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Urbanization of Forest Fires: An Evaluation on Metropolitan Forest Fires in The Mediterranean Ecosystem[#]

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ABSTRACT

The main purpose of the study is to examine the impact of drastic and proactive forest fire interventions, which are applied to avoid the risk of loss of life and property close to urban areas, on the continuity of plant species with fire-adapted characters and the potential to cause species loss. In this context, the basic assumption of the study is that the reduced frequency of fires caused by suppressed fires in natural areas in order to avoid the risk of forest fires that may affect residential areas, will lead to the reduction of various plant species that sustain their lives thanks to their fire-adaptive characters. As a qualitative data analysis method, the rates of urban and forest areas, the number of forest fires, the amount of burned area and plant species diversity data were used to deal with the study data with document analysis. In the selection of the 10 metropolitan cities that constitute the sample area of the study, the criteria of being in the Mediterranean ecosystem, containing plant species adapted to fire, and being metropolitan (where natural and built environment elements are intertwined) were taken as basis. The study will create an ecological perspective in fire prevention policies and strategies to be developed through the determination of plant species characteristics in large cities located in the fire-prone Mediterranean ecosystem.

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Introduction

With rapid population growth and migration, the number of people living in cities is increasing day by day. The increasing rate of urbanization makes the domination of people over natural resources clear and causes cities to spread in an unplanned and unhealthy way. Urban sprawl causes many social and economic problems, as well as environmental problems that deeply damage urban and ecological sustainability (Cetin et al., 2023). As a result of urban sprawl, the degradation of ecosystems and the reduction of biodiversity in forested areas, which live together with the built environment, are among the leading human-induced environmental problems. The fact that a significant part of the current forest fires is directly or indirectly caused by human-induced urban activities (OGM, 2021), simultaneous threat to human, plant and animal existence and the impact of the threat on economic, social and environmental sustainability has made forest fires an important issue (Ertugrul et al., 2021). However, the risk of extinction of forest ecosystems created by plant species with fire-adapted characteristics due to urban activities and human interventions, unfortunately, has not been as important as the risk of loss of life and property in forest fires that occur close to their habitats. In this context, the basic assumption of the study is that the reduced frequency of fires caused by suppressed fires in natural areas in order to avoid the risk of forest fires that may affect urban areas (In this study, the concept of urban area has been used for metropolitan cities and the areas within the provincial borders of these cities, where the definition of the rural-urban distinction and contiguous area disappeared with the legal and administrative regulations that took place in local governments after 2000 and conversion of provincial administrative borders to municipal borders in Türkiye. In this context, the dialectical relationship

between fire ecology and urban space is discussed through the species found in forest and scrub areas within the municipal service boundaries of 10 metropolitan cities in the Mediterranean ecosystem.), will lead to the reduction of various plant species that sustain their lives thanks to their fire-adaptive characters.

The species, which naturally have pyrogenic factors that cause ignition and are frequently adapted to fires, are subject to a decrease in its biodiversity due to living together with urban space. Urbanization does not only harm the environment through deforestation and parcellation, but also intervenes in the ecological cycle by reducing the frequency of fires to which species are exposed. The study argues that fires suppressed in order to avoid the risk of burning in residential areas, especially in areas where urban areas and forest areas are intertwined, may cause the decline of various plant species with fire-adapted characters. The main purpose of the study is to examine the relationship between the human-centered approach, which aims to protect the elements of urban life at all costs, and the sustainability of the species that provide their continuity with the fire in a vegetation intertwined with the city. In other words, it is aimed to examine the process of suppressing fires, which affect the life cycle of plant species with fire-adapted characteristics, in order to avoid the risk of loss of life and property in urban areas, causing the loss of the species.

Intense forest fires in many parts of the world, especially in countries with Mediterranean region such as Italy, Albania, Greece, Tunisia, Algeria and Türkiye, have been among the most dangerous natural disasters in recent years due to the loss of life and property in urban areas (EFFIS, 2021). Within the scope of the study, 10 cities that are located in the Mediterranean ecosystem, have an important place in the forest area of Türkiye, contain fire-adapted plant species and are metropolitan cities within the framework of an ecosystem integrated with the urban habitat will be discussed. In the light of these criteria, the effect of extinguishing interventions for fires, occurring in forest areas within the metropolitan borders in Hatay, Adana, Mersin, Antalya, Muğla, Manisa, Aydın, Denizli, Balıkesir and İzmir provinces and spreading to urban settlements, on the sustainability of plant species with dominant species characteristics and different flammability characteristics will be discussed.

Although plant flammability in the field of fire ecology (Pausas and Moreira, 2012; Pausas and Schwilk, 2012; Pausas et al., 2017), post-fire species loss (Slingsby et al., 2017), urbanization and its environmental effects (Kaufman et al., 2007), the effects of urbanization on the change of forest ecosystem services (Delphin et al., 2016) has been discussed, there has been no in-depth study on the reflection of the dialectical relationship between fire ecology and urban space on plant species, with a multidisciplinary perspective covering the fields of local governments, city, environment, ecology and forest management. In this context, the study offers a new perspective in terms of both ensuring ecological sustainability by protecting various plant species that sustain their continuity with fire, and examining the intertwined interaction of natural environmental components including forested areas and the built environment.

