HACETTEPE UNIVERSITY

THE REASONS FOR LARGE FOREST FIRES IN THE MEDITERRANEAN REGION AND WHAT TO DO AFTER A FIRE

A REPORT

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The occurrence of consecutive forest fires at disaster levels in Turkey in recent weeks has led to the public questioning of the causes of fires and a great concern about whether these areas can be restored. This report aims to inform the public about the causes of these recent fires and what needs to be done to regenerate pine and maquis ecosystems after the fire, based on the scientific studies conducted by Hacettepe University researchers for the last 20 years.

Introduction: Mediterranean ecosystems and fire

There are drought-resistant Mediterranean plants in the Mediterranean climate regions in the western and southern parts of Turkey. These plants are mainly found as components of forest and shrubland vegetation. These two vegetation types have existed as alternatives to each other in the Mediterranean geography.

Turkish red pine (*Pinus brutia*) and maquis vegetation, located in the low altitude zone of the Mediterranean ecosystems, are frequently subjected to fire and disturbed by fire. Plant species in these forests and maquis shrublands have developed various mechanisms that allow them to regenerate after a fire due to their exposure to fire for millions of years. Thanks to these mechanisms, it is possible to see that the plant community can regenerate rather quickly after a fire compared to ecosystems in other parts of the world. In particular, Turkish red pine forests subjected to fire can regain their old structures in approximately 30 years and maquis areas within 5-10 years. In addition, during this regeneration process, different plant, insect, bird, and mammal species can be found in areas in

different regeneration phases, which supports biodiversity. Therefore, wildfires are seen as a part of the natural system in Mediterranean ecosystems, and the life cycles and ecology of organisms in the Mediterranean Basin are often adapted for wildfires.

The most important adaptation that enables Mediterranean plants to survive after a fire is the ability to resprout. Evergreen shrub species and many herbaceous plants, which are primarily found in the maquis vegetation and the understorey of Turkish pine forests, can continue their lives by resprouting a few months after the fire through the underground organs that do not die during the fire. Various oaks (Quercus), mock privet (*Phillyrea latifolia*), terebinth (*Pistacia terebinthus*), lentisk (*Pistacia lentiscus*), olive (*Olea europaea*), and eastern strawberry tree (*Arbutus andrachne*) can be given as examples of these shrub species that can resprout after a fire.

Many shrubs and herbaceous plants in Mediterranean forests and maquis vegetation can recover their populations after fire by germinating their seeds. These plants die during the fire, but their seeds, which have fallen to the ground over the years, remain dormant in the 'seed bank,' waiting for the next fire to germinate. Temperatures reaching the top of the soil (80-150°C) during a fire or some chemicals in the smoke generated by burning plant material above the ground finalize the dormancy. Thanks to this adaptation, the seeds of these plants germinate in the first rainy season after the fire. In the spring period after the fire, the seedlings of these plants cover the area, and very high plant diversity can be observed.

Turkish red pine tree, which is the main component of Turkey's Mediterranean low belt forests, is also among the species that died after the fire. However, Turkish red pine individuals do not release their seeds by keeping some of their cones closed for 4-5 years after the cones mature. This adaptation is a trait that evolved millions of years ago to protect seeds from lethal fire temperatures (>500°C) during a fire. In this way, the seeds in the closed cones survive the fire. The resin holding the cone scales together melts during the fire, and the cone scales open within a few weeks after the fire, dispersing the seeds into the soil enriched with nutrients during the fire. In the first rainy season, Turkish red pine seeds germinate, and many seedlings emerge in the field in the spring.

Researches show a significant increase in plant and insect species diversity in the first few years after the fire in Turkish pine forests, compared to unburned areas. In addition, these areas are actively used by different bird and mammal species in the years after the fire. This occurs due to adaptations of plants and animals living in these regions, and fires create an environment that supports biodiversity in these ecosystems. With the recovery of the area over time, the forest and shrub ecosystems return to their former states, and a high diversity is observed in the first years after the fire decreases. In these ecosystems, the seeds of many plants that appear in burned areas by seeding strategy wait in the soil for the subsequent fire for decades to germinate.

