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# KEYNOTES

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# SOIL DISTURBANCES & RECOVERY CAPACITY WITH DIFFERENT SOIL MANAGEMENT FACING WILDFIRES IN CATALONIA, SPAIN.

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**Abstract**

The GRAM (Mediterranean Environmental Research Group) of the Department of Geography of the University of Barcelona is investigating the effects of fire disturbances and its subsequent post-fire management in different scenarios within the HOLISOILS project (Holistic management practices, modelling & monitoring for European Forest Soils). The objective is to understand soil resilience and resistance under wildfires disturbances on Mediterranean forests and to evaluate different post-fire soil management practices. The research is being conducted in three study areas. The first site in Cap de Creus, analyzing the effects on soil traits after a recent wildfire and the subsequent passage of cattle. The second area of research in Montgrí massif examine the effects of prescribed fire as forest management practice in order to prevent large wildfires. And the third study area aims to assess the long-term effect (28 years) of a large forest fire and to evaluate the evolution of soil properties in areas that undergo wildfires of low and high intensity, moreover, the resurgence of spontaneous vegetation without any forest management being implemented.Knowledge provided from this research could be used to enhance decision-making policies in forest management after wildfires and to aid in the prevention of large wildfires

**KEYWORDS:** wildfire risk, forest management, GRAF firefighters, soil properties.

# The state of the art of post-fire soil erosion mitigation treatments

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**Abstract**
Wildfires are considered to be one of the main causes of soil erosion and land degradation processes in fire-prone areas, which are expected to increase in the future because of fire patterns shifting worldwide as a consequence of changes in climate and land use. To maintain the sustainability of ecosystems and protect the values at risk downstream from the fire-affected areas, it is vital to mitigate the increased hydrological and erosive response after fires.

In this presentation, we will go through some of the main research questions in post-fire soil erosion mitigation research, showing the state of the art and findings from recent global analyses:

- Which are the most effective treatments and at which application rates?
- How key-variables in post-fire soil erosion determine the effectiveness of the treatments?
- How much does it cost to apply these treatments?
- How much does it cost to reduce post-fire erosion to tolerable rates?
- Should we always apply post-fire erosion mitigation treatments?
- Are post-fire soil erosion mitigation treatments justified?

**KEYWORDS:** soil; wildfires; runoff; sediment losses; erosion control; mulches; cost-effectiveness

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# Hydrological Modeling of the Potential Impact of a Forest Fire on Runoff in a Mediterranean Catchment

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**Abstract**

Forests provide a wide range of ecosystem services, namely provisioning, regulating, cultural and supporting services. Among the regulating services, the reduction of runoff and flooding is of great importance. Vegetation cover plays an important role in regulating the hydrologic cycle; forest vegetation reduces the amount of precipitation reaching the ground, impedes the intensity of raindrops, increases soil permeability, enhances evapotranspiration, reduces runoff formation, and contributes to the stability of soil structure. According to the forest management policy of KKL-JNF, the multipurpose forest (in our case mostly planted pine forests) is managed to provide a variety of ecosystem services, relying on natural processes and minimal management actions.

This study aims to understand runoff processes in the multipurpose forest and evaluate the effects of wildfire on water regulation service. The project was conducted in several forests in the Jerusalem Mountains and northern Israel. The research methods included: (a) preparation of a high resolution land use/land cover map (LULC) using machine learning classification of satellite imagery and field surveys, (b) mapping of water regulation service - runoff rates (as an indication of runoff regulation service) were estimated using the hydrological modeling system HEC-HMS. The model was validated using runoff data at a number of hydrometric stations along the studied basins; and c) assessment of the impact of forest fires on runoff - A comparison was made between model results before and after the forest fire in August 2021 in the affected subbasins in the Judean Mountains (1,100 ha).

The HEC-HMS model results emphasized the importance of vegetation cover, particularly the dense and multi-storied cover, prevalent before the fire, for the regulation of runoff and soil erosion. The model allowed the identification of contributing sub-basins and indicated areas of high runoff risk, both on a day-to-day basis and following extreme fire events. These data are essential as a basis for spatial management plans. The model revealed that, after forest fire, small vegetated streams that do not produce any runoff under average winter conditions might contribute substantial amount of runoff given the severity of the fire. The application of the model will allow systematic assessment of areas at risk of high post-fire runoff that require targeted management intervention to improve or rehabilitate nature-based runoff control.

**KEYWORDS:** Ecosystem services, regulating services; wildfires, Mediterranean catchments, HEC-HMS, multipurpose forest.

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# Understanding the role of photography in the field of wildfires. Aesthetics of catastrophe and aesthetics of prevention.

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**Abstract**

Scale and intensity of wildfires across the globe have increased significantly in the recent years. In fact, megafires, or the so called sixth-generation fires, are a frequent theme in environmental photography. Published photographs of forests on fire or burned landscapes focus on the aesthetics of catastrophe, showing an already affected environment, an event that has already occurred. They illustrate the immediate reality and, at the same time, underline the failure of the preventive actions necessary to avoid devastation. This project aims to discuss the visual characteristics of photographs of wildfires by analyzing their aesthetics, iconology, and staging. The question is how photography can help to visualise the complexity of the causes and consequences of wildfires. For this purpose, the codes of representation of two different photographic models are analyzed: on the one hand, photojournalism, on the other hand, documentary photography inscribed in the artistic field with the purpose of determining the greater or lesser communicative effectiveness of each model, taking into account the difficulty of telling effectively what happens from a visual point of view. Photography registers the visible evidence of the landscape modified by fire thus granting the status of truth, the referential proof that, in words of Roland Barthes, "the thing has been there". At the same time, however, the temporality inscribed in the photographic evidence of "what has been," may prove ineffective in the context of fire campaigns that call for preventive actions. Overall, environmental photography, linked to activism and political practices, is able to make us see fires not only as mere events, but also to generate debate on the causes and possible solutions to the problem. This should be the purpose of this type of photography, to contribute, through the visual, to the understanding of the dynamics of fires, to the explanation of the role of fire in ecosystems.

**KEYWORDS:** Environmental photography, Wildfire photography, Landscape photography, Documental photography, Photojournalism.

# EFFECTS OF PRE-AND POST-FIRE MANAGEMENT

# The effects of prescribed fire on soil properties and seedling dynamics in pure Anatolian black pine and scots pine stands

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**Abstract**

Pines have a wide distribution area throughout the world, mostly in the northern hemisphere. These distribution areas include different ecological regions and fire interaction situations. Anatolian black pine (*Pinus nigra* Arn. subsp. *pallasiana*) and scots pine (*Pinus sylvestris*) are fire sensitive but partially adapted pine species. With the adaptations they have developed against fires, these species not only eliminate the negative effects of fires, but also continue their lives after the fire and mostly form pure stands. For this reason, determine the effects of fire in these ecosystems is very important in terms of fire management and use.