The Relationship between Urban Expansion, Metropolitanization and Forest Area

While urbanization expresses a social transition through the rural-urban divide, it also means the continuous growth of the city borders from the center to the periphery (Keleş, 2013). The first target of urban development and expansion, which has become a necessary process in order to provide the necessary urban area and service against the population growth rate and the density occurring in the cities, is the forest areas in the city periphery. The increase in the need for residential areas with the increase in the population in the city center makes it necessary to spread beyond the city limits from the center to the periphery (Cavailhès and Wavresky, 2003). The expansion of urban area boundaries poses a threat to rural areas located on the periphery of the city.

Galster et al. (2001) defined the term “sprawl” as the equivalent of a non-agreed semantic wilderness. They stated that urban sprawl is used to characterize one or more of the residential and non-residential land use patterns, the process of expanding access to urbanized areas, the causes of land use practices, and the consequences of these practices. While sprawl is a noun when used to describe a situation that characterizes an urban area or part of it at a given time, it becomes a verb when used to describe the process of transforming land from non-urban use to urban use over time (Fulton et al., 2001) or changes in population density (Wolman et al., 2005). In this activism, damage to the natural landscape outside the city center, deterioration of forest areas, an irregular urban sprawl, uneven development, land scarcity and cost are in question (Karataş, 2007). In this context, the problems caused by the spread are expressed as the destruction of agriculture and open spaces, the consumption of natural and urban resources, and the damage to natural and built environment elements (Bruegmann, 2005). However, among all these negative consequences of urban sprawl, its effect on forest areas has not been adequately addressed in the literature. However, species loss in forest areas, which live together with the built environment as a result of urban sprawl, is one of the most important environmental problems in terms of degradation of ecosystems and reduction of biodiversity.

Many urban scientists have examined the relationship between urbanization and the green environment (Yu et al., 2012; Seto et al., 2012; Lamsal et al., 2013; Han et al., 2016). According to McKinney (2006), urbanization is one of the most homogenizing factors although anthropogenic activities encourage biotic homogenization. The reason for this is urban planning with exceptionally uniform structures. Almost all over the world, urban spaces are similar structures built to meet the basic needs of people. Almost all cities in the world typically grow by agglomeration, and their homogenizing effects expand as changes in land use intensify. In his study that sees urbanization as the main cause of biotic homogenization, McKinney (2006) highlights how urbanization destroys native species in a region, while emphasizing how it encourages the invasion of non-native species. The vital risks caused by urban sprawl, on the one hand, threaten the habitats of native species, on the other hand, cause the displacement of species that have adapted to the living conditions in a particular area. This creates the biotic

homogenization process that exposes the risks of extinction of endemic features of local ecosystems (Blair, 2001). In other words, the succession process between these native and non-native species occurring in local ecosystems accelerates biotic homogenization (Olden and Poff, 2003). In urban-environmental studies conducted in this context, it is observed that while the number of native species decreases with urbanization, the number of non-native species gradually increases (Kowarik 1995). Even when forested areas are very close to the city center, they can show traditional rural characteristics. However, in such cases, no matter how rural the land looks, it becomes functionally urbanized. Because the citizens of the city benefit from the services in these areas especially for recreational purposes. This process increases the potential for deforestation focused on urban activities. Therefore, the areas most affected by urban growth are the mentioned rural areas and forest areas. In their study on the assumption that areas with a high urbanization tendency are more frequently exposed to fire events, Beal-Neves et al. (2020) explain the effect of urbanization on biological species with fire frequency. As a matter of fact, the frequency of fire causes an increase in plant species diversity, albeit for a short time. Urbanization is also capable of altering the fire regime in which more than one species evolves. For example, the US state of Florida has a naturally pyrogenic structure. In such areas, fire is necessary to protect many local ecosystems (Mitchell et al., 2006; Slapcinsky et al., 2010). However, suppressed fires in urban areas in order to avoid the risk of forest fires that may affect residential areas, reduce the frequency of fires to which the species are exposed, and interfere with the ecological cycle. This intervention causes the decline of species that have pyrogenic factors that naturally cause ignition and that are often adapted by fires, and even their succession by dominant species (Czech, 1996). In studies conducted in the Brazilian savanna, it has been observed that fire extinguishing activities cause adverse effects on biodiversity by removing plant species native to open habitats (Pinheiro et al., 2016; Abreu et al., 2017). Almost half of the endangered species in the United States due to firefighting are found in the state of Florida (Czech et al., 2000). In his study focused on the state of Florida, McCauley (2011) emphasizes that reduced fire frequency in forest areas within urban areas negatively affects the diversity of *Taxodium distichum* seedlings. The frequency of fire suppressed in forest areas close to urban areas allows *Taxodium distichum* seedlings to encroach on woody vegetation in the same ecosystem (Ewel 1995). In the absence of fire, which has an effect on the reproduction of Taxodium distichum seed (Ewel 1995), the woody vegetation on its domes can turn into mixed hardwood swamps and gulf swamps (Casey and Ewel, 2006). In this sense, the relationship of plant species found in forest areas close to urban settlements with fire requires a multidimensional perspective on urban, forest fires and plant flammability.

