POLICY RECOMMENDATIONS FOR PREVENTING FOREST FIRES

KAPGEM Series – 4

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CONTENTS

19. PREVENTION OF AGRICULTURAL-CAUSED FOREST FIRES 77

CONCLUSION 82

REFERENCES 84

FOREWORD

Efforts are being made to protect forest resources in Turkey and around the world. One of the most important issues for the preservation of forest resources is protecting forests from fires. Forest fires in Turkey pose a serious threat to forest resources. This policy report has been prepared for public authorities on combating forest fires and contains policy recommendations for preventing fires.

In recent years, forest fires in many provinces across Turkey have caused damage to forest ecosystems. In addition, serious problems have been experienced, such as the evacuation of residential areas due to damage to homes and the temporary displacement of those affected by the fires. Furthermore, there have been fatalities that have deeply affected our country. Furthermore, significant property losses have occurred. Analyzing and developing pre-fire policies is crucial to preventing these losses.

Understanding the processes related to forest fires is important for preventing them. In this context, the processes related to forest fires are examined under the following three main headings:

I. Planning, management, and organization of pre-fire measures,

II. Planning, management, and organization during the firefighting process,

III. Rehabilitation of affected ecosystems and restoration of areas after the fire.

This public policy study analyzes the first process related to forest fires, namely "planning, management, and organization of pre-fire measures," and makes policy recommendations in this regard.

The Forest Policy Desk of the Karabük University Public Policy Research and Development Center (KAPGEM), with a sense of responsibility towards the high forest cover in the province and the negative consequences of increasing fires in the country, first produced a policy report and then developed this report to create the present work with the aim of developing public policies on the prevention of forest fires.

Best regards

KAPGEM Forest Policy Desk

INTRODUCTION

In recent years, there has been a noticeable increase in both the number of forest fires and the amount of area burned in our country. The damage caused by forest fires to forest ecosystems and to the people living in and around them, and their living conditions are having an increasing impact. On the other hand, it is now accepted that global warming and the associated unpredictable sudden changes in climate characteristics and meteorological variables increase the risk of forest fire disasters. It is now considered that the current forest fire control strategy, which is primarily based on responding to fires once they have started, is insufficient. It is acknowledged that fighting forest fires with such a strategy is both costly and increases the risk of disasters. For this reason, countries that have been intensively fighting fires have been implementing fire prevention measures over the last decade to prevent fires from starting or to facilitate controlling the energy of fires that do start through extinguishing interventions. This study highlights topics that will contribute to the prevention of forest fires both before and during fires in our country's fight against forest fires. Under each heading, the problems encountered were first identified, and recommendations for their solution were developed.

Hüseyin YÖRÜR, Cumhur GÜNGÖROĞLU, Ufuk COŞGUN, Ahmet DUYAR, Damla YILDIZ, Mustafa AYBAR

1. CREATING FIRE BUFFER ZONES BETWEEN URBAN AND FOREST AREAS

Today, because of population growth, industrialization, and the associated increase in demand for natural resources, settlements are developing in various ways within forests. On the one hand, the number of people living permanently in and adjacent to forests is decreasing, while on the other hand, there is a growing demand for land use in forested areas for different purposes, such as holiday resorts, tourist facilities, open-pit mining, etc. Existing transportation routes are being expanded, or new ones are being built. This new situation is leading to the emergence of segments of society that are unaware of how life in the forest should be.

