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Introducing the use of fire for wildfire prevention in Greece: pilot application of prescribed burning in Chios island

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Abstract

This paper presents the first steps of a 2-year pilot project on prescribed burning (PB) in Greece. To re-introduce the use of fire in wildfire prevention in the country, as an accurate and effective management tool, more research is needed. Hence, we will conduct planned field PB experiments which will provide us sound knowledge about fire behaviour matched with the fire impact on soil properties, the effects on trees and the plant biodiversity. The experimental fires can serve as an excellent training tool, also, for some of the participants (firefighters, land managers and researchers).

The first efforts to introduce and utilize the PB in Greece begun in the 1970s, when members of the Greek forest scientific community and the Hellenic Forest Service applied PB experimentally, analysed data and drew some preliminary conclusions. They made some steps to document the use of fire and study its impacts before introducing PB as a tool to prevent forest fires. Unfortunately, without constant funding, legal support, logistics, continuous scientific guidance and clear objectives, those sporadic attempts did not tie bonds with the forest and fire management community and the endeavour was soon abandoned. Almost half a century later, fire is still not used in fuel management and fire prevention and there is no institutional framework for the implementation of PB.

Inspired by those first efforts in applying PB in Greece and guided by the fire science and the best practices for wildfire prevention, a core team of researchers and practitioners from WWF Greece, the Institute of Mediterranean Forest Ecosystems of ELGO "DIMITRA", the Forest Directorate of Chios Island, and the Voluntary Action Team "OMIKRON" started in 2021 a pilot project on the implementation of the PB on the island of Chios. Fire Service of Chios Island and Municipality of Chios support the pilot project by supplying water trucks and personnel during the burns. The Project is sponsored by Procter and Gamble corporation.

The project aims to introduce PB as a tool for forest fuel management, increase social– ecological resilience to wildfire and contribute to a climate – resilient future. More specifically, the project is expected:

i. to develop the standards and procedures, through applied research, for the use of the prescribed fire in Greece,
ii. to be a successful paradigm of fuel management,
iii. to strengthen the role of the forest service in fuel management and build the capacity of local stakeholders on potential contribution,
iv. to strengthen the horizontal cooperation among agencies, by introducing compatible methods and techniques,
v. to build the capacity of the volunteer firefighters' teams on issues related to the wildfire prevention and fuel management,
vi. to increase knowledge and improve experience on the fire behaviour,
vii. to further strengthen, improve and expand local alliances in Chios Island
viii. to improve landscape resilience and prevent forest fires.

1. Introduction

Prescribed burning (PB) is a fuel management (FM) method which can be either used alone or in combination with grazing and mechanical treatment (Stephens et al 2012), depending on many factors such as fire management objectives, forest types, location, fire regime (Jain et al 2012, Moghaddas et al. 2010), possible restrictions and on the different spatial and temporal scales at which FM is applied, fine and broad. It improves fire resilience over a particular landscape, reduces the probability of fire ignition, affects fire behaviour (Samara et al. 2018), making firefighting easier and safer, mitigates fire severity and reduces fire damages. PB is both science and technique and it can be a very accurate management tool.

Although increased PB is needed to provide a diversity of public benefits, including wildfire hazard reduction, improved forest resilience, and biodiversity conservation (Varner et al. 2021), there is practically no PB in many parts of Europe (Rego et al. 2010) and progress in adopting the method across the continent remains relatively limited. Only in Portugal, Spain, and south France, PB is practiced quite often, mainly for fuel reduction.

An evidence-based, and flexible approach to prescribed burning with emphasis to the biology and ecology of species and habitats, is needed (Fernandes et al 2013). A shift to 'knowledge' (Castellnou et al 2010) with improved reporting practices to invigorate PB science and suggest minimum reporting standards for future PB experiments, will facilitate future research syntheses, and foster actionable science (Bonner et al 2021). Unfortunately, planned field PB experiments are infrequent in Mediterranean ecosystems up to now, although they can provide sound knowledge about fire impact on soil properties and effects on trees.

In Greece there is no PB application for fuel management and wildfire prevention. In March 2022, Greek Parliament approved a law, making it legal for the firefighters to use backfire and burnout techniques for fire suppression and in June 2022, the government published the technical aspects on how to use them.