The Relationship between Forest Fires, Flammability and Urban Area

The effects of the variety and distribution of plants in Mediterranean ecosystems on forest fires in the world are undeniable. In this sense, many fire ecologists have examined the parameters that are effective in all stages of the fire, through the elements that affect or change the course, level and severity of the fire, with their studies. From boreal forests to savannas, from grasslands and bushes to tropical forests, fires occur in most parts of the globe. Besides, the fires that took place during the long summer drought period in the world, especially in the regions where the Mediterranean climate is observed (California, Mediterranean Basin, Cape region, southwestern Australia), are the most important factors that cause the ecosystem dynamics to be shaped (Christensen, 1994; Pausas and Vallejo, 1999b). While fires cause a significant loss of biomass in these ecosystems every year, they also cause biomass increase by enabling the renewal and development of vegetation. Some ecosystems change their structures with fire, and their renewal as well as their continuity takes place in this way (Neyişci, 1993). The Mediterranean Basin, in which Türkiye is located, has been under the influence of Mediterranean climate types characterized by summer drought for approximately 1.6 million years. The transition to the settled order in the region since 790,000 years ago, anthropogenic fires were added to the natural fires (Goren-Inbar et al., 2004) and the plants in the Mediterranean region have been under the influence of the fires that have occurred frequently since those times (Verdú ve Pausas, 2007).

Plant species that make up the Mediterranean region, where fires occur frequently and where different fire regimes are seen, have developed different adaptations to fire throughout their evolutionary processes (Neyişçi, 1996; Tavşanoğlu and Gürkan, 2004; Pausas, 2015; Lamont and He, 2017). Adaptations such as resprouting (Pausas, 1997), plant flammability (Neyişçi, 1987; Pausas et al., 2017; Aktepe, 2021), fire-induced flowering (Borchert and Tyler, 2009), keeping the cones closed -serotiny- (Kazancı , 2021) and fire-stimulated germination (Moreira et al., 2010; Tavşanoğlu et al., 2017; Çatav et al., 2018; Kazancı and Tavşanoğlu, 2019) cause rapid ecosystem renewal after a fire (Kazanis and Arianoutsou, 2004; Moreno and Oechel, 2012; sero and Gürkan, 2014). Flammability, which is one of these adaptations, is a biological character that can evolve (Pausas and Moreira, 2012). The determination that plant species present different strategies against flammability in recent studies shows that the effect of flammability character on plant evolution and ecology is high (Keeley et al., 2011; Pausas et al., 2017; Aktepe, 2021). In any fire in urban areas, drastic response to plants with fire adaptation can result in serious species loss. Such interventions reveal the necessity of evaluating the interventions before, during and after the fire from an ecological perspective, especially in 10 metropolitan cities with Mediterranean vegetation where these species are found.

Dialectical Relationship between Forest Fires and Urban Areas in Türkiye

According to the forest asset research conducted by the Ministry of Forestry, forest areas in Türkiye, which has an area of 78 million hectares, represent approximately 30% of the total area. 5.7 million hectares of approximately 23 million hectares of forest area are located in 10

metropolitan cities within the Mediterranean ecosystem in Türkiye. 7 of these metropolitan cities, which constitute the sample area of the study, are among the top 10 provinces in Türkiye's forest area (OGM, 2021). This concentration increases the possibility of proximity, interaction and integration between forest and urban areas due to the abolition of the public legal personality of the villages and towns within the metropolitan cities and the expansion of the provincial borders as of 2012. As a matter of fact, the amendments made in the local administrations legislation with the Law No. 6360 caused 6 of the 10 metropolitan cities subject to the study to become metropolitan cities as of 2012 and the integration of the municipal borders with the provincial administrative borders (Table 1).

Table 1 shows that, the central population density of 4 provinces that were metropolitan cities before 2012, which was over 70%, is an important trigger of urban sprawl. On the other hand, almost half of the population of the provinces that gained metropolitan character after 2012 are settled in rural areas, shows a different triggering example that will increase the spread by equating all provincial property borders with municipal borders. Metropolitan cities, where the definition of the rural-urban distinction and contiguous area have disappeared, have become places where all natural and built environmental elements exist. In a much more assertive expression, all built and natural environmental elements have turned into urban elements (Aktepe, 2022). As a result, the local reform movements, which started with the renewal of the 2004-2005 local government laws and gained momentum in 2012, made the provincial administrative organization of Türkiye no longer identifiable through the rural-urban divide.

Public reform efforts in local governments after 2000, which express a transformation that accelerates the process for the intertwining of wildlife and urban life, has also increased the possibility of human activities as the perpetrator of forest fires. In addition to reasons such as rent, terrorism and arson, urban activities such as cigarette butts, picnic fires, power lines, house fires become the sole cause of forest fires, both through the expansion of the local government service area and the urban sprawl experienced in proportion to population growth. The main point to be emphasized at this stage in the study is the possibility that the convergence of urban areas to forested areas in every respect, rather than the human activities that cause fire, will harden the response in any forest fire.

The 10 metropolitan cities examined in the study constitute approximately one fourth of Türkiye's total forest areas, according to 2021 forest assets data. In parallel, the data obtained from the European Forest Fire Information System demonstrate that the areas burned in 2021 in the 10 metropolitan cities examined constitute 78% of the total burned areas in Türkiye (Figure 1). The metropolitan cities, which are considered as samples, are the provinces with the most burned forest area in the forest fires in 2021 in Türkiye. This situation reveals the dialectical relationship between forest fires and urban area, which is emphasized in the hypothesis of the study. As a matter of fact, the dominant situation (46.9%) in the ratio of the forest area of the 10 metropolitan cities to the general area of the province (Orman Genel Müdürlüğü, 2021) makes this mutual relationship important. This ratio is one of the most important factors that brings urban life closer to forest area for the sample area, which constitutes approximately one fourth of both Türkiye's population and Türkiye's forest assets.