According to official data in our country, there are 23 million hectares of forest area, covering 29.4% of the country's total land area. A large portion of the approximately 12 million hectares of forest area is in fire-prone regions under fire regime. Increasing land management problems in land use in these fire-prone areas and the emergence of new fire-prone areas due to climate change increasing sensitivity in these fire regime areas have led to an increase in the intensity and frequency of forest fires. Under these conditions, one of the significant consequences of forest fires is the increased likelihood of exposure to fire hazards that can spread rapidly in forest-urban interfaces. In our country, fires in forest-urban interfaces are not directly linked to any fire legislation or firefighting organization. This situation makes it difficult to fight fires in the settlement areas, especially in rapidly developing large fires, leading to increased loss of life and property. Forest-urban interface areas are complex land use systems where various structures (especially privately owned residences) and other human structures (agriculture and livestock farming, etc.) come together or intermixed with combustible types of forest or wild vegetation (Marzano et al., 2008; Güngöroğlu et al., 2025). Different forest-urban interface typologies emerge in areas with forest trees and shrub species, depending on the concentration of buildings and the fragmentation between this concentration and the vegetation (Chas-Amil et al., 2013).
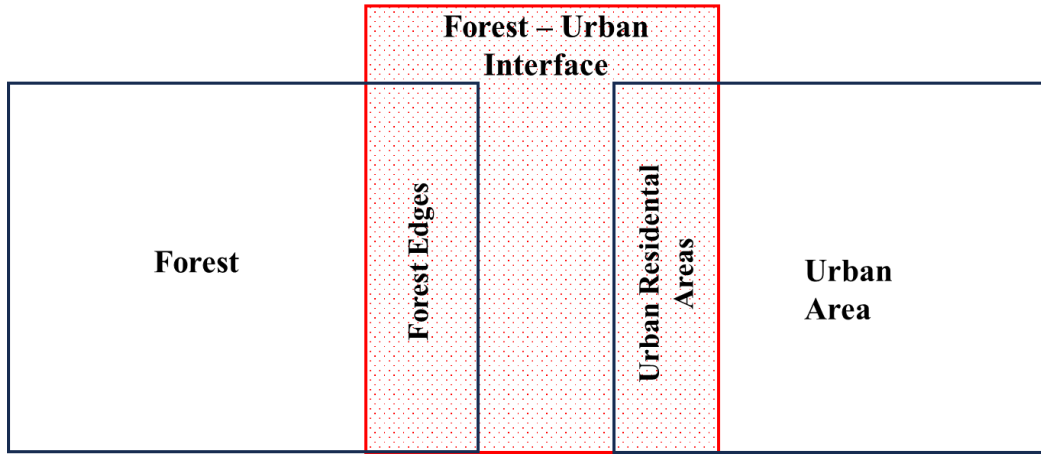
Figure 1. General representation of the forest-urban interface (Güngöroğlu et al., 2025)

Figure 2. Urban residantal elements affected by forest fires (Anonymous)

As the interaction between forest and urban areas increases, it has become possible for numerous settlements to be damaged in a forest fire. This situation has brought forth new disaster issues that need to be resolved. The existence of environments that are vulnerable to disasters such as forest fires is at the forefront of these issues. Fires that may occur near such environments can cause great damage, resulting in loss of life and property. On the other hand, these areas can also cause fires by increasing the accumulation of combustible material if the necessary precautions are not taken (Yanalak et al., 2021). In forest and urban interface areas, the need to create fire-resistant areas has now become imperative to prevent forest fires from turning into major disasters.

There are examples of practices around the world targeting fires in forest-urban interface areas. Detailed examples of implementation at the country level are more common in fire-sensitive state administrations in the USA (Güngöroğlu et al., 2025). While approximately 10% of the USA's land area is forest-urban interface, approximately one-third of the country's population lives in these areas. An average of 75,000 forest fires occur annually in the country. Studies

show that regulations concerning forest-urban interface areas have been defined in coordination with the national forest management and the Department of the Interior, and the legal regulations established in this regard are linked to the forestry legislation (Modugno et al., 2016). The Canadian Forestry Department has also conducted studies on forest-urban interfaces with both national organizations and local stakeholders, and a national forest-urban interface guide was prepared in 2021 (Bénichou et al., 2021).

