soils, carbon sequestration, climate change, soil organic matter.

Varie e tutte importanti per il benessere umano sono le funzioni dei suoli. I suoli forestali più di altri giocano un ruolo essenziale nella regimazione e depurazione delle acque o nella conservazione della biodiversità. Ciononostante, è grazie alla loro capacità di stoccare enormi quantità di CO_2 atmosferica sotto forma di sostanza organica che i suoli forestali hanno recentemente beneficiato di un interesse finora sconosciuto. A livello globale, i suoli contengono dal doppio al triplo del carbonio presente nell'atmosfera o nelle biomasse. I suoli forestali sono tra quelli più ricchi in carbonio, sebbene in molti casi il loro contenuto effettivo sia molto al di sotto rispetto al loro massimo teorico. Ciò li rende un formidabile fattore di controllo del cambiamento climatico in atto, le cui conseguenze negative potrebbero essere limitate sfruttando maggiormente il potenziale dei suoli forestali quali *sink* di carbonio. Non solo i suoli forestali contengono tanto carbonio, ma lo trattengono per tempi lunghi, assai più lunghi di quanto facciano le biomasse che su di essi insistono. I suoli forestali hanno capacità estremamente diverse di immagazzinare il carbonio e di trattenerlo nel tempo, in dipendenza delle loro caratteristiche fisiche, chimiche e mineralogiche, ma anche di fattori esterni – climatici, topografici e biologici –non ultimi il tipo di specie arboree e il tipo di gestione del bosco. Anche eventi catastrofici per il bosco, quali gli incendi o morìe da attacchi parassitario fenomeni climatici estremi e gli interventi di ripristino susseguenti ad essi possono incidere in maniera sensibile sullo stock di carbonio del suolo. Molto si sa a riguardo, molto ancora resta da studiare. Mai come adesso, la selvicoltura è chiamata a considerare con attenzione il suolo e le sue caratteristiche, allo scopo di attuare una gestione del bosco che abbia tra gli obiettivi anche quello di massimizzare il sequestro del carbonio da parte del suolo. Il presente lavoro tratta di esperienze dell'autore e, più in generale, della conoscenza finora acquisita e disponibile in letteratura riguardo alla capacità di sequestro del carbonio da parte dei suoli forestali, dei meccanismi con cui il carbonio è trattenuto, dell'impatto di varie pratiche di gestione forestale sullo stock di carbonio nel suolo, delle possibilità che il selvicoltore ha di aumentare tale stock ed il suo tempo di residenza.

The role of forest soils in carbon sequestration

Various and all important for human well-being are the functions of soils. Forest soils over others play an essential role in water regulation and purification or biodiversity conservation. Nevertheless, it is due to their ability to store huge amounts of atmospheric CO_2 in the form of organic matter that forest soils have benefited from an interest so far unknown. Globally, soils contain from two to three times the carbon in the atmosphere or in biomasses. Forest soils are among the richest in organic matter, although in many cases their organic matter stock is much lower than the theoretical maximum. This makes forest soils a formidable factor in the control of the on-going climate change, and exploiting more them as carbon sink could help to limit the negative consequences of climate change. Not only the forest soils contain a lot of carbon, but hold it for much longer time than do biomasses. Forest soils have very different capacity to store carbon, in terms of both quantity and time, depending on their physical, chemical and mineralogical properties, but also on external factors – climatic, topographical, and biological – not least the type of vegetation and forest management. Even catastrophic events, such as wildfires or disease attacks or extreme weather conditions and the remedial measures subsequent to them, may have a significant impact on the soil carbon stock. Much is known about it, much other remains to be studied. Never as now, forestry is required to take into account the soil and its properties, eventually implementing a forest management having among its objectives also the soil organic carbon maximization.
The present work deals with some author's experiences and, more generally, the public knowledge gained so far and available in the literature about the ability of forest soils to sequester carbon, the mechanisms by which carbon is held in soil, the impact of various forest management practices on the soil carbon stock, the ways in which forestry can increase that stock and its residence time.

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LA SELVICOLTURA SISTEMICA RIFERITA ALLE MOLTEPLICI ESPRESSIONI DELLA FORESTA MEDITERRANEA DELL'ITALIA MERIDIONALE PENINSULARE

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Parole chiave: selvicoltura sistemica, foresta mediterranea.
Keywords: systemic forest management, Mediterranean forests.

Il contributo che lo scrivente intende presentare al prossimo *Congresso Internazionale di Selvicoltura* è costituito da tre distinte parti.
La prima di esse consiste nell'analisi degli studi propedeutici alle proposizioni della *Selvicoltura sistemica*, condotti da Ciancio et Nocentini, senza i quali le stesse proposizioni non sarebbero state affatto avanzate o, se avvenute, sarebbero risultate del tutto prive dei necessari supporti logici e scientifici, così come delle indispensabili argomentazioni etiche, riferite alle gestioni boschive passate e future. La seconda parte è formata dalla definizione delle molteplici espressioni della *foresta mediterranea* delle regioni meridionali peninsulari, dominate da *Pinus halepensis* Miller, *Quercus ilex* L., *Q. cerris* L., *P. calabrica* Delam e *Fagus sylvatica* L..
Ciascuna di esse è considerata prima negli aspetti fitosociologici e tipologici e poi in quelli selvicolturali, con particolari riferimenti alle strutture dei popolamenti arborei conseguenti agli interventi selvicolturali realizzati.
La terza parte, infine, è riferita agli effetti della *Selvicoltura sistemica* nelle espressioni considerate della *foresta* di studio, prefigurando scenari di rilevante interesse scientifico e tecnico.