Another important point is that these cities are the only metropolitan cities in the Mediterranean ecosystem in Türkiye. Many of the plant species found extensively in the Mediterranean region are considered environmentally and economically. Therefore, it is very important to understand the consequences of using fire as a management tool.

In Türkiye, approximately 195,538 ha burned in 2021. Although this figure seems like a sudden increase, the last 10-year data on the number of burned forests and fires from the European Forest Fire Information System show that the number, intensity and impact of forest fires is gradually increasing (Figure 2).

Turkish pine and scrub communities are common in 10 metropolitan cities due to the Mediterranean Ecosystem's area of influence in Türkiye. These species include those that often dry out and, so to speak, naturally form a pyrogenic highland landscape and are therefore frequently adapted by fires (Table 2). After the updating of provincial administrative borders, the fact that these species remain within the metropolitan borders in the Mediterranean region causes urbanization to turn into a pressure factor on these species.

Table 1. Expansion of the Borders of 10 Metropolitans after 2012 and Population Ratio

Metropolitans with Expanded Borders after 2012 within the scope of Law No. 6360					
No	Metropolitans	2012 Provincial Population	2012 Centers Population	2012 Metropolitan Population Share (%)	2020 Total Population
1	İzmir	4.005.459	3.661.930	91,4	4.394.694
2	Adana	2.125.635	1.886.624	88,7	2.258.718
3	Mersin	1.682.848	1.327.870	78,9	1.868.757
4	Antalya	2.092.537	1.492.674	71,3	2.548.308
New Metropolitans After 2012 within the scope of Law No. 6360					
5	Hatay	1.483.674	742.590	50	1.659.320
6	Aydın	1.006.541	611.846	60	1.119.084
7	Denizli	950.557	670.812	78,8	1.040.915
8	Muğla	851.145	373.937	43,9	1.000.773
9	Manisa	1.346.162	904.513	67,1	1.455.451
10	Balıkesir	1.160.731	711.743	61,3	1.244.419

Source: TUIK, 2020

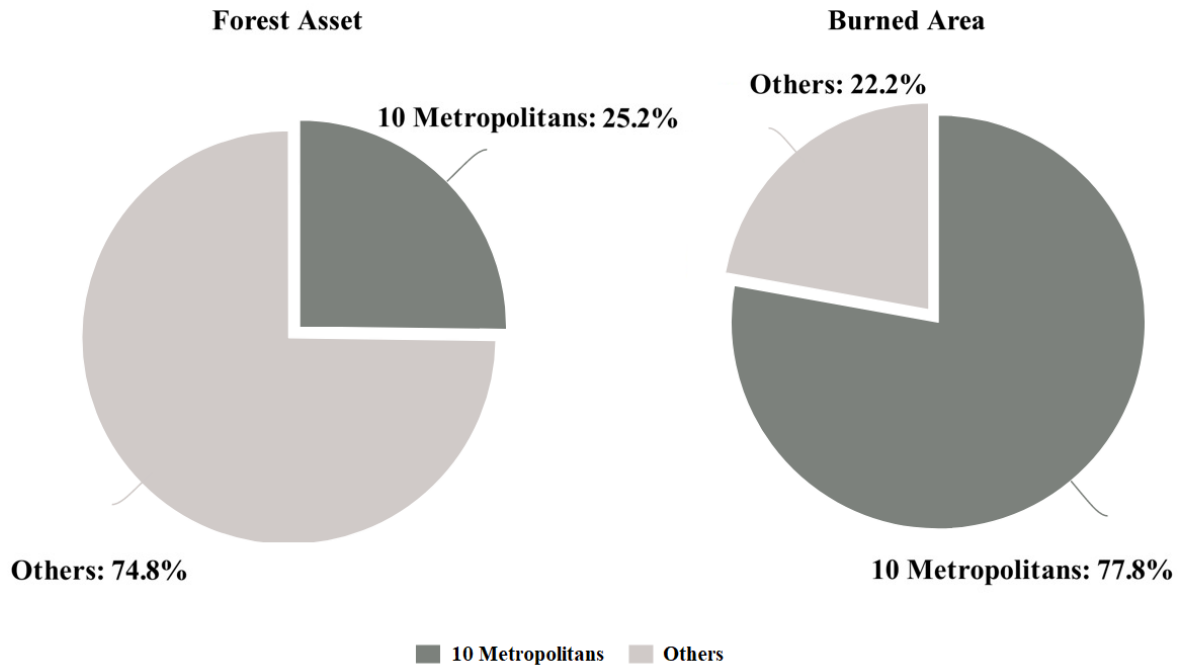

Figure 1. Forest Presence and Burnt Forest Area Rate by Provinces in Türkiye (2021)
Source: (Orman Genel Müdürlüğü, 2021)