| Yerleşim Yeri | Yangın Emniyet Yol ve Şeridi | Zayıflatma Zonu (Tepe kapalılığı 0,3'e kadar düşürülmüş orman) | Orman |
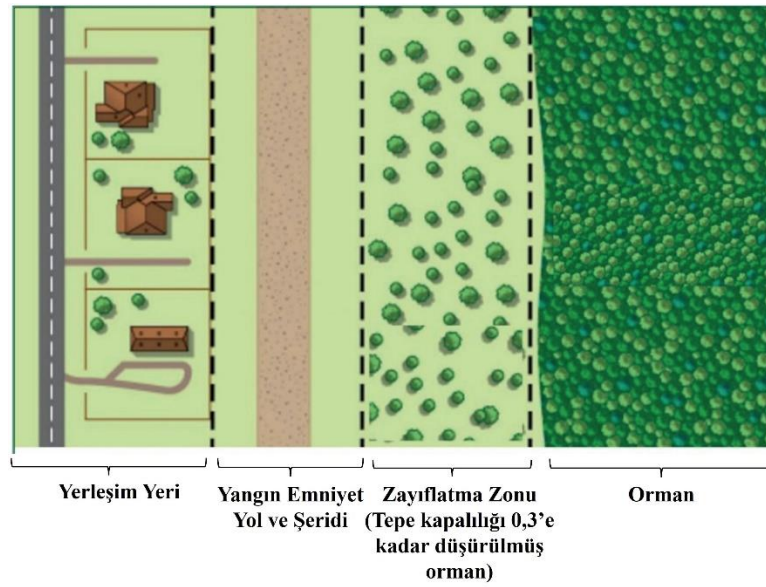
Figure 3. An example of a fire-resistant system design in a settlement-forest interface applied in Australia (modified from Güney, 2025)

In our country, there is a unique structure based on land use in the interface between urban within and adjacent to forests. Forest-urban interfaces in our country can be characterized in terms of both ownership and type of use: grazing, cultivation of annual and perennial agricultural products, treasury lands, and fragmented areas with forest and scrub vegetation cover. In addition, transportation routes are often absent in these areas (Güngöroğlu et al., 2025).

Figure 4. Examples of forest-settlement interfaces from Muğla (Güngöroğlu et al. 2025)
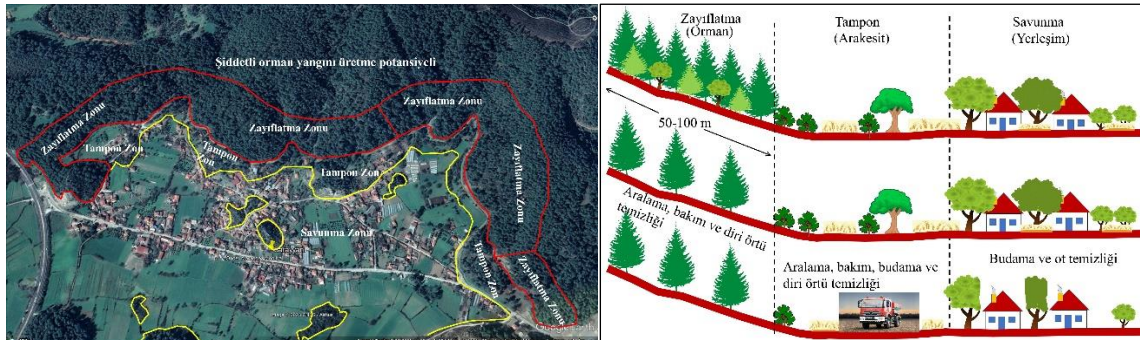
Figure 5. Cross-sections of proposed forest-urban interface buffer zones (Güngöroğlu et al. 2025)

As a result of this fragmented land mosaic created by human-induced land uses that increase forest fragmentation, the areas covered by forest-urban and forest-agriculture interfaces have increased, and areas with combustible material properties that are now more susceptible to burning and not subject to regular forestry management measures have begun to appear (Güngöroğlu et al., 2024). Although the institutions responsible for managing these complex areas (forest administrations based on operation and protection, metropolitan and district municipalities, provincial special administrations, village councils, etc.) are clear, there are

problems with organization and coordination based on legislation that would provide fire prevention management measures in the interfaces.