Systemic forest management for Southern Italy's numerous Mediterranean forest types

The contribution that this writer intends to present at the next *International Congress of Forestry* is made up of three distinct parts. The first is an analysis of the studies leading up to the proposals of *Systemic Forest Management* conducted by Ciancio e Nocentini, without which such proposals would not have been advanced at all or, if they had been, would have entirely lacked the logical and scientific support such management requires, as well as the ethical arguments needed for past and future forest management. The second part defines the numerous Mediterranean forest types in southern Italian regions, dominated by *Pinus halepensis* Miller, *Quercus ilex* L., *Q. cerris* L., *P. calabrica* Delam and *Fagus sylvatica* L..
Each of these is considered first from a phytosociological and typological point of view and then from a forestry management angle, with particular reference to the structures of the tree populations resulting from the management operations carried out.
The third and final part addresses the effects of *Systemic Forest Management* on the expressions considered in the study forest, offering scenarios of considerable scientific and technical interest.

CARBON ACCUMULATION OF NATURAL FOREST IN THE CENTRAL HIGHLAND OF VIETNAM

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Keywords: carbon storage, mixed forest, carbon pools, carbon dioxide sequestration.

The calculation of carbon for natural forest is the basic of payment for forest environmental service in Vietnam which is mentioned in programs of Reduce Emissions from Deforestation and forest Degradation (REDD).
The objectives of this study were to estimate the amount of carbon stocks retained within the forests of Bidoup Nui Ba national park.
Using the method based on the relationship between tree biomass and volume, diameter and wood density, the amount of the forest carbon accumulation was determined without falling trees.
Also, the above-ground biomass of each tree was calculated based on 61 species which have the highest important value index (IVI); from which to establish equation on the above ground biomass of the forest AGB = $0.4691*\rho*D_{1.3}^{2.295}$. Moreover, the study estimated the amount of carbon accumulation for natural forest types mixed coniferous and broadleaves for four carbon pools. Specifically, the above-ground carbon was 375.5 tons/ha; carbon below-ground plant was 86.07 tons/ha; carbon of litter fall to the forest floor was 5.52 tons/ha and soil carbon was 99.9 tons/ha.
The results indicated that this method can be applied to calculate biomass for the natural forest.

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OZONE-INDUCED STOMATAL SLUGGISHNESS IS RELATED TO OZONE UPTAKE PER NET PHOTOSYNTHETIC RATE IN THREE TREE SPECIES IN CHINA

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Keywords: tropospheric ozone, stomatal response, stomatal conductance, stomatal sluggishness.

We examined chronic ozone impacts on steady-state leaf gas exchange and dynamic stomatal response under severe water stress imposed by severing a leaf in three common tree species in China (*Ailanthus altissima*, *Fraxinus chinensis* and *Platunus orientaris*). Experiments were made in Changping near Beijing in China.
Seedlings of these species were grown in open-top chambers and were exposed to three levels of ozone (NF: non-filtered ambient air, NF+40: NF supplied with 40 nmol mol^{-1} of ozone, NF+80: NF supplied with 80 nmol mol^{-1} of ozone) during daytime. Leaf gas exchange rate was measured on fully expanded sun leaves (leaf order: 4th to 6th in a shoot) using a portable infra-red gas analyzer (Model LI-6400, Li-Cor instruments, Lincoln, NE, USA) from 8 to 14 August 2013.
When stomatal conductance reached to the equilibrium under constant light at 1500 μmol m^{-2} s^{-1}, we cut a leaf petiole to see dynamic stomatal response under severe water stress imposed by leaf excision.
Data were logged at 1 min intervals in the 30 min after cutting the leaf petiole.
The present study found that ozone exposure slowed stomatal response after leaf severing especially in *A. altissima* and *F. chinensis*.
The result highlighted that an efficient restriction of stomatal ozone flux by stomatal closure may reduce ozone-induced damage to stomatal control in *P. orientaris*.
The ozone-induced impairment of stomatal control was better explained by stomatal ozone flux per net photosynthesis rather than by stomatal ozone flux only. This suggests that the ozone-induced damage to stomatal control may result from not only a diffusion of ozone into a leaf, but also a capacity for biochemical detoxification capacity or repair.

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STOMATAL OZONE FLUX-RESPONSE RELATIONSHIP FOR NET PHOTOSYNTHESIS IN POPLAR TREES TREATED WITH OR WITHOUT EDU

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Keywords: tropospheric ozone, ethylenediurea (EDU), stomatal ozone flux, photosynthesis.

We investigated leaf gas exchange in an ozone-sensitive poplar clone (Oxford clone, *Populus maximoviczii* Henry × *berolinensis* Dippel) after 6-year treatment with ozone-protectant ethylenediurea (EDU) or with only water (WAT) under field conditions. We measured seasonal course of leaf gas exchange rate in sun leaves with same leaf age from June to October 2013. And the intercellular CO_2 concentration-response curve of the net photosynthetic rate (*A*-*C*i curve) in the sun leaves were determined in October 2013. Parameterization of the multiplicative stomatal conductance model was carried out to estimate stomatal ozone flux for both EDU and WAT treatments. We then analyzed the stomatal ozone flux-response relationship for net photosynthetic rate. It appears that the relationship between stomatal ozone flux and photosynthesis was modified by EDU. A decrease in light-saturated net photosynthetic rate of WAT treated plants (-12% compared to EDU plants in October 2013) was found with increasing stomatal ozone flux. The difference in photosynthetic traits between WAT and EDU plants was mainly due to the increase of dark respiration rate in WAT plants. Based on the analysis of *A*-*C*i curve, also maximum carboxylation capacity (V_{cmax}) tends to be lower in WAT plants compared to EDU plants. The higher rate of dark respiration rate in WAT plants may be due to detoxification involving reactive oxygen species (ozone or other oxidative stress), and/or repair of damaged tissues. WAT plants may need higher investment of photosynthates to repair and detoxification.

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CLINAL VARIATION AND THE GENETIC BASIS OF ADAPTIVE TRAITS IN TREES

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Identifying the loci underlying the variation in quantitative traits and detecting the selection acting on them remains, to this day, one of the main challenges in biology. Genome wide association studies (GWAS) have become the main approach to identify the genetic factors controlling complex traits. Limitations of GWAS have, however, started to become evident and different strategies have been offered to alleviate those. In particular, GWAS have limited power unless very large datasets are used. They therefore remain prohibitively expensive, and often not so informative, for non-model organisms with limited or nascent genome resources such as forest trees. So, at least in the short term, a more targeted strategy, combining common gardens, population genetics, physiological and expression studies of candidate genes remains a very fruitful alternative. We will illustrate this with recent studies of clinal variation in phenological traits in forest trees, with special focus on boreal conifers, oaks and poplars.