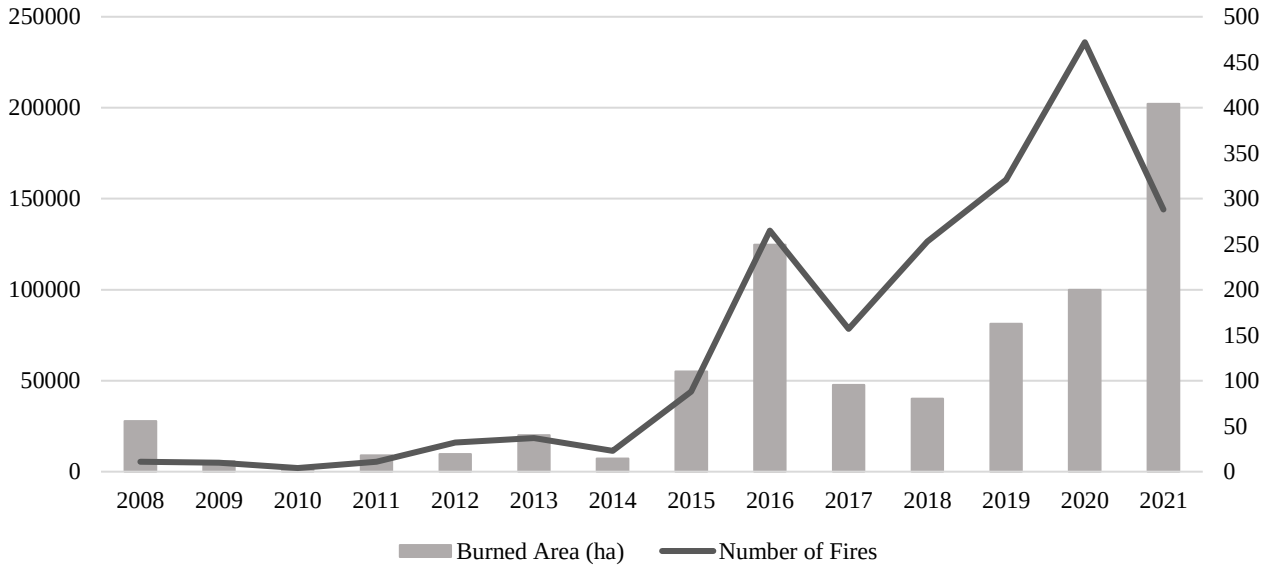

Figure 2: Burnt Forest Areas and Number of Fires in Türkiye by 2010-2020
Source: (EFFIS, 2021)

The widespread availability of fire-adapted species in the 10 metropolitan cities studied in the study indicates that plant species diversity is high in the cities studied (Table 2). Fires occurring in Mediterranean-type ecosystems have caused the plants here to have different fire adaptations.

Conclusion

With the municipal law numbered 6360, the municipal service areas of a total of 30 metropolitan cities were combined with the provincial administrative borders. As a matter of fact, according to the results of the address-based population registration system for 2020 published by the Turkish Statistical Institute (TUIK), 93% of the population of Türkiye now lives in the city and district centers, which we can define as urban areas (TUIK, 2020). In that case, there is an irresistible closeness and interaction process between forest areas and urban spaces. The resulting urban sprawl and metropolitanization processes not only increase the fragmentation of natural habitat, but also reduce species diversity and suppress various fire-adapted plant species, making them vulnerable to the invasion of different species. This danger necessitates a multidisciplinary approach to the relationship of plant species that sustain their life with their flammability feature and urban areas.

Proactive interventions made due to the risk of splashing to the built environment in fires occurring in the forests within the provincial borders of Hatay, Adana, Mersin, Antalya, Muğla, Aydın, Denizli, Balikesir and İzmir, which constitute the Turkish leg of the

Mediterranean ecosystem, are remarkable in terms of the sustainability of fire-adapted plant species. In other words, in any fire that will occur in urbanized forest areas, it will cause a decrease in the species diversity of various plant species that continue their life with their flammability feature. This risk necessitates a multi-faceted study that simultaneously deals with the concepts of urbanization and flammability in the formation of intertwined forest and urban policies. The interaction that exists between wildfires and the human population is likely to increase due to a number of factors. The increasing proximity between the vegetation prone to forest fires and urban areas, the ignition caused by human activities and the increase of global warming as a result of urban activities cause urbanization to negatively affect the natural ecosystem. As a result, accelerating urbanization can lead to fragmentation of natural habitats, change in species composition and reduction in the number of native species. As a matter of fact, it is emphasized in the study that urbanization increases the fragmentation of natural habitat, reduces species diversity, and suppresses various fire-adapted plant species, making them vulnerable to invasion by different species.

In this context, a natural barrier to be created between forest areas and urban spaces will not only prevent the loss of life and property in the urban space in a possible fire, but also prevent the loss of species of various plant species that continue their life with their flammability feature, which is an adaptation developed against fire. In policies designed to prevent urban spread by surrounding the city with both let it burn and green belt strategies and regarding forest fires, the identification of species adapted to fire in different degrees and forestation and spatial arrangement activities according to these species should be in question. The preference of species with low flammability in regions that define the border of urban and forested areas in forestation policies will positively affect both the course of the fire and the species diversity of ecosystems.