In this study, the effects of prescribed fire on soil properties and seedling growth and development were studied in mature pure Anatolian black pine and scots pine stands. The study areas were determined from the areas where black pine and scots pine are naturally distributed. Study areas were divided into different experimental plots. Different silvicultural practices were carried out in these plots. In plots, standard mechanical soil preparation and prescribed fire techniques were practiced. Measurements and observations were made in these plots for a period of two years.

Differences were found in terms of basic soil properties between the plots where different silvicultural practices were carried out. As a result of mechanical site preparation, the soil structure was destroyed, the soils in different levels of depth were mixed together and time-dependent fluctuations occurred in soil properties. The burning applications affected the mineral topsoil (0-5 cm) and soil properties vary over time depending on the combustion conditions. The results indicated that the seedlings in the plots where prescribed fire practices were carried out showed better growth and development compared to the seedlings in the plots where standard silvicultural practices were carried out.

**KEYWORDS:** Fire management, Prescribed fire, Pine ecosystems, Natural regeneration, Soil properties

# Assessing fire impacts on soil burn severity using satellite imagery in Portugal

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**Abstract**

Mapping burn severity after a fire is important to identify priority regions for post-fire recovery. This is usually done using satellite imagery, for example, using the difference Normalized Burn Ratio (dNBR) index. However, this index is optimized for vegetation burn severity, and its capacity to map soil burn severity (SBS) is not well understood. To investigate this, we assessed soil burn severity in three fires that occurred during the summer of 2020 in Portugal, with different dominant landcovers: eucalypt plantations, pine plantations, and Mediterranean oak forest/shrublands. In each fire, 6 to 8 20x20m plots (representing one Sentinel-2 pixel) were selected for assessment with varying classes of burn severity, based on dNBR maps made from Sentinel 2 images. The field assessment was done 2 weeks after each fire; in each plot SBS was assessed at 9 square meters quadrats using the USDA field classification method. The results indicate that dNBR was able to identify areas with low and extreme values of SBS, but with a large uncertainty in intermediate SBS severity classes. Part of the error could be attributed to the spatial variability of SBS within each plot; however, the relation between dNBR and SBS also appeared to be different for each site. An analysis of each plot based on pre-fire fuel types indicates that the type of burned vegetation may be responsible for these differences in relation. These results indicate the potential of dNBR, and eventually other satellite indices, to be used for mapping SBS when modified by pre-fire vegetation cover. Further work is needed to collect and compare more data points from fires with different characteristics.

**KEYWORDS:** Soil Burn Severity, Satellite imagery, dNBR.

# EFFECTS OF PRESCRIBED FIRE IN A MEDITERRANEAN ENVIRONMENT: A CASE STUDY IN THE MONTGRÍ MASSIF (GIRONA, SPAIN)

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**Abstract**

Wildfires are the main disturbance in Mediterranean forests. Prescribed fire is a tool used to reduce the amount of fuel in forests and reduce the risk of high-severity fires. In the Montgrí massif are being made by the firefighters since 2006 to avoid vertical continuity from the shrub stratum to the top of the trees, in this case, *Pinus halepensis*. The aim of this study was to evaluate the immediate effect on soil properties after the use of prescribed fires as a forest management technique and their annual evolution. After a prescribed fire on 1st March 2022, five plots (n=5) were established in the Prescribed Fire area (PF) and an adjacent unburned Control area (C), and soil samples were collected, sampling was repeated in 2023. After burning the pH was slightly higher in PF than in C, remaining at 2023 (~7.7; ~7.3, respectively). Related to electrical conductivity, in 2022 higher values were observed in PF than in C, but they decreased in 2023 to reach similar values to C (~200µS cm-1). However, the content of Ca2+, Mg2+, Na+, K+ was initially similar in both treatments, although in 2023 lower values were observed in PF (~5350 mg kg-1, ~290 mg kg-1, ~89 mg kg-1, ~349 mg kg-1; respectively) than in C (~6754 mg kg-1, ~410 mg kg-1, ~131 mg kg-1, ~500 mg kg-1; respectively). Both treatments had a hydrophilic behavior of the soil. These results suggest that the use of prescribed fires does not imply a detrimental effect on soil properties in the short term, however, to evaluate its long-term effect it will be necessary to continue with its annual monitoring.

**KEYWORDS:** wildfire risk, forest management, GRAF firefighters, soil parameters.

# EFFECTS OF CLIMATE ON FIRE

# Advancing Knowledge of Fire Response to Climate Change: The ONFIRE Project

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**Abstract:**
The increasing exposure of society to large fires has raised concerns about potential shifts in fire regimes due to climate change. To adapt fire management systems and develop future prevention strategies, understanding the response of fires to climatic variations is essential. However, much remains to be discovered about this topic.
The ONFIRE project, a Spanish national research initiative supported by the State Investigation Agency and the Ministry of Science and Innovation, seeks to advance the state-of-the-art knowledge of climate impacts on fires beyond its current limitations and applications. Moreover, the project is open to contributions from any researcher or fire agency and we invite them to join this initiative.

This paper presents some preliminary results related to the main objectives of the ONFIRE project:

- The creation of a unified, open-access, and user-friendly database that includes all available burned area records from national inventories.
- A better understanding of past trends in fire series and their attribution to the anthropogenic component of climate change.
- The design and implementation of a public operational prototype system to perform global seasonal predictions of climate-driven fire risk for decision making applications.

We acknowledge funding through the ONFIRE project (grant PID2021-123193OB-I00) funded by MCIN/AEI/10.13039/501100011033. A.G. thanks the Ministerio de Ciencia, Innovación y Universidades of Spain for the PhD contract FPU19/06536.

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# Increasing of mega forest fires in Chile: how to prevent and mitigate the soil damage in forestry plantations and in the endemic native forest?

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**Abstract**

The 2022-2023 Chilean summer season brought increased temperatures and a burned area similar to that affected during the 2016-2017 season. In each season approximately 500,000 hectares were compromised, mostly located in the rural sector. A brief review revealed that studies regarding the effects of forest fires on soil and hydrological processes are scarce in Chile. Here, we implemented a climatological analysis that showed sharp temperature increases registered in the 2016-2017 season, considered unusual, as well as another unexpected increase four years later in 2022-2023, resulting in high-severity fires known as

‘mega-fires’ or “storm fires”. These fires affected forest plantations and native forests in southern Chile from 33º S (Maule Region) to 39º S (Los Ríos Region). Storm fires are expected to become increasingly frequent due to rising temperatures associated with climate change. Here, we present a brief overview of the influence of wildfires on soil components in the most affected areas of Chile (Coastal and Andes mountain ranges), their hydrological impacts, and their correlation to erosion risk. Also, we contrasted the effects of wildfire on plantations to those on endemic native forests. Wildfires created a potential risk of increased erosion and flooding of eroded Chilean hillsides and piedmont due to high winter precipitation. We propose several management practices that could help prevent or mitigate these problems, including pre-and post-fire interventions that are not similar in plantations and native forests, such as afforestation and seeding, selective logging, mulching, erosion barriers, soil preparation, and dam monitoring. Moreover, we conclude that the optimal solution in fire-affected areas could be a combination of hillslope soil and integral ecosystem management actions, whose effectiveness should be monitored and verified regionally at the watershed scale.
Project: “FiRING: Multiscale effects of extreme wildfires on soil, water, biogeochemical cycling and erosion in natural and managed forests”, ACT192006.