The proximity or intermingling of residential areas with forests increases the risk of human-caused forest fires. Furthermore, forests near residential areas play a role in triggering fires in these areas. Therefore, buffer zones of appropriate width should be established between residential areas and forested areas. The structural and functional characteristics of fire safety roads and strips in these buffer zones should also be determined. The implementation of combustible material management measures in buffer zones to reduce the risk of fire ignition and spread before the fire season should be guaranteed by legislation. This legislation should specify the activities to be carried out by the responsible institutions. In this way, it is possible to increase the physical resilience of urban areas within and adjacent to forests by creating buffer zones against fires. In order to implement this approach recommended for our country, the duties and responsibilities of central (forest management units based on operation and protection, AFAD, Provincial Banks, etc.) and local public administrations (neighborhood or village, town, metropolitan municipalities, provincial special administrations, etc.) in forest fire management, ensuring that administrations become strategic stakeholders responsible for reducing forest fire risks within their own management areas (Güngöroğlu et al., 2024). This approach will bring about a fundamental paradigm shift in forest fire management, establishing that urban residential areas adjacent to forests must be part of forest fire management. Buffer zones to be implemented in forest-urban interfaces form the basic strategy for integrating urban residential areas into forest fire management. At this point, the main elements of firefighting can be ensured by coordinating the buffer zones around residential areas with other firefighting facilities (see policy I), primarily the YOAT and ZOAT established by the OGM, in line with their objectives, and by establishing their connectivity in terms of access. In addition, under the coordination of the forest administration, the implementation of fire prevention measures by the responsible authorities in these buffer zones will pave the way for increasing the physical resilience of both forests and settlements against forest fires. This strategy will also reduce fire risks, the number of fires, and the amount of burned area.

2. INCREASING FIRE AND FUEL BREAKS IN FOREST AREAS

Fire prevention and intervention facilities are defined as wide strips of land that act as a buffer against the spread of fire by changing the existing barrier or fuel type, or by altering or clearing the natural vegetation cover, thereby making fires easier to control (CIFFC, 2017). Fire prevention and control facilities function as areas where a fuel break exists that will reduce burning or the spread of fire in the event of a fire. They can occur naturally in areas with low amounts of combustible material or be intentionally established as part of forest fire reduction or prevention activities (Başlı et al., 2023: EUFOFINET, 2012). A study on the effectiveness of fire prevention facilities established before a fire in large fires revealed that the length of the facilities is more important than their width in terms of fire prevention. It has been stated that the length covered by a fire prevention facility within a forest potentially provides more opportunities for firefighting, as it allows for more intersections with other fire prevention facilities (Syphard et al., 2011). These opportunities can be explained by facilitating access to the fire for initial response or replenishment and increasing the number of suitable areas where firefighting activities can be concentrated to suppress the fire. Before deciding to establish a fire prevention facility in an area, the number of past fires in that geography, the flame heights encountered, the intensity of the fires, the spread rate, and the fire throw distance are fire behavior characteristics that require attention to the density of fire prevention facilities in that area (Syphard et al., 2011: Güngöroğlu et al., 2014). To prevent fires that cause significant damage to forests in our country, Article 75 of Forest Law No. 6831 obliges the responsible institution, OGM, to construct fire safety roads within a plan. To fulfill this obligation, matters related to the planning and construction of fire breaks and fuel breaks by the OGM were determined by Circular No. 285, which came into effect on January 1, 1995. To make our forests resistant to fires, fire-preventive facilities called YMT, YOAT, ZOAT, transportation facilities, and fire weakening areas are also being established under Circular No. 6976, under the short name YARDOP, which stands for "Project *for the Rehabilitation of Burned Forest Areas and Establishment of Fire-Resistant Forests.*"

Figure 6. Use of fire break roads and fuel breaks in firefighting (1), YARDOP facilities (2 and 3) (Anonymous)