The increase in fire frequency and intensity seen in the fire data of the last 10 years sheds light on two important hypotheses. First, the basic assumption of this study is that there is an upward trend due to the increase in fire and post-fire interventions due to the gradual urbanization of forests. The second is the increase in the frequency and intensity of fires in forest areas within the Mediterranean ecosystem due to climate change. The meeting point of both assumptions is the formation of an atmosphere (urbanization and air temperature increase) that will cause the formation of fire, especially in big cities.

Table 2. Tree and Scrub Species in Forest and Scrub Areas in 10 Metropolitan Areas

Species	Provinces									
	Muğla	Antalya	İzmir	Mersin	Hatay	Aydin	Adana	Balikesir	Manisa	Denizli
Pinus brutia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Astragalus sp.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Olea europea	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pistacia terebinthus	✓	✓	✓	✓	✓		✓	✓	✓	
Nerium oleander	✓	✓	✓		✓	✓	✓		✓	✓
Quercus cerris	✓		✓	✓	✓		✓		✓	✓
Genista acanthoclada	✓	✓	✓	✓			✓	✓	✓	
Pistacia lentiscus	✓	✓	✓	✓	✓		✓			
Myrtus communis	✓	✓	✓	✓	✓		✓			
Styrax officinalis	✓	✓		✓	✓	✓		✓		
Laurus nobilis	✓	✓	✓	✓		✓		✓		
Juniperus oxycedrus	✓	✓	✓	✓			✓			
Erica manipuliflora	✓	✓	✓		✓		✓			
Cistus creticus	✓	✓	✓	✓		✓				
Cistus salviifolius	✓	✓		✓	✓	✓				
Spartium junceum	✓	✓	✓	✓	✓					
Crataegus monogyna	✓	✓	✓	✓		✓				
Arbutus unedo	✓	✓	✓	✓				✓		
Arbutus andrachne	✓	✓	✓	✓		✓				
Origanum onites	✓	✓	✓		✓			✓		
Daphne gnidioides	✓	✓	✓	✓						✓
Quercus coccifera	✓		✓			✓				✓

Source: The fire-adapted species in the table, such as Nerium oleander Ceratonia siliqua Quercus ilex Eucalyptus camaldulensis (Dimitrakopoules and Papaionnou, 2001), Erica manipuliflora (Liodakis and Kakardakis,2006), Cupressus sempervirens (Neyişçi and Intini, 2006; Xanthopoulos,2012) and other species (Aktepe, 2021) were obtained by matching the relevant flammability literature with TÜBİVES data.

Subjective, human-centered and unilateral policies and strategies created in response to the increase in the level, area and severity of the fire remain ineffective in the holistic solution of the problem. As a matter of fact, it has been observed that the preferred extinguishing intervention methods are not effective in forest fires located in the cities of the United States of America, European countries and Türkiye, which have the characteristics of the Mediterranean ecosystem. No form of intervention that does not have an ecological character will exhibit an inclusive and holistic approach to the built and natural environment elements. This situation will cause irreversible damage to people or vegetation in the fire area, even when the fire is extinguished. The main point emphasized by the study is that interventions with increasing severity in parallel with the increase in the probability of fire will reduce the species diversity of fire-adapted plant species as well as cause extinction.

People, who are the high suspects of urbanized forest fires, turn into a savior charismatic human imagination in extinguishing forest fires that cause loss of life and property. In other words, both fire-causing activities and post-fire extinguishing activities are actually unnatural human interventions in nature. In this sense, even in the ecological cycle defined by the flammability of a plant, the individual and society are simultaneously involved in all of the perpetrator, victim and savior positions. The intricate interrelationship of natural and built environment elements, which are inextricably mixed with each other, should make urban policy planning, urban actions and strategies decisive factors for the sustainability of ecology and the protection of biodiversity.

References

Abreu RCR, Hoffmann WA, Vasconcelos HL, Pilon NAL, Rossatto DR, Durigan G. 2017. The biodiversity cost of carbon sequestration in tropical savanna, Sci. Adv, 3:e1701284.

Aktepe N. 2021. Kızılçam (*Pinus brutia* Ten.) ormanlarında bitkilerin yanabilirliğinin popülasyon, tür ve komünite düzeyindeki değişkenliği ve bu değişkenliğin yangın rejimi ile ilişkisi, Doktora Tezi, Hacettepe Üniversitesi, Fen Bilimleri Enstitüsü, Ankara.

Aktepe E. 2022. "Kamu Hizmetlerinin Sunumu ve Kentsel Dirençlilik", Aktepe, E. (der.), Kentsel Kamusal Hizmetler içinde, İstanbul: Efe Akademi, 349-370.

Atmış E, Günşen H. 2016. Kentleşmenin Türkiye ormancılığının dönüşümüne etkisi (1990-2010 Dönemi), Journal of the Faculty of Forestry Istanbul University, 66 (1), 16-29.

Beal-Neves M, Cleusa VE, Marjorie WE, Betina B, Regis AL, Everton LLQ, Pedro MAF. 2020. The Influence of Urbanization and Fire Disturbance on Plant-floral Visitor Mutualistic Networks, Diversity 12, no. 4: 141.

Blair RB, Launer AE. 1997. Butterfly diversity and human landuse: species assemblages along an urban gradient, BiologicalConservation, 80, 113–125.

Blair RB. 2001. Birds and butterflies along urban gradients in twoecoregions of the U.S. In: Lockwood JL, McKinney ML. (Eds.), Biotic Homogenization. Kluwer Academic Publishers, Norwell,MA, pp. 33–56.