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RELAZIONI TRA STRUTTURA FORESTALE, INDICATORI DI NATURALITÀ E FAUNA SAPROXILICA: UN CASO STUDIO NELL'ABETINA DI "ABETI SOPRANI" (MOLISE)

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Parole chiave: *Abies alba* Mill., caratteristiche strutturali, necromassa, microhabitat, organismi saproxilici.
Keywords: *Abies alba* Mill., forest structural features, deadwood, microhabitat, saproxylics.

La struttura forestale, la presenza del legno morto e l'occorrenza di microhabitats sono fattori chiave nell'ottica della conservazione della biodiversità in foresta. In questo studio vengono descritte le principali caratteristiche strutturali di un

popolamento forestale dominato dall'Abete bianco, l'abbondanza del legno morto ed il ruolo di questi parametri nell'influenzare la presenza ed abbondanza di insetti saproxilici, ma anche la presenza dei microhabitats ed una loro eventuale differenziazione. Le attività sono state realizzate presso l'abetina di "Abeti Soprani", localizzata nel territorio dell'Alto Molise, in provincia di Isernia. L'area forestale, di elevata valenza ecologica, è caratterizzata da un popolamento relitto di abete bianco sopravvissuto all'ultima era glaciale, aree forestali che un tempo caratterizzavano l'arco Appenninico, ma che oggi sono ridotte a pochi lembi localizzati in aree ancora microclimaticamente favorevoli. É stato quindi pianificato un campionamento sistematico allineato su un'area di circa 240ha, materializzando 50 punti di campionamento di 530 m2, in cui è stata quantificata e descritta la struttura forestale e l'occorrenza del legno morto nelle sue diverse componenti (alberi morti a terra, in piedi, snags, ceppaie, e frammenti grossolani al suolo). Negli stessi plots, sono state posizionate trappole a caduta ed eclettori sul legno morto a terra, questi ultimi utili a quantificare e caratterizzare la successione degli insetti saproxilici nei diversi stadi di decadimento del legno morto. La fauna saproxilica è stata controllata nell'ambito della stagione estiva-autunnale del 2012, con cadenza bisettimanale. Inoltre, sono state censite ventitre tipologie di microhabitats, occorrenti sia sa alberi vivi che sul legno morto, come ad esempio cavità lungo il fusto, ceppaie sradicate o con accumuli di acqua, chiome lesionate, fratture nel fusto.I risultati hanno evidenziato relazioni significative tra l'abbondanza del legno morto e la diversificazione saproxilica, mostrando anche i differenti ruoli che il legno morto può svolgere in relazione allo stato di decadimento. La struttura forestale e la presenza di gaps favoriscono inoltre la diversificazione saproxilica, mentre la presenza di microhabitats si correla ad una disomogeneità strutturale del popolamento. I risultati ottenuti evidenziano come sia indispensabile integrare gli attuali sistemi di inventariazione forestale con l'ausilio di nuovi indicatori che possano descrivere più compiutamente i molteplici aspetti di un popolamento forestale, nell'ottica di una gestione attenta al ruolo multifunzionale delle foreste ed ai servizi ecosistemici ad esse connesse.

Forest structure, indicators of naturalness and saproxylic fauna: a case study in the "Abeti Soprani" silver fir forest (Molise)

The conservation of biological diversity has become one of the important goals of managing forests in an ecologically sustainable way. The relationships between potential forest structural indicators and biodiversity are not well established. Carefully designed studies are required to test relationships between the presence and abundance of potential indicators and the maintenance of critical ecosystem processes in forests. In this study, forest structure, deadwood amounts and microhabitats occurrence were considered indicators for conservation issues at stand level.
We described the stand structural attributes, deadwood characteristics and microhabitats occurrence, evaluating their role on the abundance, distribution and diversity of saproxylic beetle fauna. The study was realized in Central Apennines (Italy), in a silver fir stand that has been unmanaged since several decades. A systematic aligned sampling method was realized on 240 ha, examining 50 plots of 530 square meters each. Data were collected to assess forest structural parameters and deadwood volumes, and the relative abundance of different deadwood components in decay classes. Saproxylic beetles were sampled using window flight traps and emergence traps, with the aim of obtaining data on abundance and species richness at plot level and dead wood level. The heterogeneity in types and frequency of microhabitats, and the link between structure-based indicators and saproxylic species were also analyzed. Geostatistical analyses were conducted in order to highlight the spatial variability of the parameters investigated and the beetle pattern distributions.Results showed how the saproxylic community is influenced by the deadwood amounts, size and decay, but also by the forest complexity and microhabitats presence. Gaps dynamics and natural disturbances had effects on deadwood amounts and microhabitat abundances in this unmanaged forest stand, that were significantly higher than in managed and structurally simplified forest stands. With the aim of describing the complex saproxylic ecological network, the species of beetles were classified according to the type of interactions with wood and other insects and to trophic guilds. The results implied the importance of deadwood traits and microhabitat amounts as monitoring tools for assessing and forest attributes for preserving biodiversity in these forests. New indicators, such as microhabitats, should be implemented in the traditional forest inventory approaches as a measure of nature conservation. Finally, in order to preserve biodiversity, forest management should reproduce certain environmental characteristics of unmanaged forest in managed forests through the conservation of diverse stand structure and species composition, and increasing deadwood amounts.

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FOREST WATER-USE EFFICIENCY. ACCLIMATION TO CLIMATE AND GLOBAL CHANGE, INTERACTIONS WITH FOREST MANAGEMENT

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Forests cover over 30% of Italy and are estimated to sequester about 10 Mt C yr-1 in their biomass alone, countering the effects of anthropogenic C emissions; forest growth also provides a sustainable source of timber and bioenergy.