**KEYWORDS:** Wildfires, Soil erosion, Hydrological impacts, Climate change, Mega-fires, Storm fire, Management measures

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# Interaction between Snow Layer and Smoldering Peat Fire under Extreme Environment

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**Abstract**

Peatlands are critical carbon pools in tropical, boreal and Arctic ecosystems, storing over one-fifth (500-600 Gt) of Earth's terrestrial organic carbon. On the other hand, peat is also a porous and charring natural fuel that is prone to smoldering fires. Smoldering is the combustion phenomenon in the absence of flame. Smoldering wildfires are difficult to detect due to their low temperature and propagation rate, as well as their ability to sustain underground. Even though the smoldering fires were observed, it is still challenging to extinguish since they can survive in more extreme conditions (i.e., higher moisture content, less oxygen supply and lower ambient temperature). During the past several decades, smoldering peat fires often occur in boreal and even Arctic areas with extreme temperatures. However, it is still not clear how the snow weathers that are expected in these areas will affect the smoldering fires, and whether the smoldering fire will influence the surface snow layer. Therefore, in this work we conducted experiments under sub-zero temperature to investigate the interaction between the snow layers and smoldering peat fires below them.

Results show a significant difference between snowfall and accumulated snow layer on smoldering fires. Natural snowfall is very difficult to extinguish a smoldering fire, because even in the case of heavy snow, the actual amount of precipitation is relatively low (< 5 mm in the experiments). On the other hand, it is found that when the snow layer thickness exceeds 9 cm (equivalent water column height 20 mm), the smoldering will be significantly affected and eventually extinguished. This is because of the heat absorption from both snow melting process and the evaporation of water after melting. This work help understand the smoldering behaviors of peat soil under extreme environment as well as the interaction of snowfall weather and smoldering wildfires.

**KEYWORDS:**

Peat fire; smoldering fire; snowing effect; moisture effect; fire suppression; fuel mass loss; heat transfer; cold ambient; snowfall; snow layer.

# FIRE EFFECTS ON SOIL PROPERTIES

# DOES ASH COVER REALLY MATTER TO SOIL HYDROLOGICAL RESPONSE?

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**Abstract**
Wildfires and prescribed fires are occurring worldwide. The ash covering the soil post-fire creates countless complexities in understanding runoff and soil erosion. Therefore, it is not uncommon to find ambiguous or contradictory results in the literature. The objectives of this study are to (1) test if the ash covering the ground can affect runoff and soil erosion; (2) test if the runoff and soil erosion change with ash covering in different plot slopes (6° and 11°). In this study, the measurements of soil and water losses were done on twelve 1 $m^2$ erosion microplots (0.5 m width × 2.0 m length). The erosion plots were set up in pairs in two random blocks on slopes of 6° or 11°. Each block was composed of six paired plots. Ash was allowed to remain in one plot of each pair and carefully removed from the other plot. The combined average soil loss from the 12 plots was 360.8 ± 350.5 $g.m^{-2}$. Ash was responsible for around 40% of the total sample weight at the study's start (one month). Rain volume was more effective in producing runoff than soil loss. Soil loss was highly variable between plots, even in the same block and treatment. Probably, the fire severity variability (i.e., patchy) has a bigger impact on the hydrological processes than ash cover and slope. We noticed no effect of ash in reducing or increasing surface erosion and runoff. The process of runoff and soil erosion is scale-dependent. In addition, the characteristics of the experiment (i.e., plot length of 2-m) may have prevented the ash effect from being detected (null results) compared to most studies reported in the literature.

**KEYWORDS:** prescribed fire, slash-and-burn, mixed ashes, replication experiment.

Please note that there will be no editing of the abstracts.

# Post-fire forest floor succession in a Central European temperate forest depends on organic matter input from recovering vegetation rather than on pyrogenic carbon input from fire

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The predicted global increase in the frequency, severity, and intensity of forest fires includes Central Europe, which is not currently considered as a wildfire hotspot. Because of this, a detailed knowledge of long-term post-fire forest floor succession is essential for understanding the role of wildfires in Central European temperate forests. In this study, we used a space-for-time substitution approach and exploited a unique opportunity to observe successional changes in the physical, chemical, and microbial properties of the forest floor in coniferous forest stands on a chronosequence up to 110 years after fire. In addition, we assessed whether the depletion of organic matter (OM) and input of pyrogenic carbon (pyC) have significant effects on the post-fire forest floor succession. The bulk density (+174%), pH (+4%), and dissolved phosphorus content (+500%) increased, whereas the water holding capacity (–51%), content of total organic carbon and total nitrogen (–50%), total phosphorus (–40%), dissolved organic carbon (–23%), microbial respiration and biomass (–60%), and the abundance of fungi (–65%) and bacteria (–45%) decreased shortly after the fire event and then gradually decreased or increased, respectively, relative to the pre-disturbance state. The post-fire forest floor succession was largely dependent on changes in the OM content rather than the pyC content, and thus was dependent on vegetation recovery. The time needed to recover to the pre-disturbance state was < 110 years for physical and chemical properties and < 45 years for microbial properties. These times closely correspond to previous studies focusing on the recovery of forest floor properties in different climate zones, suggesting that the times needed for forest vegetation and forest floor properties to recover to the pre-disturbance state are similar across climate zones.

**Keywords:** space-for-time substitution; chronosequence; coniferous forest; nutrients; microorganisms

# The immediate impact of forest fire on soil infiltration rates. The Pinet forest fire in Eastern Spain

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**Abstract**
Forest fire induces the loss of most of the vegetation cover, changes in the soil properties due to the heating, and the development of an ash bed. Fire also changes the soil's hydrological properties. Although little has been researched on fire-affected land, soil infiltration is a key process in the hydrological cycle. Before and after the forest fire of Pinet (August 2018) a set of water infiltration measurements using ring infiltrometers was developed. Twenty measurements were carried out before (summer and winter 2017), immediately after (August 23rd, 2018), and 4, 12, 18, and 24 months after the fire. The results show an increase in infiltration rates immediately after the wildfire and a decrease once the ash bed was removed or transported to the soil porous soil. After two years, the infiltration rates were still low compared to the immediate post-fire and pre-fire conditions. We found that the infiltration rates were highly variable before the forest fire and the impact of the fire reduced the spatial variability. The seasonal cycle of the infiltration rates determined by the Mediterranean summer drought was disturbed by the impact of fire.