Borchert M, Tyler CM. 2009. Patterns of post-fire flowering and fruiting in Chlorogalum pomeridianum var. pomeridianum (DC.) Kunth in southern California chaparral, International Journal of Wildland Fire, 18: 623–630. DOI: 10.1071/WF08039.

Bruegmann R. 2005. Sprawl: a compact history, The university of Chicago Press, Chicago.

Casey W, Ewel KC. 2006. Patterns of succession in forested depressional wetlands in north Florida, USA, Wetlands, 26:147-160.

Cavailhès J, Wavresky P. 2003. Urban influences on periurban farmland prices, European Review of Agricultural Economics, 30 (3): 333– 57.

Cetin, M., Sevik, H., Koc, I., & Cetin, I. Z. (2023). The change in biocomfort zones in the area of Muğla province in near future due to the global climate change scenarios. Journal of Thermal Biology, 112, 103434.

Christensen NL. 1994. The effects of fire on physicaland chemical properties of soils in Mediterranean-climate shrublands, The role of fire in Mediterranean-Type ecosystems (ed. by J.M. Moreno and W. Oechel),pp. 79 – 95, Springer Verlag, Berlin.

Czech B. 1996. Challenges to establishing and implementing sound natural fire policy, Renewable Resources Journal, 14: 14–19.

Czech B, Krausman P, Devers P. 2000. Economic Associations Among Causes of Species Endangerment in the United States, Bioscience, 593-601.

Çatav ŞS, Küçükakyüz K, Tavşanoğlu Ç, Pausas JG. 2018. Effect of fire-derived chemicals on germination and seedling growth in Mediterranean plant species, Basic and Applied Ecology, 30: 65-75.

Dimitrakopoulos AP, Papaioannou KK. 2001. Flammability assessment of Mediterranean forest fuels, Fire Technology, 37, 143–152.

Ertugrul, M., Varol, T., Ozel, H. B., Cetin, M., & Sevik, H. 2021. Influence of climatic factor of changes in forest fire danger and fire season length in Turkey. Environmental monitoring and assessment, 193, 1-17.

Ewel KC. 1995. Fire in Cypress swamps in the Southeastern United States, Fire Ecology Conference, No:19, 111-116.

Fulton W, Pendall R, Nguyen M, Harrison A. 2001. Who Sprawls the Most: How Growth Patterns Differ Across the United States, Brookings Institution Center on Urban and Metropolitan Policy, Washington, D.C.

Goren-Inbar N, Alperson N, Kislev ME, Simchoni O, Melamed Y, Ben-Num A, Werker E. 2004. Evidence of hominin control of fire at Gresher Benot Ya'aqov, Science, 304, 725–727.

Han L, Zhou W, Pickett STA, Li W, Li L. 2016. An optimum city size? The scaling relationship for urban population and fine particulate (PM2.5) concentration. Environ. Pollut. 208:96–101.

Karataş N. 2007. İzmir'deki şehirsel saçaklanma eğilimlerinin Torbalı-Ayrancılar'da arazi sahipliliği el değişim süreçlerine etkileri, TMMOB Şehir Plancıları Odası Planlama Dergisi, Ankara, 3-10.

Kazancı DD. 2021. Kızılçam'da (Pinus brutia Ten.) yangınla ilişkili karakterlerin popülasyonlar arası değişkenliği ve bu değişkenliği ortaya çıkartan faktörler, Doktora Tezi, Hacettepe Üniversitesi, Fen Bilimleri Enstitüsü, Ankara

Kazancı DD, Tavşanoğlu Ç. 2019. Heat shock-stimulated germination in Mediterranean Basin plants in relation to growth form, dormancy type, and distributional range, Folia Geobotanica, 54: 85-98.

Kazanis D, Arianoutsou M. 2004. Long-term post-fire vegetation dynamics in Pinus halepensis forests of Central Greece: A functional group approach, Plant Ecology, DOI: 171: 101-121.

Keeley JE, Pausas JG, Rundel PW, Bond WJ, Bradstock RA. 2011. Fire as an evolutionary pressure shaping plant traits, Trends in Plant Science, 16, 406–411.

Keleş R. 2013. Kentleşme Politikası, Ankara, İmge Kitapevi.

Kowarik I. 1995. On the role of alien species in urban flora andvegetation. In: Pysek, P., Prach, K., Rejma´nek, M., Wade, P.M.(Eds.), Plant Invasions – General Aspects and Special Problems.SPB Academic, Amsterdam (Netherlands), pp. 85–103.

Lamont BB, He. 2017. Fire-proneness as prerequisite for the evolution of fire-adapted traits, Trends in Plant Science, 22: 278–288.

Lamsal LN, Martin RV, Parrish DD, Krotkov NA. 2013. Scaling relationship for NO2 pollution and urban population size: a satellite perspective. Environ. Sci. Technol. 47:7855–61.

Liodakis S, Kakardakis T. 2006. Measuring the particle flammability of forest species from wildland/urban interface (WUI) near Athens by thermal analysis, First International Symposium on Environment Identities and Mediterranean Area (ISEIM) 2006 Conference (July 10–13, France), pp 24–28.

McCauley LA. 2011. The Effects Of Urbanization On Cypress (taxodium Distichum) In Central Florida, Electronic Theses and Dissertations, 2004-2019. https://stars.library. ucf.edu/etd/1771.