The first efforts to introduce and utilize the PB in Greece had begun in the 1970s, when members of the Greek forest scientific community and the Hellenic Forest Service applied PB experimentally, analyzed data and drew some preliminary conclusions. They made some steps to document the use of fire and study its impacts before introducing PB as a tool to prevent forest fires.

In Thasos, an island situated in the northern Aegean Sea, there was periodic application (every 3 years with some repetition i.e., 1974, 1977, etc.) of experimental prescribed burns in plots in mature *Pinus brutia* stands (Papanastasis 1977). Since at those years, there was lack of data and research findings derived from Greece, regarding the use of the fire, the foresters who applied the PB in Greece had followed some U.S. standards. They had met in scientific meetings and workshops, had demonstrated how to use the fire, discussing also ecological and managerial issues as well as its potential combination with grazing and mechanical treatments (Tsiouvaras et al. 1987, Nastis 1989). Unfortunately, without constant funding, legal support, logistics, continuous scientific guidance, and clear objectives, those sporadic attempts did not tie bonds with the forest and fire management community and the endeavour was soon abandoned. In 1980s, according to the legislation, safety standards for the application of the fire, were occasionally defined by the Forestry Administration and the applicant had to file an impact assessment study, including techniques, a time plan, safety precautions and measures during and after the use of fire and attach a plat (contour plan), also.

Almost half a century later, fire is still not used in fuel management in Greece and fire prevention, and there is no institutional framework for the implementation of PB. Inspired by those first efforts in applying PB in Greece and guided by the fire science and the best practices for wildfire prevention, a core team of researchers and practitioners from WWF Greece, the Institute of Mediterranean Forest Ecosystems of ELGO "DIMITRA", the Forest Directorate of Chios Island, and the Voluntary Action Team "OMIKRON" started in mid-2021 a 2-year pilot project on the implementation of the PB on the island of Chios. Fire Service of Chios Island and Municipality of Chios support the pilot project by supplying water trucks and personnel during the burns. The General Directorate for Forests and Forest Environment of Ministry of Environment and Energy provided all necessary permits for the implementation of pilot application of PB in Chios.

The project aims to introduce PB as a tool for forest fuel management, increase social– ecological resilience to wildfire and contribute to a climate – resilient future.

The wildfire problem in Chios is significant, often threatening human lives, disturbing biodiversity and affecting or burning mastic and olive groves. Chios, is the fifth largest of the Greek islands, located in the northern Aegean

Sea and was chosen for two reasons: i) it hosts a variety of Mediterranean forest types with typical characteristics i.e., phrygana, maquis, and thermophilic conifers, so the research findings can be utilized across the country and because ii) of the achieved alliance (Figure 6) and cooperation among the stakeholders, agencies, and the volunteers.

The Chios Voluntary Action Team – Omikron was created in 1999. It is based on Chios Island; operates across the entire island and potentially in the Prefecture of Northern Aegean, and is quite active in wildfire suppression, in prevention [construction of fuel breaks (Athanasiou 2016, 2018, Figure 1), population awareness raising] as well as in restoration and reforestation activities (such as planting seedlings for reestablishing forest vegetation in desertified areas).

Figure 1 Omikron volunteers constructing a fuel break in Chios Island, in 2012 (Photo: Apostolos Flioukas)

2. Methods

The 2-year project started in summer of 2021, and it is to be implemented in at least 4 PB campaigns. Since data-driven decision making is the key to providing effective and efficient wildfire protection (Hogland et al. 2021), we carefully chose 16 plots for the PB application (Table 1, Figure 2). Unfortunately, due to the adverse weather conditions in the 2021-2022 winter in Greece, there were no weather windows for PB application in Chios in the fall of 2021, so we ran two campaigns, in February (Figure 4) and April 2022, and there will be at least two more, in November 2022 and February 2023.