At the same time, forests use a sizeable fraction of available water resources; the resulting tradeoff can be partly analyzed in terms of forest intrinsic water-use efficiency, as directly measured or estimated from C isotope discrimination. Several studies have documented a substantial increase in the water-use efficiency of temperate and boreal/alpine forests over recent decades, which has been attributed to the combined effects of increasing atmospheric CO2 concentration, temperature and precipitation changes, and atmospheric N deposition. However, water-use efficiency is also known to be affected by tree age, as modulated by forest management. Such changes overlap in time with the co-occurring effects of Climate and Global Change, making it difficult to partition them and forecast their future development.
In the present study, available evidence of the effects of Climate- and Global Change components on forest water-use efficiency will be reviewed. Results from a recent diachronic study on a Pseudotsugamenziesiichronosequence in the Central Apennines will be used to discriminate between age- and Global Change effects, resulting in a more reliable prediction of future changes in forest water use in the coming century. The implications for forest growth water availability for alternative uses will be finally discussed

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FUNCTIONAL RESPONSES AND MANAGEMENT STRATEGIES OF WOODLANDS AND FORESTS IN RELATION TO VULNERABILITIES CAUSED BY INCREASED DROUGHT RISKS

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In the last ten years, there has been a sharp increase in the research effort dedicated to understanding the impacts of changes in rainfall regimes on the ecology and management of forests. In parts of the Mediterranean and of several other drought-prone regions of the world, episodes of defoliation and increased mortality have been noted and often attributed to periods of intense heat coupled with long and severe droughts. A few important physiological and ecological processes have been identified that may contribute to identify the proximal causes of these phenomena. In addition to changes in rainfall regimes and other factors contributing to global change, more distal processes have also been identified, such as the progressive densification of forests, the effects of past fire suppression practices and the logging of old-growth forests that also help to explain the current evolution of forests in drought-prone regions. Management strategies based on intense thinning, controlled ground fires and planting of drought-resistant genotypes have also been proposed. I will focus on these themes with examples taken from various forests and ecosystems where the scientific community has worked in recent years.

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EFFETTO DELLE DEPOSIZIONI AZOTATE SULLE CARATTERISTICHE STRUTTURALI E FUNZIONALI DI UN ECOSISTEMA FORESTALE IN TRENTINO - ALTO ADIGE: UN APPROCCIO MULTIDISCIPLINARE

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Parole chiave: deposizione azotate, crescita delle foreste, rovere, multidisciplinarità.
Keywords: nitrogen deposition, forest growth, sessile oak, multidisciplinary approach.

L'aumento della produttività primaria netta (PPN) dei boschi temperati e boreali osservato negli ultimi decenni sia in Europa che in Nord America è stato messo in relazione al cosiddetto Cambiamento Globale causato dall'effetto delle attività antropiche sulla concentrazione atmosferica dei gas serra e sui cicli biogeochimici dei principali elementi. Il ruolo svolto dalle deposizioni azotate nel determinare tale incremento non è stato del tutto chiarito. A livello europeo i siti sperimentali di concimazione azotata a lungo termine sono pochi e concentrati principalmente in boschi di conifere nell'emisfero boreale. L'eterogeneità degli approcci metodologici nelle stime della crescita e la prevalente applicazione

di azoto (N) direttamente al suolo ha spesso portato a risultati contrastanti. È risaputo che a livello del suolo le piante subiscono la competizione della comunità microbica nei confronti del N disponibile, e che in natura buona parte delle deposizioni azotate vengono trattenute e assorbite dalla pianta a livello di chioma. Per studiare l'effetto a breve e lungo termine delle deposizioni azotate sulle foreste decidue dell'arco alpino, è stato istituito un sito sperimentale in un querceto mesofilo di rovere (*Quercus petraea*) situato presso Monticolo, in provincia di Bolzano. Nove aree circolari di 12 m di raggio sono state individuate, tutti gli alberi all'interno sono stati cartellinati e specie, diametro ed altezza sono stati registrati. A partire dalla primavera 2015, tre aree saranno trattate con una soluzione di NH_4NO_3 applicata al suolo, tre con la medesima soluzione applicata sopra chioma, tre solo con acqua e serviranno da controllo. Le applicazioni saranno ripetute 5 volte nell'arco della stagione vegetativa. A livello di soprassuolo arboreo, verrà stimata la PPN attraverso la quantificazione delle variazioni annuali di carbonio (C) nelle componenti ipogee ad epigee. La stima delle variazioni negli stock di C nel suolo (lettiera e sostanza organica) permetterà di calcolare la produttività netta dell'ecosistema (PNE). L'uso dell'isotopo stabile ^{15}N come marcatore renderà possibile ottenere un bilancio del N nel sistema, fornendo indicazioni sul comportamento dispersivo o conservativo del ciclo di questo elemento nell'ecosistema. Campioni di chioma verranno presi nell'arco dell'anno per stabilire gli effetti delle deposizioni sulla struttura delle comunità batteriche nella fillosfera tramite estrazione e quantificazione del DNA genomico e l'utilizzo di tecniche di fingerprinting e analisi biomolecolari. A livello di sottobosco, la composizione specifica e le caratteristiche funzionali di alcune specie vegetali selezionate, verranno monitorate nell'arco dell'esperimento in modo da evidenziare eventuali adattamenti alle nuove condizioni edafiche prodotte dalla concimazione azotata. Verranno inoltre inventariate le principali specie di insetti terrestri presenti ponendo speciale attenzione alle specie sensibili ai cambiamenti ambientali e ai microartropodi del suolo. A livello di micosfera verrà studiato il grado di micorrizzazione degli apparati radicali in funzione della concimazione azotata. L'approccio multidisciplinare permetterà di chiarire le interconnessioni fra le varie componenti dell'ecosistema e i meccanismi di adattamento alle nuove condizioni ambientali. L'attività illustrata in questo poster verrà svolta nell'ambito di tre progetti finanziati dalla Provincia Autonoma di Bolzano e dalla Libera Università di Bolzano /Bozen (NITROFOR, MICRONITRAIR, MULTFOR).