**KEYWORDS:** Fire, Wildfire, Oaks, Soil, Infiltration, Pinet, Mediterranean.

# Surveying key soil hydrological properties and the activation of soil erosion processes in the 2022 Guájares forest fire

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In 2022, in Los Guájares, Granada, 5,000 ha were affected by a forest fire reaching a perimeter of 150 km. To date, the origin and causes of this forest fire are unknown. The general objective of the research is to establish the bases for the realization of a first map of soil properties, especially hydric and biological, in soils subjected to different uses, in recently burned and adjacent areas. This objective is intended to be, in turn, the starting point for the application of a larger-scale project. The research presents a multidisciplinary and transversal approach, aimed at a problem with global repercussions that requires an urgent response and from a multiscalar point of view: key soil hydrological properties and the activation of soil erosion processes. We conducted drone flights, rainfall simulation experiments, and infiltration measurements, and sampled a total of thirty rings (15 in a severely affected burned area and 15 in a non-burned mango plantation) to assess hydrophobicity (drop test), saturated hydraulic conductivity and water retention capacity. Moreover, using an online geographic information tool designed by Auravant, we will assess vegetation changes and status before and after the forest fire.

**Keywords:** land management; regional geographic analysis; land-use changes; Los Guájares

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# FIRE EFFECTS ON BIOTA

FE SP 9 NL2023

**Soil fauna in the post-fire chronosequence: the effects of the simultaneous evolution of soil properties and carbon**

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After forest fire, restoration of affected soil organic matter and other soil properties and biotic communities begins. The exposed substrate is colonised by soil organisms involved in soil formation, a process in which soil properties and the biotic community interact. In this complex study, soil fauna was investigated along the chronosequence of former forest fires in the Bohemian Switzerland National Park in the Czech Republic. The recovery of different groups of soil fauna after fire on a chronosequence of burned areas was studied, ranging

from recent sites to sites more than a hundred years old. We studied all important groups of soil fauna such as microfauna (Rotifera, Nematoda, Tardigrada), mesofauna (Acari, Collembola, Enchytraeidae, Protura) and macrofauna (Lumbricidae, Diplopoda, Chilopoda, Formicidae, Aranea). Community development was characterised by a gradual addition of species, with many pioneer species remaining present throughout the soil development. In general, abundance and species richness of soil animals increased from the earliest to the well-developed sites, and in most groups the pre-fire condition is reached up to 40 years after fire. It can be said that severe fire greatly changes the conditions in the soil profile by removing mainly the upper litter layer, which in turn affects the entire faunal community, whose recovery is closely related to its development.

Key words: Forest fire, soil fauna, soil organic matter, microfauna, mesofauna, macrofauna, microflora community, chronosequence.

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**Title: Disentangling how the parasitic fungus *Armillaria* and other biotic drivers affect the flammability of coarse deadwood in exotic pine plantations**

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**Abstract**
Parasitic wood fungi are important to forest carbon cycles globally. However, whether or how they affect the flammability of coarse deadwood is poorly understood. Given the predicted climate-driven increase in wildfires and associated carbon emissions into the atmosphere, potentially amplifying climate warming, filling this knowledge gap should have high priority.

We thereto investigated coastal *Pinus nigra* J.F. Arnold plantations in the Netherlands, which are widely suffering from *Armillaria mellea* (Vahl) P. Kumm. infection. We hypothesized: At given wood density, branches from *Armillaria* infected forest stands will burn at higher intensity than branches from uninfected stands.

We tested this hypothesis by burning coarse *Pinus nigra* branches across a range of densities from infected and uninfected forest patches under standardized conditions in a fire lab and by measuring *Armillaria* biomass (via ddPCR), deadwood traits and key flammability parameters.

*Armillaria* infection did increase the flammability of *Pinus nigra* branches. This higher flammability originated from both direct *Armillaria* influences, e.g. via changing wood structure, and indirect influences, e.g. by facilitating nitrogen fixation in wood, thereby increasing wood decomposability and consequently reducing wood density. Thus, gradually

replacing these exotic pines with more resistant native species in future forest management, may help to reduce wildfire risks.

**Keywords:** parasitic fungus, black pine, honey fungus, plant flammability, coarse deadwood, wildfire

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# Short-term behaviour of soil fungal and bacterial communities after a wildfire in a *Pinus sylvestris* ecosystem

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**Abstract**

The impact of wildfires on soil microbiota and their post-fire development over time are highly dynamic with regard to community composition and microbial functionality. In this study, fungal and bacterial groups were analyzed for nine months after the Navalacruz wildfire in a *Pinus sylvestris* area in Spain. Seven sample plots of 1x1m were chosen within the wildfire perimeter, and soil samples were taken in October-November, and in June (1, 2, and 9 months after the wildfire), five control samples were taken from a similar area outside the perimeter of the wildfire in June. All soil samples were frozen until DNA extraction in the laboratory. Metataxonomic techniques were used to define the composition of bacterial and fungal communities.

The results showed different patterns in alpha diversity variables such as rarefaction richness, Shannon's Diversity, or Simpson's dominance in bacterial and fungal communities. The bacterial community showed a significant decrease in all alpha diversity variables immediately after the fire, followed by a pattern of recovery towards control values. The changes in the fungal community were less significant regarding Shannon's diversity and Simpson's dominance. However, Simpson's dominance and rarefaction richness showed a decreasing pattern nine months after the fire, indicating long-term effects on fungal community composition.

The relative abundance of principal taxonomic levels in bacterial and fungal communities also exhibited differences. Principal bacterial phyla like Actinobacteria and Proteobacteria showed little variation in the first and second month after fire, but in the ninth month they had an important increase. Other phyla like Firmicutes or Bacteroidetes increased in the first months and then decreased in the ninth. Acidobacteria showed a significant decrease in their relative abundance over the time. Regarding the fungal community, the Agaricomycetes class (Basidiomycota phylum) was the most dominant in control samples. However, this class decreased after the fire. Some classes like Pezizomycetes were dominant

in the first and second month after fire and then decreased, while high relative abundance of different Ascomycota classes were observed in the ninth month.

In conclusion, the first year after fire resulted in significant changes in the soil microbial community of *Pinus sylvestris* ecosystem. These findings provide insights into the dynamics of soil microbiota after wildfires and their potential impact on ecosystem recovery.