A series of parameters are monitored, measured, and recorded before, during and after the implementation of PB in some of the selected plots:

i. soil infiltration (mm),
ii. soil temperature (ºC) in various depths,
iii. erodibility,
iv. soil texture, nutrients and carbon in the soil,
v. soil respiration,
vi. organic matter decomposition,

vii. soil enzyme and microbial activity,
viii. plant biodiversity,
ix. sap flow ($cm \cdot h^{-1}$),
x. water potential (MPa),
xi. fireline construction rate ($m \cdot h^{-1}$) along the plot perimeter, by mowing and using various hand tools,
xii. surface fuel loading ($kg \cdot m^{-2}$), cover (dimensionless), height (cm) and fuel moisture content (%) through destructive sampling (Figure 3), to describe the fuel situations and complexes before the burn,
xiii. meteorological conditions,
xiv. fire behaviour that is rate of fire spread (ROS, $m \cdot min^{-1}$) and flame lengths (FL, m).

Table 1 16 plots for the PB application in Chios island

ID	Protected Area	Forest type	Area (m^2)	Ownership / Notes
Π3Σ24	No	Maquis, phrygana	3,099	Municipal
Π4Σ12α	No	Maquis	1,528	National
Π4Σ12β	No	Maquis	2,167	National
Π7Σ1	No	Grass, pine litter	5,741	National
Π8Σ30	SPA	Phrygana, pines' regeneration	2,750	Municipal / Fire break maintainance
Π9Σ56	Wildlife Refuge	Phrygana	2,900	National / Shaded fuel break maintainance
Π10Σ57α	Wildlife Refuge	Phrygana, grass	6,812	Glebe / Shaded fuel break
Π10Σ57β	Wildlife Refuge	Phrygana, grass	4,578	Glebe / Shaded fuel break
Π11Σ54	No	Pine litter	10,641	National Public
Π12Σ50	SCI SPA	Phrygana, grass	9,573	Municipal / Fire break maintainance
Π13Σ38α	SCI SPA Wildlife Refuge	Phrygana	1,172	National Public
Π13Σ38β	SCI SPA Wildlife Refuge	Phrygana	294	National Public
Π13Σ38γ	SCI SPA Wildlife Refuge	Phrygana	388	National Public
Π13Σ40α	SCI SPA Wildlife Refuge	Phrygana	1,491	National Public
Π13Σ40β	SCI SPA Wildlife Refuge	Phrygana	1,584	National Public
Π14Σ100	SCI SPA Wildlife Refuge	Broadleaf litter (oak)	1,031	Private
Total area			55,749	

Recording includes ground and aerial photographs. Regarding the aerial perspective, the use of unmanned aerial vehicles (UAVs) provided highly detailed mosaics pre- and post-PB (Figure 5). Fine resolution 3D models were generated by applying low altitude and slow velocity grid flights.

The predefined dimensions of the test areas instructed the use of a versatile, yet robust multirotor UAV, with sophisticated camera load. DJI Phantom 4 Pro was selected as an ideal combination, since it provides wind resistance up to 10 m/sec, more than 20 minutes of autonomous flight per battery and carries an 1'' CMOS, 20Mp sensor, with FOV 84° 8.8 mm/24 mm (35 mm format equivalent) f/2.8 - f/11 auto focus at 1 m - ∞ lens and mechanical/electronic shutter speed of 8 - 1/2000 sec. Images were created in a 3:2 JPEG format of 5472 × 3648 aspect ratio.

Each grid flight was predesigned in Pix4dCapture application, respecting the National Cadastre Digital Elevation Model (2007-2009) and neighbouring obstacles. Data processing (mosaic and dsm/dtm creation) was completed in Pix4d Mapper software.