Effect of nitrogen deposition on structural and functional characteristics of a forest ecosystem in Trentino-Alto Adige: a multidisciplinary approach

An increase of Net Primary Productivity (NPP) has been reported in last decades in temperate and boreal forests both in Europe and Northern America. This has been related to the so called Global Change caused by the human-induced modifications to the atmospheric concentration of greenhouse gasses and to biogeochemical cycles. The role played by nitrogen (N) depositions on the observed NPP increases is still debated. In Europe, long-term N addition experiments are scarce and mainly located in boreal conifer forests. Moreover, different methodological approaches in NPP estimates and the prevalent application of N fertilizers directly to the soil led to contrasting results. It is well established that in the soil there is high competition between plants and microbes for available N, and that a large amount of N from atmospheric depositions is directly absorbed by tree canopies. An experimental site has been established in a sessile oak (*Quercus petraea*) stand near Monticolo in the province of Bolzano (Italy) to study the short- and long-term effect of N depositions on deciduous forests in the Alpine region. Nine circular experimental plots (12 m radius) have been marked and every tree inside each plot has been measured (height, diameter at breast height) and tagged. Starting from spring 2015, a N manipulation experiment will be started by fertilizing 3 plots with a NH_4NO_3 solution applied to the soil and 3 plots with the same solution applied to the canopies. The remaining 3 plots will be used as unfertilized controls where only water will be added. The N application will be repeated 5 times during the growing season. The NPP of the forest stand will be estimated by measuring annual carbon (C) changes in above- and below-ground trees biomass, while the quantification of changes in soil C stocks will allow to estimate the Net Ecosystem productivity (NEP). By using the ^{15}N stable isotope as a tracer, a complete N balance will be obtained and the conservative or dispersive behaviour of N cycle will be assessed. Tree canopies will be sampled during the growing season to characterize the bacterial community in the phyllosphere by extraction and quantification of total genomic DNA and by studying the community structure with fingerprinting techniques and biomolecular analyses. Specific composition and functional characteristics of selected species of the understory will be monitored in the short and long term in order to stress plant functional plasticity and the impact of the N manipulation on biodiversity. An inventory of the main insect species present at the site will be carried out and the dynamic of the environmental sensitive species of insects and soil microarthropods will be studied. Regarding fungi, the proportion of tree roots symbiotic with mycorrhizal fungi and the density of mychorrhizal tips will be estimated and related to N fertilization. This multidisciplinary approach will allow to clarify the connections between ecosystem's compartments and the mechanisms underlying the adaptation to the modified environmental conditions. The present poster describes the activity that will be carried out in three different projects funded by the Autonomous Province of Bolzano and from the Free University of Bolzano/Bozen (NITROFOR, MICRONITRAIR, MULTFOR).

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STATO ENERGETICO E CAPACITÀ ANTIOSSIDANTE IN SEMI RECALCITRANTI DI LECCIO (*QUERCUS ILEX* L.) CONSERVATI IN SACCHETTI DI POLIETILENE

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Parole chiave: antiossidanti, etilene, leccio, conservazione.
Keywords: antioxidant, ethylene, holm oak, storage.

Il leccio (*Quercus ilex* L.) costituisce una tipica specie recalcitrante dell'area mediterranea che si caratterizza per una debole dormienza e per una spiccata sensibilità alla disidratazione nei semi. Per descrivere e comprendere meglio i meccanismi fisiologici e biochimici che sottostanno a queste peculiarità, sono stati misurati nel corso della conservazione alcuni parametri tecnologici e biologici. I semi, mantenuti in condizioni di elevata umidità e bassa temperatura, sono stati conservati secondo le usuali metodiche in bidoni riempiti con torba umida per un intero anno. Tale modalità è stata confrontata con una soluzione che prevedeva l'uso di sacchetti in polietilene. L'accorgimento adottato ha consentito di mantenere un livello accettabile di germinazione per un periodo superiore di circa 3 mesi rispetto al controllo e di rallentare il deterioramento del seme grazie a un miglior controllo dei danni provocati dal metabolismo ossidativo. La barriera costituita dal film plastico ha infatti limitato gli scambi gassosi, prevenendo le alterazioni dovute a una respirazione troppo elevata e alla liberazione di H2O2. L'ambiente ipossico ha mantenuto un miglior equilibrio ossidoriduttivo, preservando il contenuto di glutatione ridotto e di ATP. La conservazione nei sacchetti ha inoltre favorito l'accumulo di etilene nell'atmosfera di stoccaggio e ha abbassato le attività metaboliche dei semi, nonostante il loro intrinseco stato di debole dormienza. Un'appropriata modulazione di questi fattori biologici potrebbe consentire il prolungamento del periodo di conservazione in semi recalcitranti.

Energetic status and antioxidant capacity in recalcitrant seeds of holm oak stored in polyethylene bags

Holm oak (*Quercus ilex* L.) is a typical recalcitrant species in the Mediterranean area, which is characterized by a weak dormancy and a marked sensitivity to dehydration in seeds. In order to describe and better understand the physiological and biochemical mechanisms underlying this behaviour, some technological and biological parameters were measured during storage. The seeds were kept in conditions of high humidity and low temperature, and stored for an entire year according to the usual protocol in bins filled with moist peat.
This method was compared with an alternative solution, providing the use of polyethylene bags. The adopted device allowed to maintain an acceptable level of germination for a 3 month-longer period with respect to the control. In addition, bag conservation slowed down the deterioration of the seed, limiting the damages caused by oxidative metabolism. The barrier formed by the plastic film actually restricted the gas exchange, thus preventing deterioration due to high respiration rate and to the release of H2O2. The hypoxic environment maintained a better redox balance (poise) and preserved reduced glutathione and ATP content. Seed conservation into bags facilitated also the accumulation of ethylene in the storage atmosphere and lowered the metabolic activities of the seeds, despite their intrinsic weak state of dormancy.
Appropriate modulation of these biological factors may allow a longer storage period in the case of recalcitrant seeds.