**KEYWORDS:** Microbial communities; Fungal; Bacterial; temporal turn-over; post-fire.

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# Short-term impact of fire on the total soil microbial and nitrifier communities in a wet savanna

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## Abstract

Savannas are characterized by the coexistence of grasses and trees. Fires are critical for their coexistence, because they decrease the survival of tree seedlings and saplings and their recruitment to the adult stage. In some humid savannas, perennial grasses inhibit nitrification, this ability to suppress soil nitrification is called biological nitrification inhibition (BNI). Grass roots exudate into the soil nitrification-inhibiting molecules that can block the bacterial ammonia oxidation (AOB) pathway and probably the archaeal ammonia oxidation (AOA) pathway. Besides, in humid savanna such as Lamto (Ivory Coast), trees probably stimulate nitrification through a mechanism that has so far not been identified. As a result, grasses and trees create heterogeneity in N cycling, which could facilitate their coexistence. However, fires may influence plant capacity to control nitrogen cycling, which could subsequently influence tree–grass coexistence and savanna nitrogen budget.

Therefore, we sampled soil in a humid savanna of Ivory Coast under the dominant nitrification-inhibiting grass species and the dominant nitrification-stimulating tree species and under bare soil before and after (i.e., 5 days) fire during the long dry season. We quantified the total microbial and nitrifier abundances and transcriptional activities and the nitrification enzyme activity.

Fire decreased soil water content, probably by increasing evaporation and, maybe, by triggering the growth of grasses, and increased soil ammonium availability likely due to ash deposition and increased mineralization. Fire did not impact the total archaeal, bacterial, or fungal abundances, or that of the nitrifiers. Fire did not impact archaeal transcriptional activity but increased bacterial and fungal total transcriptional activities. In contrast, fire decreased the archaeal nitrifier transcriptional activities and the nitrification enzymatic activity, likely due to the often-reported resumption of the growth of nitrification-inhibiting grasses quickly after the fire (and the subsequent increase in root exudation). These results pave the way for a better understanding of the short-term effects of fire on nitrogen cycling and tree–grass competition for nitrogen.

**KEYWORDS:** AOA, AOB, Biological Nitrification Inhibition (BNI), fire, nitrification, perennial grasses, savanna, trees

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# Changes in soil microfaunal communities during the first 110 years after a wildfire in Central European pine forest

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**Abstract**

Metazoan microfauna such as nematodes, rotifers, and tardigrades live in soil and help to recycle nutrients and support plant growth. They usually stay in place during disturbances, waiting for the amelioration of conditions in the resting state called cryptobiosis. In this state, they can survive extreme conditions, for example, complete drought, extreme temperatures, and the presence of toxic compounds. When the environment becomes hospitable again, they revive from the resting state and play an important role in early soil development. Fire, however, may represent a disturbance hard to survive even for these durable animals. Here, we observed the post-fire development of nematode, rotifer, and tardigrade communities on a long-term gradient (up to 110 years after fire). By studying the traits of these microfauna, we could understand how these changes affected the soil food web and ecosystem functioning. The research was performed in a transnational natural park between Germany and the Czech Republic – Bohemian/ Saxon Switzerland. In this area, fires are part of natural development for at least the last 2500 years. Since fires are becoming more frequent and intense due to climate change, it is essential to understand how microfauna recover after a fire to assess future risks and support recovery efforts.

**KEYWORDS:** nematodes, rotifers, tardigrades, micro food web, long-term fire effect

Please note that there will be no editing of the abstracts.

# OPEN SESSION

FE SP 9 NL2023

# ANALYSIS OF SUB-WATERSHEDS BURNT AREA USING MACHINE LEARNING MODELS

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**Abstract**

Following wildfires, there is an increase in soil erosion, which helps to move, transport, and deposit sediments and nutrients in watersheds. The quality of the water is harmed by this scenario. In the Iberian Peninsula, wildfires have a tendency to grow in response to climate change; therefore, soil erosion must also rise, worsening water availability. To ensure that the population has access to clean water for consumption, steps should be taken to reduce the consequences of soil erosion in watersheds. The aim of this study was to assess machine learning models in watersheds with recurring fires. Sub-watersheds in northern Portugal and Catalonia, Spain, were investigated. The parameters analyzed were: burnt area by watershed, soil erosion by water in Europe - Revised Universal Soil Loss Equation (RUSLE2015), Topographic Wetness Index (TWI) and the morphometric parameters: Elongation ratio (Re), Circularity ratio (Rc), Compactness coefficient (Cc), Form factor (Ff), Shape factor (Sf), Area (A), Perimeter (P), Length (L), Width (W), Orientation (O), Altitude, Slope, Curvature and the machine learning, Support Vector Machine Linear (SVMLinear), Support Vector Machine Polynomial (SVMPoly) and Random Forest (RF). The classification and regression training care package was used to create the analysis in R. The best models considering Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) were the RF and SVMpoly with small data dispersion, while SVMLinear registered greater dispersion. The variables that registered the most importance in the analysis were A, Cc, P, Rc, and W. This indicates that an analysis that takes into consideration morphometric data, along with data on soil erosion by water and soil moisture, is a key indication in the study of soil erosion in watersheds.

**KEYWORDS:** Soil erosion, wildfires, recurrence fires, RUSLE, Iberian peninsula.

# Wildfires as a Weathering Agent of Carbonate Rocks

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While most of the scientific effort regarding wildfires has predominantly focused on fire effects on vegetation and soils, the role of fire as an essential weathering agent has been largely overlooked. Our study aims to evaluate rock decay processes during wildfires in relation to ground temperatures and rock morphologies of limestone, dolomite, and chalk. In 2010, a major forest fire in Israel caused massive destruction of the exposed rocks and accelerated rock weathering over the burned slopes. While a detailed description of the bedrock exfoliation phenomenon was previously reported, here we conducted an experimental open fire to determine the temperature and gradients responsible for boulder shattering. The results show ground temperatures of 700 °C after 5 min from ignition, while the peak temperature (880 °C) was reached after 9 min. Temperature gradients show a rapid increase during the first 5 min (136 °C/min), moderate increase during the next 4 min (43 °C/min), and slow decrease for the next 9 min (25 °C/min). After 12 min, all boulders of all lithologies were cracked or completely shattered. The behavior of carbonate rocks upon heating was studied to identify the erosive effects of fire, namely the formation of new cracks and matrix deterioration.

**Keywords:** wildfires; mechanical weathering; exfoliation; rock breakdown; thermal shock; carbonate rocks; limestone

# Soil, Water and Fire concepts at the Degree in Agrifoods and Rural Environmental Engineering. Universitat Politècnica de València.

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**Abstract**

The key to understanding Earth's biogeochemical cycles is fire, water, and soil. However, in most environmental degrees, the three terms do not show equally. We here review the number of times that Fire, Water, and Soil concepts are used at the Degree in Agrifoods and Rural Environmental Engineering "Grado en Ingeniería Agroalimentaría y del Medio Rural" from the Polytechnic University of Valencia. The results show that Water is shown 103, Soils 50, and Fire 0. The use of fire by humans and the importance of fire on the Earth System is not shown. We wish to discuss this situation in comparison to other degrees in different universities of the world and create a debate about the importance of fire in university curricula.