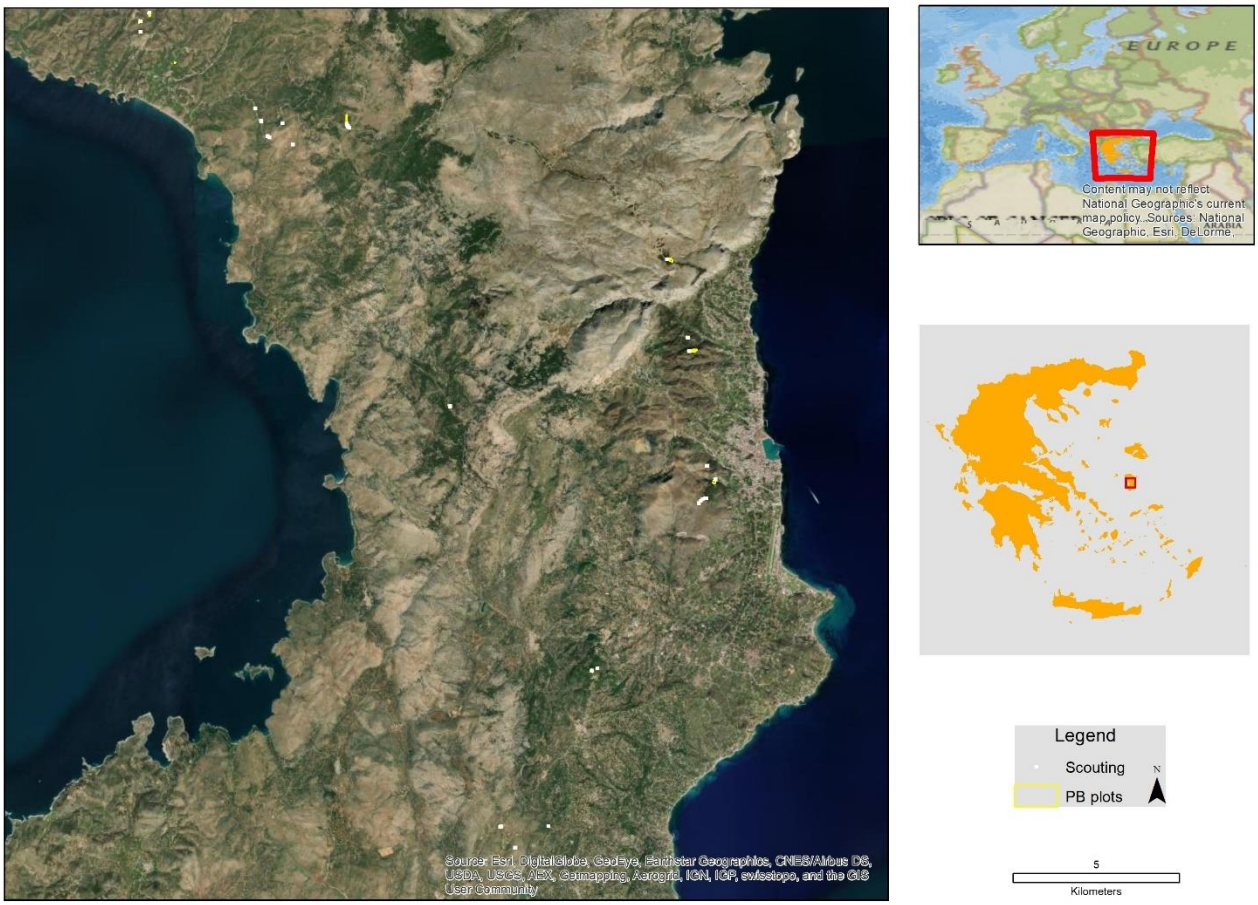

Figure 2 - 16 plots for the PB application in Chios island

Figure 3 - Training Omikron volunteers in destructive sampling of surface fuels

Figure 4 - PB application in one of the plots, in February 2022. The upper left photo is taken in July 2021

3. Discussion – conclusions

This pilot project is expected to be the starting point for the application of PB in Greece, using specific standards. More specifically, the project is expected:

i. to develop the standards and procedures, through applied research, for the use of the prescribed fire in Greece,
ii. to be a successful paradigm of fuel management,
iii. to strengthen the role of the forest service in fuel management and build the capacity of local stakeholders on potential contribution,
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Figure 5 - A post-PB highly detailed mosaic

Figure 6 - The stakeholders showed interest in the kick off meeting of the project, in Chios island, October 2021 which included a training seminar and initial briefing.

Thus, through this effort we expect, in the long run, PB to be institutionalized in Greece, and assimilated by competent services and local communities, as a tool for fuel management and consequently forest fire prevention through documented policy proposals that will be based on the results of this pilot implementation.

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