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RICOLONIZZAZIONE IN ALTITUDINE DI *PINUS NIGRA* NELL'APPENNINO CENTRALE: DINAMISMI PREPARATORI ALL'INNALZAMENTO DELLA *TREELINE*?

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Parole chiave: pino nero, anelli legnosi, IADF, cambiamenti climatici.
Keywords: European black pine, tree rings, IADF, climate change.

In Italia gran parte degli studi sulle dinamiche della *treeline* sono stati condotti in ambiente alpino. Pochi sono invece quelli inerenti cenosi appenniniche, dove l'influenza sinergica dei disturbi naturali e antropici è stata decisamente più accentuata. Negli Appennini l'attuale *treeline* è caratterizzata prevalentemente da cenosi di faggio, situate tra 1500 m e

1900 m slm. Alcuni studi hanno evidenziato una notevole stazionarietà spazio-temporale delle faggete nel settore centrale ed un maggiore dinamismo di formazioni arbustive. Nell'Appennino centro-meridionale le cenosi naturaliformi con *Pinus mugo*, *P.laricio, P.leucodermis* appaiono più dinamiche. Tale fenomeno trova analogie nelle zone calcaree dell'Appennino centrale con la diffusione spontanea di individui di *Pinus nigra* sopra l'attuale limite superiore del bosco, spesso ma non solo, a partire da rimboschimenti di protezione.
La ricolonizzazione di pino nero in ecotoni di *treeline* è stata analizzata in 5 siti dell'Appennino centrale lungo un gradiente Nord-Sud di circa 170 km compreso fra Marche e Abruzzo. Obiettivi dello studio sono: i) individuare possibili pattern comuni nell'assetto fisionomico-strutturale e nei dinamismi di diffusione del pino nero; ii) datare accuratamente l'insediamento degli individui arborei; iii) determinare l'influenza dei principali fattori climatici nel processo ricolonizzativo. Globalmente sono stati censiti oltre 900 individui arborei di pino nero, tutti localizzati al di sopra della *treeline* attuale fino alla massima altitudine possibile. E' stata rilevata la loro posizione mediante GPS e sono stati misurati il diametro del fusto, l'altezza totale, gli accrescimenti longitudinali ed altri caratteri fisionomici e del contorno microstazionale. Da ogni fusto è stata anche prelevata una carota basale per la determinazione dell'età cambiale, accrescimento radiale e individuazione di fluttuazioni intra-annuali di densità (IADF). Carote legnose sono state estratte anche da 20 individui arborei adulti per ogni sito al limite esterno dei rimboschimenti presenti di pino nero per stabilire la sensitività climatica della specie. Con l'analisi multivariata (PCA), univariata e dendroecologica sono state esplorate rispettivamente le correlazioni fra i diversi attributi strutturali degli alberi, le relazioni fra incrementi radiali e longitudinali e l'influenza di temperature e precipitazioni mensili sull'accrescimento e la formazione delle IADF.
Gran parte dei pini è ubicata ad altitudini elevate e i loro caratteri fisionomico-strutturali sono molto simili nei cinque siti, nei quali il processo ricolonizzativo sembra essere iniziato fra 30 e 40 anni fa con picchi di frequenza e dinamismi di accrescimento sincroni.
Il pino nero è particolarmente sensibile alle temperature massime estive periodo in cui si formano preferenzialmente anche le IADF, il cui acme di frequenza è avvenuto nel 2003 e 2004. Il processo ricolonizzativo del pino nero, sebbene le differenze nei caratteri ambientali e nell'uso del suolo pregresso dei cinque siti, appare sincronico e spazialmente disperso. Simili dinamismi di accrescimento e adattamento della specie al riscaldamento climatico sono segnali che potrebbero preludere ad un futuro innalzamento del limite superiore del bosco.

High altitude encroachment of *Pinus nigra* in central Apennines: a natural process preparing a treeline upshift?

Most of the studies on treeline dynamics in Italy have been conducted in the Alps. Only a few ones concern the Apennines where stronger isthe synergic influence of natural and anthropic disturbance. In the Apennines the current treeline is usually formed by beech forests located between 1500 and 1900 m asl. In central Apennines some studies have proved that these forests feature a spatiotemporal stationarity, whereas shrubs community are more dynamic, as well as treeline ecotones with *Pinus mugo*, *Pinus laricio, Pinus leucodermis* in southern Apennines. This process finds its analog in several limestone slopes of central Apennines where we observed a natural encroachment of *Pinus nigra* trees above the current treeline, especially where pine plantations have been created for soil erosion control.
This process occurred at increasing elevation and was analyzed at five treeline ecotones in central Apennines (Italy). The study sites are located along a 170 km North-South gradient across Marche and Abruzzo regions in Central Italy. The aims of this study were: i) to detect possible common patterns of structural attributes of black pine regeneration at the treeline ecotones; ii) to date the germination of encroached trees; iii) to assess the climate influence on the pine upward encroachment process also using intra-annual density fluctuations (IADFs) in tree-rings. We sampled over 900 encroached black pine trees above the current treeline to the mountain tops. All individuals were mapped and their basal stem diameter, total height, annual height increments and other structural attributes measured. One increment core was extracted from stem base of most samples for cambial age determination and detection of intra-annual density fluctuations (IADF). At two sites we also extracted cores at DBH from forest trees to assess climate-growth relationships of black pine. We used multivariate analysis (PCA) to explore the correlation structure of the main tree attributes, regression analysis to relate radial and height increment and dendroclimatic analysis to assess the influence of climate on tree growth and IADF formation. Most black pine trees were located at high altitude and their structural attributes were similar at the five sites, where the pine encroachment process started between 30 and 40 years ago featuring similar germination peaks and growth patterns. Black pine is particularly sensitive to maximum temperatures and IADF occurred in mid-late summer with highest frequency peaks between 2003 and 2004. The pine encroachment process, besides the differences of environmental features and land use histories of the four study sites, appears synchronic and spatially diffused. The consistent tree-growth dynamics and the species adaptation to a warming climate are signals envisaging a possible treeline upward shift.