**KEYWORDS:** Fire, Education, University, Spain, Soils.

# POSTER CONTRIBUTIONS

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# The role of post-fire erosion in the Carbon cycle

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**Abstract**

Wildfires burn on average 448 million hectares globally every year, releasing around 2.2 Pg of carbon (C) into the atmosphere. The net effect of wildfires in the C cycle goes, however, beyond emissions and involves many other interacting processes. Among those, there is a significant knowledge gap on the role of post-fire soil organic carbon (SOC) erosion as a carbon sink mechanism.

The post-fire erosive response is greatly enhanced by the direct and indirect effects of wildfires on soil and vegetation, such as the loss of protective cover and soil structure or the development of a water-repellent layer. In addition, biomass and soil organic matter undergo quantitative and qualitative changes during wildfires, such as the formation of pyrogenic carbon, highly resistant to degradation. The resulting PyC and non-PyC carbon fractions, with contrasting physical properties and chemical stability, will be differently redistributed and mineralized during the erosion process. Ultimately, post-fire SOC erosion could act as a carbon sink when the post-fire burial and stabilization of eroded carbon, together with the recovery of net primary production and soil organic carbon content, exceed the SOC losses during its post-fire transport. All these processes have been scarcely investigated and poorly quantified to the date. In this presentation, we will provide new insights into the magnitude of post-fire SOC erosion, reviewing the state of the art and highlighting key research gaps.

**KEYWORDS:** redistribution; soil organic carbon; carbon sequestration; erosion; soil

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# Impact of the risk of forest fires on nature tourism in protected areas of Northwest Portugal

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**Abstract**

Portugal faces serious risks of wildfires in rural and nature protection areas in the Northwest of the country, influenced by various factors, including climate, flammable vegetation, and inadequate forest management practices [1]–[3]. This has a significant impact on tourism, especially in protected areas with a dense network of hiking trails, where there are additional risks due to careless use of fire and lack of trail maintenance. The CLICTOUR project – *Climate change resilient tourism in protected areas of Northern Portugal (NORTE-01-0145-FEDER-000079)*, aims to establish a link between the highest occurrence of forest fires within the only national park, Peneda Gerês National Park, and the country's smaller park, Alvão Natural Park, as well as the hiking trail network within these two protected areas. The protected areas present numerous problems, such as the absence of escape routes, exacerbating the risk of exposure to adverse smoke conditions, and posing a risk to the safety of hikers. The presence of hiking infrastructure in high fire risk has also been observed. The use of hiking trails in fire-affected areas hinders vegetation recovery and damages tourist attractiveness [5]–[8].

Trends indicate that the Mediterranean climate, characterized by hot and dry summers, will tend to lengthen the dry season. The Northwest region of Portugal is characterized by the presence of highly flammable vegetation, such as eucalyptus, making the areas particularly susceptible to large-scale fires [1]. The abandonment of agricultural lands and inadequate agricultural and forest management practices also contribute to the increased risk of fire [3],

[4]. Furthermore, many fires are caused by human negligence or criminal actions, such as burning rubbish or intentional arson [1]. Therefore, it is essential to implement effective risk management to protect forests against fires and preserve biodiversity, promote rural development, and increase tourism revenues.

**KEYWORDS:** Forest fires, protected areas, vegetation recovery, destruction of forest heritage.

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# Economical analysis of the use of prescribed fire in natural generation studies

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**Abstract**
Prescribed fire is used for forestry purposes. Revealing the fire-ecosystem interaction in many aspects has increased the use of fires in ecosystem services. Silvicultural use of fire involves site preparation, managing competing vegetation, stand conversion and stand rehabilitation. Prescribed fire is an economical and practical tool in pine stands.
In this study, economic analysis of different silviculturel practices used in site preparation phase in natural regeneration studies was made. In addition, a regeneration approach based on the role played by fires in ecosystem processes was also suggested for the Türkiye. Study areas were determined in pure Anatolian black pine (*Pinus nigra* Arn. subsp. *pallasiana*) and scots pine (*Pinus sylvestris*) stands, which were included in the natural regeneration program. Study areas are divided into experimental plots where different silvicultural practices are carried out. Cost-benefit analysis was made regarding the silvicultural practices carried out in these experimental plots.
As a result of the cost-benefit analysis, it has been determined that it is economically viable to integrate fires into natural regeneration practices. The use of fire in site preparation phase was more economical than mechanical site preparation. There was no significant difference between the approach that takes into account the use of fire and the regeneration method used in practice in terms of the economic benefit to be obtained. Moreover, it should not be overlooked that besides the economic benefits of the use of fire, there are also many benefits that cannot be expressed in money. In the approach proposed within the scope of the study, it is foreseen to shorten the natural regeneration period. It is thought that this situation will positively affect the growth and development of the stand, while reducing the costs incurred in regeneration studies.

**KEYWORDS:** Fire management, Prescribed fire, Shelterwood system, Pine ecosystems, Cost-benefit analysis

# USING SOIL PROFILE DESCRIPTIONS TO DESCRIBE THE IMPACTS OF HUMAN MANAGEMENT IN MEDITERRANEAN BURNED FOREST AND AGRICULTURAL FIELDS

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**Abstract**
Soil profiles in burned areas can be significantly affected by wildfires. Wildfires can cause severe damage to the vegetation and organic matter in the soil, which in turn can impact the physical, chemical, and biological properties of the soil. The severity of the impact on the soil profile will depend on the intensity and duration of the fire, as well as the type of soil and vegetation present in the area. In this research, survey different soil profiles to assess the soil quality status, changes and evolution after a different number of wildfires (no-fire, once and twice) and management (abandoned agricultural terraces and reforested hillslopes). We considered an experimental area located on the Balearic island, in the municipality of Andratx. We conducted an exhaustive fieldwork campaign surveying different soil profiles and sampling and analyzing the main soil properties in each soil horizon. We consider each soil profile attending the type of management, the land-use and main geomorphological processes, for example, slope, altitude and connectivity index. We hypothesize that the characterization of the current status of the soil profiles will allow us to understand the possible loss of organic matter, soil compaction, changes in soil structure, nutrient levels, loss of soil biodiversity. This will help us to understand the impacts of wildfires on soil profile, post-fire management practices such as erosion control, reforestation, and soil amendment.

**Keywords:** Soil profiles; soil geography; wildfire; resilience;

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# Fire against chipped pruned branches. A long-term research on soil organic matter, bulk density, infiltration rates and water repellency in citrus plantations.