All these adaptations mentioned above ensure that post-fire regeneration occurs naturally and quickly in the Turkish red pine forests and the maquis shrublands. In this way, Turkish red pine forests and

maquis vegetation can regain their old appearance in a short time. However, in some cases, Turkish red pine seedlings cannot successfully establish in the area after the fire, and the burned area, which was a forest before, can turn into maquis vegetation. Such forest -> maquis or maquis -> forest transitions occur in a fire-shaped cycle of hundreds of years in the Mediterranean Basin. In this respect, pine forests and maquis shrublands are natural components of Mediterranean Basin ecosystems as vegetation states with significant biodiversity.

The reasons for the fires

Many claims have been proposed regarding the causes of forest fires that occurred in recent days. The fact that there was no significant lightning activity in the area when fires occur indicates that these fires were not caused by natural causes but most likely by human origin. Indeed, some fires are a result of human negligence. However, there was evidence that only a few of the fires were for sabotage purposes. In recent years, the increase in the number of allocations given within forest areas (tourism settlements, mining sites, etc.) and the millions of tourists in the area may have increased the risk of human-induced forest fires.

Since a large number of fires (over 100) occurred in a few days, an opinion that such an event could only have occurred through sabotage gave rise. However, during the fires, the predominance of extremely hot weather conditions and dry winds due to the heatwave in the central and eastern Mediterranean Basin stands out as the main reason for the spread of these fires. In fact, there have been fires with this frequency in the summer months in this region, and since most of these fires are suppressed before they spread, they are not noticed by the public. Furthermore, like Turkey, many large fires simultaneously occurred in other Mediterranean countries such as Italy, Cyprus, Lebanon, and Greece. This showed that the weather conditions were among the most important reasons for the spread of these fires to attract the public's attention.

It is expected that the frequency and severity of heatwaves will increase in the Mediterranean Basin due to climate change. In recent years, large and high-intensity fires have occurred in all Mediterranean countries during such heatwaves. The most important reason behind this is that the moisture content of the vegetation decreases and becomes more flammable in extremely dry conditions during heat waves. In particular, the combination of dry winds and extremely hot weather makes a fire difficult to control and stop. This means that climate change will trigger large forest fires more and more in Turkey and nearby geography. In this respect, it is possible to say that climate change is to some extent responsible for the uncontrollable fires we have experienced in the past few weeks.

It is a common opinion in the public that the spread of fires is due to failures in the intervention to fire. In fact, terrestrial intervention methods in firefighting (including backfire technique) have been effectively implemented by the General Directorate of Forestry. However, the fact that there are only three firefighting aircraft in the inventory of the Turkish state, and this number is deficient compared to other Mediterranean countries, creates the impression that there is a lack of aerial intervention capacity to fires in Turkey. Firefighting aircraft are planes that are actively used in firefighting in many countries of the world, and they play a role in effectively suppressing the fire, especially in the first moments of the fire. However, the effectiveness of firefighting vehicles, including aircraft, helicopters, or water trucks, is reduced in suppressing a fire that has already been spread in the presence of extreme weather conditions. Therefore, it is understood that having a large fleet of firefighting aircraft is very important to suppress fires when they are just starting to spread and before they become more intense.

Whatever the cause of a fire, the factors that cause a fire to spread are weather conditions and vegetation cover. Another reason for the spread of fires in Turkey, apart from climate change and heatwaves, is the spatial continuity of forests that has increased over the years. What is meant here is the emergence of continuous forest areas with denser understory vegetation

today, from the forest structure with sparse understory vegetation and fewer forest openings in the past. The two main reasons for the increase of forest areas and their continuity over the past decades are the socio-economic changes (especially rural-to-urban migration) and afforestation activities in Turkey. The number of villagers using forested areas by cutting trees and branches, creating clearings for agricultural purposes and grazing their animals (i.e., goats, sheep) decreased rapidly with the accelerated rural-urban migration in the 1980s, and these activities of people living in villages in forested areas came to a standstill. After this period, the abandoned fields were either covered with trees and shrubs by natural regeneration or were afforested by the Turkish state. The absence of grazing animals such as goats in the forest and around has led to the accumulation of shrubs and grasses under the forest, increasing the fuel load in natural habitats. In addition, the active fire suppression policy, which has continued for several decades, has prevented the burning of forests and led to an increase in the amount of fuel in the forests. For these reasons, the fuel load of the Mediterranean forests has gradually increased, and these forests have become continuous. This situation has caused the fire to spread rapidly, become more severe, and be difficult to control when a fire occurs in the forest in recent years.