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COMPORTAMENTO ECOFISIOLOGICO DELLA QUERCIA DA SUGHERO IN CONDIZIONI NATURALI

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Parole chiave: sughera, Mediterraneo, fotosintesi netta, potenziale idrico.
Keywords: ecophysiology, Mediterranean, net photosynthesis, water use efficiency.

La quercia da sughero (*Quercus suber* L.) trova un areale di naturale diffusione in Sardegna (IT), dove rappresenta circa il 90% della superficie totale nazionale. Spesso le foreste di sughera occupano suoli relativamente poveri e poco profondi che, in concorso con le condizioni climatiche dell'isola, creano le condizioni per periodi di carenza idrica spesso prolungati, in particolare nella stagione estiva. In questo lavoro vengono mostrati i risultati del monitoraggio degli andamenti giornalieri e stagionali del potenziale idrico xilematico e degli scambi gassosi della quercia da sughero in condizioni naturali in due areali di tradizionale presenza in Sardegna. Le misure sono state effettuate nel periodo 1999-2004, su piante adulte. La dinamica giornaliera del potenziale idrico ha mostrato, in tutte le stagioni, un abbassamento dei valori durante le ore centrali della giornata rispetto alle misure effettuate prima dell'alba, con una capacità di recupero da parte delle piante nel pomeriggio. A scala stagionale i valori di potenziale idrico sono decresciuti progressivamente dall'inverno all'estate e talvolta anche all'autunno. La specie ha mostrato una buona capacità di modulazione del potenziale idrico, specialmente nei periodi di carenza idrica, durante i quali si sono ridotte sensibilmente le differenze tra i valori misurati prima dell'alba e quelli misurati nelle ore più calde della giornata. Gli scambi gassosi assumono una caratteristica dinamica giornaliera in tutte le stagioni, col tasso fotosintetico netto che mostra i valori più elevati al mattino, dopo il raggiungimento di un'adeguata intensità luminosa, mentre la conduttanza stomatica e il tasso traspirativo sono generalmente più alti nelle ore centrali della giornata.
L'analisi dei dati ha evidenziato come la depressione del tasso di fotosintesi netta nelle ore centrali della giornata non sia una conseguenza diretta della chiusura stomatica ma sembra piuttosto dovuta alla riduzione dell'efficienza fotosintetica in questa parte della giornata rispetto al mattino.
La sughera ha confermato di possedere un'alta efficienza del proprio sistema vascolare e meccanismi di adattamento alle condizioni ambientali che consentono di fissare grandi quantità di carbonio con quantità limitate di acqua.

Gas exchange and water potential monitoring in cork oak trees under natural conditions

Cork oak forests (*Quercus suber* L.) have a natural diffusion range in Sardinia (IT), where they cover about 90% of the total national area. Frequently, the cork oak forests occupy relatively poor and shallow soils which, together with the climatic conditions of the island, can often create conditions for prolonged periods of water scarcity, especially during summer. Several Authors linked the water stress of cork oak trees to the cork oak decline, a disease due to endophytic fungal pathogens.
In this paper we present the results of monitoring daily and seasonal patterns of xylem water potential and gas exchange of naturally grown cork oaks in two main study sites in Sardinia. The measurements were carried out during the period 1999-2004, on adult plants.
The daily water potential dynamics showed, along the year, a decrease during the hottest hours of the day as compared to pre-dawn measurements, and a recovering capacity in the afternoon. Ata seasonal scale, water potential values decreased gradually from winter to summer and sometime sto fall. Cork oaks have shown a good modulation capacity of water potential, especially in periods of water scarcity, during which the differences between the values measured before dawn and those measured during the hottest hours of the day decreased significantly. Leaf gas exchanges follow a typical daily pattern, with the net photosynthetic rate showing the highest values in the morning, after adequate sunlight intensity has been reached, whereas stomatal conductance and transpiration rates are generally higher in the middle of the day.
The data analysis suggests that the depression in net photosynthesis rate in the hottest hours of the day is not a direct consequence of stomatal closure, but it is rather due to the reduction in photosynthetic efficiency in this part of the day. Cork oaks proved to have highly efficient vascular system and adaptation mechanisms to the environmental conditions that allow for fixing high amount of carbon using limited water resources.

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MOLECULAR SIGNATURES OF CLIMATE ADAPTATION IN MEDITERRANEAN CONIFERS

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Understanding range-wide patterns and interactions among environments, demography and evolution is essential in the face of impending climate change. Species from the Mediterranean Basin, inhabiting highly heterogeneous environments, are particularly at risk because of the predicted increase in aridity and recent land-use change in this area, which fosters fragmentation.
Conifers are ecologically and economically important tree species and it is hence of great interest to assess their adaptive potential to foreseen climate changes. In this talk, we review our studies on population genomics and association genetics in maritime and Aleppo pines, two relevant elements of Mediterranean landscapes. In maritime pine (*Pinus pinaster* Aiton), 17 SNPs (Single Nucleotide Polymorphisms) were found to be strongly correlated with climate, once population genetic structure was removed from environmental association models. The utility of these SNPs to predict climate maladaptation of forest stands was further tested in a common garden showing that genetic distance to optimal allele frequencies resulted in reduced survival.
At the same time, some of these loci were correlated with both fire-related and drought traits using association genetic approaches. In Aleppo pine (*Pinus halepensis* Miller), we are studying the genetic signatures of range expansions, from refugia populations in Turkey and Greece towards its large western Mediterranean distribution. This species showed signatures of selection while expanding its range in a previous study based on drought-response candidate genes. However, new SNP data showed signals of recurrent bottlenecks in the colonized range and 'gene surfing' in the expanding wage of colonization appears now as a feasible alternative explanation.
These studies at large spatial scales are accompanied by research at local scales aiming at detecting the role of micro-environmental variation in creating and maintaining genetic diversity within populations. The combination of approaches and spatial scales gives an integrated view to understand the quantitative genetic and molecular mechanisms responsible for adaptation as well as the drivers of selection (both climatic and ecological) in Mediterranean conifers. Furthermore, it will also provide a basis to identify population differences that may help the species to survive future environmental changes, as well as insights on optimal management strategies for the future European forests.