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**Abstract**
European, national, regional, and local policies demand the removal of fire as a tool to manage chipped pruned branches in the fields. The use of fire is traditional in groves of citrus in Eastern Spain. Several causes induced the policymakers to promote subsidies and restrictions on the use of fire to change the strategy. The use of fire in the fields can cause wildfires. Moreover, chipped pruned branches can be a source of nutrients for the soil and improve soil properties, but litter research has been done on this.
We measured on 21 years old chipped pruned branches in citrus fields the soil organic matter content, soil water repellency (WDPT- Water Drop Penetration Time), the soil bulk density, and the infiltration rate (single ring infiltrometer) and in a paired plot where the branches were burnt. The samples were collected at 0-1, 2-3, 5-6, 10-11, 20-21, and 30-35 cm depth. Soil organic matter increased mainly in the 0-1 cm sample and changed from 1,1 % to 5,23 %. After 10 cm there were no significant changes. Soil water repellency was found in the chipped pruned branch plots but not in the fire ones. Bulk density reduces in the surface from 1.43 g $cm^{-1}$ to 1.32 g $cm^{-1}$. The steady-state infiltration rate moved from 63 mm $h^{-1}$ to 234 mm h-1 due to the development of macropores.
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**KEYWORDS:** Branches, Soil, Fire, Infiltration, Branches, Citrus, Soils, Valencia.

# Impact of Climate Change and Temperature Increase on Increased Forest Fire Risk in Protected Areas in Northwest Portugal

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**Abstract**

One of the most sensitive environmental problems in the national territory, in the last five decades, closely related to climatic factors and affecting the National Park of Peneda-Gerês and the Natural Park of Alvão is the forest fires. Under the project CLICTOUR - "Climate change resilient tourism in protected areas of Northern Portugal", data from the model HadGEM3-GC31-LL, provided by the Coupled Model Intercomparison Project, phase 6 (CMIP-6), were analyzed in RCP (Representative Concentration Pathways) scenarios 4.5 (moderate) and 8.5 (extreme). Maximum and minimum temperatures were also evaluated for the two natural parks under analysis.

In the Peneda-Gerês National Park (PNPG) between 1975 and 2022 fires caused 9 356.89 hectares of burned area. In the RCP 4.5 scenario, the minimum average temperature in the PNPG will increase by 1.6ºC and the maximum average temperature will increase by 2ºC until 2100. For the same period, in the RCP 8.5 scenario, the minimum and maximum temperatures will increase, on average, 3.5ºC and 4.6ºC, respectively.

In the Alvão Natural Park (PNA), between 1975 and 2022 there were 2 863.22 hectares of burnt area, with burnt areas with higher frequency and dimension. In the RCP 4.5 scenario the average minimum temperature in the PNA will increase by 0.85ºC and the average maximum temperature will increase by 1.2ºC until 2100. For the same period, in the RCP 8.5

scenario the minimum and maximum temperatures will rise by an average of 1.5ºC and 1.9ºC, respectively.
For both parks, the periods of high temperatures will be extended to more months of the year.

**KEYWORDS:** Forest Fires; Climate Change; Protected Areas; Temperature Increase; Forest Destruction.

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# Chemical characteristics of wildfire ashes across the globe and their relationship to soil properties

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**Abstract**

The combustion of biomass during wildfires results in the formation of an ash layer, which is highly erodible and often enriched in nutrients and contaminants compared to the underlying soil. The mobilisation of potentially harmful constituents in wildfire ash poses widespread societal risks, including risks to human health, and socio-economic and environmental impacts. A fuller understanding of ash chemical composition is needed to anticipate and mitigate these risks. We present a global dataset on the chemical characteristics of a wide range of ashes (42 types and a total of 148 samples) from a range of ecosystems and burn severity conditions and compare these to those of underlying soils. We analysed physicochemical properties, including major nutrients and toxic metals, and completed an extensive review of studies analysing chemical composition of wildfire ash to complement and compare our ash dataset.

Most ashes in our dataset were alkaline (mean pH 8.8, ranging between 6 – 11.2). The main components in the ash (mean; minimum and maximum) were organic carbon (204; 2.5 – 450 g $kg^{-1}$), calcium (47.9; 1.3 – 215 g $kg^{-1}$), aluminium (17.9; 0.6 – 69.3 g $kg^{-1}$), and iron (17.1; 0.6 – 77.2 g $kg^{-1}$). Mean nitrogen and phosphorus ranged between 1 - 25 g $kg^{-1}$, and between 0.2 to 9.9 g $kg^{-1}$, respectively. The largest concentrations of metals of concern for human and ecosystem health were observed for manganese (1,488; 34.5 – 15,350 mg $kg^{-1}$), zinc (181; 25.5 – 1,016 mg $kg^{-1}$) and lead (67; 1 – 782 mg $kg^{-1}$). Burn severity and sampling timing significantly influenced key chemical characteristics in the ash like pH,

carbon and nitrogen concentrations. Concentrations of elements of concern were very close to, or exceeded international contamination standards in some ashes, however, the actual effect of ash will depend on factors like ash loads and the dilution into environmental matrices such as water, soil and sediment. Given the absence of established procedures for sampling and analysis of wildfire ash, our approach can serve as an initial framework for standardizing sampling and chemical analysis protocols.

**KEYWORDS:** wildfire impacts; water contamination and eutrophication; water quality; ash redistribution; biogeochemical cycles; element mobilization

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# Physicochemical drivers of postfire boreal community assembly in a changing climate

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**Abstract**
The boreal region accounts for only 10% of global land cover yet stores 40% of the earth's terrestrial carbon (C). High-latitude systems are experiencing some of the most rapidly increasing temperature and fire activity, threatening to release large amounts of their dense C reserves to the atmosphere. While climate and wildfire place strong controls on ecosystem function, little is known about their synergistic effects. To fill this knowledge gap, we sampled 50 separate wildfires occurring in 2018 which spanned the near-entire climatic range of boreal Sweden. It was found that climate influenced prefire soil fuel amount and quality, which in turn controlled C and nitrogen (N) removal levels. Warmer regions preserved more N relative to C during burning, promoting enhanced nutrient mobilization under oligotrophic processing of residual burnt organic soil. Ecosystem restructuring due to burning appeared to be responsible for increased climatic control over microbial community structure and nutrient cycling, with this control mitigated by residual vegetation structure adapted to previous climates. The results suggest that climate change and burning have the power to deborealize large areas of land, with dwindling resilience provided by persisting stand structure.