McKinney ML, Lockwood JL. 2001. Biotic homogenization: a sequential and selective process, in Biotic Homogenization, Lockwood, J.L. and McKinney, M.L., Eds., New York: Kluwer/Plenum Publ, 1–17.

McKinney ML. 2006. Urbanization as a Major Cause of Biotic Homogenization, Biological Conservation, 127, 247-260.

Mitchell RJ, Hiers JK, O'Brien JJ, Jack SB, Engstrom RT. 2006. Silviculture that sustains: the nexus between silviculture, frequent prescribde fire, and conservation of biodiversity in logleaf pine forest of the southeastern United States, Canadian Journal of Forest Research-Revue Canadienne De Recherche Forestiere, 36:2724-2736.

Moreira B, Tormo J, Estrelles E, Pausas JG. 2010. Disentangling the role of heat and smoke as germination cues in Mediterranean Basin flora, Annals of Botany, 105: 627-635.

Moreno JM, Oechel WC. 2012. The Role of Fire in Mediterranean-Type Ecosystems, Springer-Verlag, New York.

Neyisçi T. 1993. Ecological Adaptive Traits of Pinus brutia Ten. to Fires, International Symposium on Pinus brutia Ten, 18-23 October, Marmaris/Türkiye.

Neyişçi T. 1996. Kolay ve güç yanan bitki türleri, Orman Mühendisliği Dergisi, 33 (5), 3-9.

Neyişçi T. 1987. Orman yangınlarının önlenmesinde kullanılabilecek yavaş yanan bitki türleri üzerinde bir çalışma, TÜBİTAK Doğa Dergisi, 2: 595-604.

Neyişçi T, Intini M. 2006. The use of cypress barriers for limiting fires in mediterranean countries, In proceedings of the "Il cipresso e gli incendi" workshop, June 14-16, Valencia, Spain, Interreg IIIB MEDOCC, Project MedCypre. Florence, Italy: 3-18.

OGM. 2021. Orman Genel Müdürlüğü, 2020 yılı ormancılık istatistikleri, https://www.ogm.gov.tr/tr/ormanlarimiz/resmi-istatistikler

Olden JD, Poff NL. 2003. Toward a mechanistic understandingof prediction of biotic homogenization, American Naturalist, 162, 442–460.

Pausas JG, Schwilk DW. 2012. Fire and plant evolution, New Phytologist, 193: 301–303.

Pausas JG. 1997. Resprouting of Quercus suber in NE Spain after fire, Journal of Vegetation Science, 8: 703-706.

Pausas JG. 2015. Bark thickness and fire regime, Functional Ecology, 29, 315-327.

Pausas JG, Keeley JE, Schwilk DW. 2017. Flammability as an ecological and evolutionary driver, Journal of Ecology, 105, 289-297.

Pausas JG, Moreira B. 2012. Flammability as a biological concept, New Phytologist, 194, 610-613.

Pausas JG, Vallejo VR. 1999b. The role of fire in European Mediterranean ecosystems, In: Chuvieco E. (eds) Remote Sensing of Large Wildfires, Springer, Berlin, Heidelberg.

Pinheiro LFS, Kolb RM, Rossatto DR. 2016. Changes in irradiance and soil properties explain why typical non-arboreal savanna species disappear under tree encroachment, Aust. J. Bot, 64, 333–341.

Rahel FJ. 2002. Homogenization of freshwater faunas. AnnualReview of Ecology and Systematics, 33, 291–315.

Seto KC, Guneralp B, Hutyra LR. 2012. Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. PNAS 109:16083–88.

Slapcinsky JL, Gordon DR, Menges ES. 2010. Responses of Rare Plant Species to Fire in Florida's Pyrogenic Communities, Natural Areas Journal, 30:4-19.

Slingsby JA, Merow C, Aiello-Lammens M, Allsoppa N, Hallf S, Mollmann HK, Turnerg R, Wilson AM, Silander JA. 2017. Identifying postfire weather and biological invasion drivespecies loss in a Mediterranean-type biodiversity hotspot, Proc. Nat. Aced. Sci, 114(18), 4697–4702.

Tavşanoğlu Ç, Ergan G, Çatav ŞS, 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.

Tavşanoğlu Ç, Gürkan B. 2014. Long-term post-fire dynamics of co-occurring woody species in Pinus brutia forests: the role of regeneration mode, Plant ecology, 215(3), 355-365.

Verdu M, Pausas JG. 2007. Fire drives phylogenetic clustering in Mediterranean Basin woody plant communities, Journal of Ecology, 95(6), 1316–1323.

Wolman H, Galster G, Hanson R, Ratclife M, Furdell K, Sarzynski A. 2005. The fundamental challenge in measuring sprawl: which land should be considered? Prof Geogr 57(1):94–105.

Xanthopoulos G, Calfapietra C, Fernandes P. 2012. Fire hazard and flammabilityof European forest types. In: Moreira F, Heras J, Corona P, Arianoutsou M.(Eds.), Post-Fire Management and Restoration of Southern European Forests, 79-92.

Yu M, Carmichael GR, Zhu T, Cheng Y. 2012. Sensitivity of predicted pollutant levels to urbanization in China. Atmos. Environ. 60:544–54.