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MONITORING OF GENETIC DIVERSITY - AN EARLY WARNING SYSTEM TO AID THE ASSESSMENTOF A SPECIES RESPONSE TO ENVIRONMENTAL CHANGE AT A LONG-TERM TEMPORAL SCALE

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Keywords: monitoring, genetic diversity, indicator, LIFEGENMON.

Forest conservation and sustainable use of the multitude of forest functions in natural and managed forests are the main goals of monitoring programmes in forest ecosystems at the national and international level. Yet, the genetic aspect as a basis of biological diversity has been neglected in all forest monitoring programmes to date. As sustainable forest management is based on the long-term adaptability of forest ecosystems and starts at the lowest, namely the gene level, forest genetic monitoring (FGM) is a crucial component of any sustainable forest management because it gives a possibility to detect potentially harmful changes of forest adaptability before they are seen on higher levels. A new LIFE+ project LIFE for European Forest Genetic Monitoring System (LIFEGENMON) that aims to design such a monitoring system on a transect spanning from Bavaria to Greece started in July 2014 and will last until 2020. Forest genetic resources face a large number of increasing threats.
By introducing genetic monitoring into conservation programmes and sustainable forest management one has the tool in hand to assess information on relevant changes of a species and/ or populations' adaptive and neutral genetic variation

through time. In fact, genetic monitoring can be based on indicators and their verifiers in order to serve as an early warning system to aid the assessment of a species response to environmental change at a long-term temporal scale.
The aims of the project are:
- To define optimal indicators and verifiers for monitoring of genetic diversity changes in time across a transect from Bavaria to Greece for two selected target species, a stand forming broadleaf and a stand forming coniferous species
- To prepare guidelines for forest genetic monitoring for these two and additional five forest trees species, which differ in their biology and distribution, for implementation of FGM at a national, regional and EU scale
- To prepare a Manual for Forest Genetic Monitoring for implementation at the EU level
- To prepare a Decision support system for an optimal choice of the level of FGM based on needs and means
- To organize series of workshops / trainings for the forestry sector to be capable of implementing FGM according to standardized procedures in their territories
- To prepare background professional documents / guidelines for policy makers at the national, regional and the EU level for supporting development of possible new regulations at the national level, the FOREST Europe process and future European Forestry and Biodiversity Conservation policies and strategies
- To disseminate the information about FGM and sustainable forest management among different target audiences and stakeholders
- To establish a well-functioning internationally linked team of forestry professionals working in and for FGM.

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IMPACTS OF SOIL MOISTURE ON DE-NOVO MONOTERPENE EMISSIONS FROM EUROPEAN BEECH, HOLM OAK, SCOTS PINE, AND NORWAY SPRUCE

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Keywords: soil water content, monoterpene emission, drought stress, boreal and temperate forests.

Biogenic volatile organic compounds (BVOC) are important atmospheric trace gases. They are released from plants into the surrounding atmosphere and are involved in photochemical ozone and particle formation. For this reason BVOC impact the oxidation capacity of the troposphere. The release of BVOC is frequently associated with a range of biotic and abiotic stress factors. On a quantitative basis, the most important BVOC are isoprenoids such as isoprene and monoterpenes. Isoprene and monoterpene emissions from trees originate from the synthesis of complex molecules from simple molecules (*de-novo* biosynthesis) in a light- and temperature-dependent manner and environmental conditions can have a strong influence on their biosynthesis. For this reason, impacts of soil moisture on *de-novo* monoterpene (MT) emissions from Holm oak, European beech, Scots pine, and Norway spruce were studied in the laboratory. The results showed that mild drought caused only slight increases of MT emissions. The increases were explainable by increasing leaf temperature due to lowered transpirational cooling and by recovery from a preceding hard drought. Severe drought decreased MT emissions to almost zero. Re-watering the plants caused increasing emissions until the same levels were reached as before the drought stress, implying that impacts of drought were reversible on a time scale of days. To incorporate impacts of soil moisture on *de-novo* MT emissions into the Model of Emissions of Gases and Aerosols from Nature (MEGAN), the volumetric water content of the soil, Θ, was used as a reference quantity. As long as Θ was > 0.2 m^3/m^3, emissions were not directly affected. With Θ below a certain threshold, MT emissions decreased simultaneously with Θ. The relationship between Θ and MT emissions was to a good approximation linear, allowing the determination of $\Delta\ \Theta\ 1$ (the range of Θ where the emissions drop from their maxima to zero). As average from 7 independent replicates was found $\Delta\ \Theta\ 1 = 0.08\ m^3 / m^3$ with a standard error of 0.02 m^3 / m^3. There were no systematic differences of $\Delta\ \Theta\ 1$ between Mediterranean Holm oak and trees from boreal and temperate forests. The value $\Delta\ \Theta\ 1 = 0.08\ m^3 / m^3$ was therefore used in MEGAN. It was also tested whether a factorial approach, such as the one used in MEGAN, was suitable to describe the soil moisture dependence of de-novo MT emissions. Using Holm oak the temperature and light intensity dependence of the emissions was measured for well watered plants and during severe drought stress. No substantial interdependencies were found, indicating that the approach used in MEGAN for isoprene is also suitable for de-novo MT emissions. Describing the soil moisture dependence using Θ as a reference was unsuccessful in case of sudden soil moisture changes. Re-watering the plants after severe drought stress caused emissions to increase on a time scale of days. During recovery no relationship between Θ and the emissions was observed. Hence, impacts of heavy rainfall after a long lasting drought cannot be described by this approach.