**KEYWORDS:** boreal forest wildfire, carbon emissions, nutrient cycling, microbial community, plant community, climate change, secondary succession

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# Characterizing Forest Fire-Affected Soils in SE France

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**Abstract**
Forest fires burn close to half a million ha each year in the Euro-Mediterranean zone. The combustion of live and dead vegetation leaves the soil surface bare and exposed to post-fire runoff and soil erosion processes which contribute to downstream flooding risks and soil degradation. Characterizing soil properties of fire-affected soils allows us to better model these risks and define appropriate post-fire response strategies. The objective of this study was to quantify soil characteristics of burnt soils in SE France. A GIS burn scar database was used to map areas affected by forest fires in SE France since 1990. Burn scar polygons covered a total area of about 220 kha and were overlain on vegetation and soil depth, pH, and texture maps to calculate both the distribution of burnt polygons by category and the percentage of each category affected by a forest fire. Shrublands are the vegetation type most affected by forest fires: 54% of wildfires occur on shrublands and 49% of shrublands have been burnt at least once. In addition, 59% of areas burnt more than once are in shrublands. The other vegetation categories all have values less than 20%. Shallow soils are the category most affected by fires: 46% of fires occur on soils <30 cm and about 20% of these soils are affected by forest fires, the greatest percentage area of all soil depth categories. In comparison, only about 10% of soils with depths >100 cm have experienced a forest fire. Shallow soils can be either sandy or sandy loam soils with slightly acidic pH values or slightly alkaline soils richer in clay depending on parent material. In the first case, *maquis* shrublands develop on crystalline metamorphic substrates made up mainly of gneisses and schists. In the latter case, *garrigue* shrublands occupy limestones. The results highlight the role soils play in determining vegetation type (deeper soils tend to be forested while shallow soils support shrublands) and biomass inflammability since shallow soils have lower soil water reserves. In addition, the results provide some indication of suitable parameters for runoff and soil erosion modeling since soil depth and texture determine both infiltration rates and soil erodibility.

**KEYWORDS:** fire-affected soils, soil depth, soil texture, fire-affected vegetation, post-fire runoff, post-fire soil erosion

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# Burning against chipped pruned branches in citrus plantations. Their impact on soil infiltration rates.

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**Abstract**

Fire has been used in agricultural land since agriculture's invention. Fire has been applied to open forests, remove scrubland, favor herbaceous covers for grazing, removal the residues, and in fruit and citrus production areas to remove the chipped pruned branches. Until the 1990's, the pruned branches use to be burnt in the fields, and since then, the option to chop them is getting more successful and getting popular due to: i) improvement in the machinery and the prices of the chopping; ii) increase of the cost of labor to burnt the branches; iii) restriction due to risk of forest fires in nearby forest and rangelands, and; iv) the pressure to reduce the CO2 emissions and increase the soil carbon.

Within the REACT4MED PRIMA project, the impact on soil properties of the chipped pruned branches is researched in the Montesa study area, Eastern Iberian Peninsula. We selected two paired plots: i) CONTROL, where branches are removed and burnt; and ii) BRANCHES, where the branches are chopped. Ring infiltrometer measurements were carried out in 25 sites in the interrow area of the CONTROL and 25 in one of the BRANCHES. The measurements were carried out in 2016 and 2022. Until 2017 the two plots burnt the branches, and after 2017 different management was applied. In 2016 the mean steady-state infiltration rate was 56.45 mm $h^{-1}$ in the BRANCHES and 57.45 $mmh^{-1}$ in the CONTROL. Six years after the use of chipped pruned branches resulted in an increase in the steady-state infiltration rate (123.45 $mmh^{-1}$) meanwhile in the CONTROL plots the average steady-state infiltration rate was 55.87 $mmh^{-1}$. The influence of the chipped pruned branches resulted in an increase (x2) in the infiltration rates. We propose that fire will be removed from the agriculture fields as the use of chipped pruned branches increases the infiltration rates and results in the improvement of the soil quality, and reduce the runoff discharge.

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**KEYWORDS:** Infiltration, Branches, Citrus, Soils, Valencia.


# Soils and Fire concepts in the Spanish primary education system

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**Abstract**

Soils are the key component to understanding the biogeochemical cycles on Earth. Soils were developed upon the plant colonization of the continents. The fire was present in the Earth System since plants colonized the continents 400 million years ago. Then, fire and soils are twins in the Earth's evolution. Primary school teaches the basic knowledge of Earth Sciences and both, soils, and fire, should be present to achieve the main target of education to students from 6 to 12 years old. Primary Education is compulsory and free in Spain. It comprises six academic years that will provide a common education that makes possible the acquisition of basic cultural elements such as oral expression, reading, writing, and arithmetic calculations, as well as basic knowledge of their environment. We reviewed the current educational plans and look for the words soils and fire. We found that soils are mainly related to agronomy, and the environmental approach is not considered. The word fire only is used in a negative way. Both words never are connected. There is a need to introduce new concepts related to soil and fire in the Spanish primary school.

**KEYWORDS:** Fire, Education, Primary School, Spain, Soils.

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# Soil water repellency changes in Pinet fire-affected land. Western Mediterranean

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**Abstract**

Soil water repellency is a key hydrological process in Mediterranean forest as determine the surface runoff initiation. Water repellency can be removed or enhanced after forest fire, and usually is translocated to a few mm below the surface. We measured via 1000 drops located in a 1 m2 (100 x 100 cm) to determine the water repellency at different depths. The measurements were carried out before and after the forest fire in Pinet in August 2018). The measurements were carried out in the summer of 2017, 2018 (before, 4 days, and 4 months after the wildfire), 2019, and 2020. The measurements were carried out at 0, 1, 2, 5, and 10 cm of soil depth). The results show a sudden reduction in the soil water repellency because of the fire that mainly affected the surface layer. The water-repellent layer was not recovered over the three years after the fire.

**KEYWORDS:** Fire, Wildfire, Oaks, Soil, Water repellency, Pinet, Mediterranean.

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# Fire against chipped pruned branches. A economic approach.

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**Abstract**
In the Mediterranean groves and orchards, chipped pruned branches use to be removed from the fields and burnt since the 1960s. Before the Green Revolution, the branches were used as fuel or as a forage. The chipped pruned branches can be a source of nutrients as they contribute to enriching the soil after decomposition and mineralization. Moreover, chipped pruned branches act as mulch and induce higher water content, larger organic matter content, and improved soil aggregation. However, many farmers prefer to remove the branches, burnt them, and keep the fields "clean and tidy" with no other cover than the crop. Chipped pruned branches are a proven beneficial cover to reduce soil degradation, control soil erosion, and enhance soil water infiltration.
This research investigates the perception of the farmers and the cost to chop or burnt the branches. Based on 100 interviews of farmers from the La Ribera District, Valencia, Spain, we evaluate their perception of the use of chipped pruned branches, the cost, and the demand of the farmers to shift from fire to chopping the branches.
The results show that farmers use to prefer the use of fire and 22 chops of the pruned branches. The cost of the use of fire is on average 345 € $ha^{-1}$, meanwhile, the cost of chopping the branches is 250 € $ha^{-1}$. The cost to chop the branches decreased in the last 10 years from 410 € $ha^{-1}$ upon the interviews; meanwhile, the use of fire increased from 250 € $ha^{-1}$. Although in the last five years, the cost became lower, there is a perception among the farmers that the use of chipped pruned branches can create a problem of pests, and that they are not good farmers as the fields became "dirt". The use of fire is widespread in small farms, meanwhile, large farms use it to chop the branches. Farmers claim a subsidy of 222,23 € on average to shift from the use of fire to chop the branches.

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**KEYWORDS:** Fire, Branches, Orchards, Mediterranean, Valencia,, Branches, Citrus, Soils, Valencia.