In summary, it can be said that the causes of the mega-fires that occurred in Turkey in the past few weeks are the result of the interaction of long-term socio-economic changes, forestry policies, and climate change. This result is not a new finding, and it has been demonstrated before by studies conducted in Mediterranean Europe that these interactions increase the intensity and size of forest fires. As of 2021, Turkey seems to have joined the southern European countries that have experienced mega-fires at disaster levels in the past 15 years.

Restoration treatments needed to be applied after the fire

In Turkish red pine forests and maquis vegetation, the ecosystem has the capacity to recover itself naturally after a fire. Recovery after the fire can be achieved by fire adaptations of the plants in these ecosystems mentioned above. In this direction, it is essential to choose the techniques to be used to restore and manage these ecosystems after the fire by including the solutions that nature has found over millions of years.

The General Directorate of Forestry uses three main techniques in Turkey in the post-fire restoration of Mediterranean forests and shrublands. One of these techniques is to leave the burned area entirely on its own, taking into account the natural regeneration capacity of the vegetation. Another technique is to remove other plants by plowing or hoeing the burned area and planting Turkish red pine seedlings. After implementing the first technique, it is possible to see a self-recovery in the area thanks to the fire adaptations of the plants. In contrast, the latter technique transforms the area into a plantation rather than a natural forest, causing damage to its biodiversity. Among these practices, leaving to natural regeneration is a restoration repair practice with an ecological focus (i.e., the continuity of biodiversity), while sapling planting practice includes an economic focus (timber production).

In addition to these two techniques, another restoration method has been practiced in the Mediterranean forests of Turkey for decades. This third technique involves laying the cone-bearing branches of the Turkish red pine on the burned area in a homogeneous way while cutting the burning trees and supplementing the area with Turkish red pine seeds if necessary. The branches on the field reduce the amount of soil erosion and seed drift that may occur in the first rainy season, and at the same time, it is possible for the seeds that survived the fire in pine cones to reach the soil by opening the closed cones of the Turkish red pine. Thus, this technique also ensures the establishment of Turkish red pine seedlings in the area. This technique, which can be called “natural regeneration with branch laying application and seed addition,” is an application that includes both ecological and economic restoration targets at the same time and does not harm biological diversity. For this reason, it is the most ecologically appropriate technique to be applied in burned areas where it is not left to self-regeneration after the fire and is desired to be forested.

By considering the effects of climate change and fire regime changes in the future, it is important to prioritize a restoration approach with an ecological focus on burned Turkish red pine forests and maquis shrublands. Among the restoration techniques mentioned above, the application of laying branches as much as possible in burnt Turkish red pine forests and the application of planting saplings should not be considered unless there are critical conditions. On the other hand, to leave the maquis shrublands for their regeneration without any intervention is sufficient and is essential for the sustainability of biological diversity.

Appendix: List of publications and theses by Hacettepe University researchers on the causes of forest fires, ecological effects of fires, and post-fire restoration:

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- Kaptanoğlu, A. S., Tavşanoğlu, Ç., Turgay, O. C. (2018) Soil chemistry and microbial activity after a surface fire in a mixed temperate forest. Eurasian Journal of Forest Science 6: 1-13.
- Ergan, G. (2017) The relationship between Mediterranean plants and fire, and the determination of fire ephemerals. Hacettepe University, Institute of Science, Ankara.
- Bekar, İ., Tavşanoğlu, Ç. (2017) Modeling the drivers of natural fire activity: The bias created by cropland fires. International Journal of Wildland Fire 26: 845-851.
- Tavşanoğlu, Ç., Ergan, G., Çatav, Ş.S., Zare, G., Küçükakyüz, K., Özüdoğru, B. (2017) Multiple fire-related cues stimulate germination in *Chaenorhinum rubrifolium* (Plantaginaceae), a rare annual in the Mediterranean Basin. Seed Science Research 27: 26-38.
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