OGM Circular No. 285 states in the introductory section regarding the planning and construction of fire safety roads and strips that "in order to successfully combat forest fires and ensure the safety of existing coniferous forests and newly established and future coniferous afforestation and reforestation areas, fire safety roads and strips must be opened in these forest areas." This provision defines the forest types where these facilities will be established as coniferous forests. It would be beneficial to review and update this provision considering today's fire risks and hazards. Instead of the term "coniferous forests," it is necessary to use terms that refer to forest areas with a high risk of ignition and fire hazard. Although the planning and implementation principles for firefighting facilities are detailed in Circular No. 285 and the YARDOP circular, observations in fire-affected areas indicate that if the pre-fire season maintenance of the facilities specified in both regulations is neglected, these facilities will fail to fulfill their intended purpose.
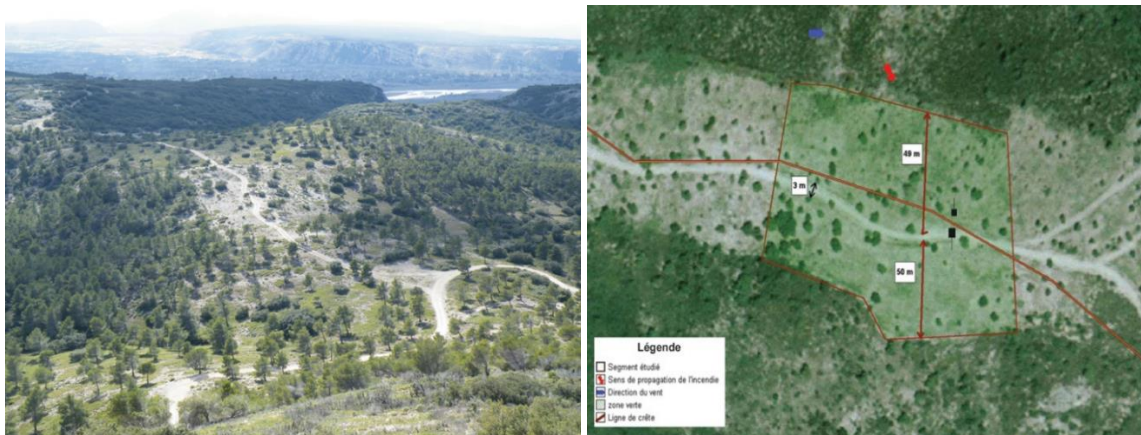
Figure 7. Fire breaks and fuel breaks implemented in France

For this purpose, it is of great importance that the fire breaks and fuel breaks for forest fires are arranged in such a way as to prevent the flames from spreading to the forested area on the other side of the strip and that their regular maintenance is monitored. Fire breaks and fuel breaks created to protect forested areas from fires and facilitate intervention in the event of a fire, as well as YARDOP facilities, need to be replanned and expanded according to today's conditions. In particular, the width of the strips should be considered for expansion in ten-year planning periods based on the average height and crown development of the adjacent forest trees. Other important factors to consider when determining the location and width of fire safety roads and strips: forecasting combustible material characteristics, including the region's fire regime data, locations suitable for maximum wind speed and direction observed during the summer months, canopy and ground cover density of forest stands, canopy height, stratification, ladder fuels, amount of combustible load, etc. It can be said that the width of a safety strip along a road should be 2–2.5 times the average height of the forest trees adjacent to the strip. On the other hand, to facilitate firefighting in the strip, ladder fuels within the forest adjacent to the strip can be removed within a distance of at least the width of the strip, and the canopy closure between the tops of the trees can be loosened. In this way, the effect of high fire intensity rapidly advancing along the strip can be reduced, and the effect of radiation-related heat transfer, which complicates firefighting efforts, can be mitigated. In our country, Circular No. 285 and the YARDOP circular are two separate applications that essentially serve the same purpose and cover similar facilities. Integrating the facilities covered by these two applications into each other through new legislation and determining the characteristics of the priority areas where each type of facility will be implemented, connecting all types of firefighting facilities to each

other through interconnections, will contribute significantly to firefighting strategies. Particularly in areas where fire-prone forested areas are fragmented and densely populated, placing greater emphasis on ZOAT and YOAT will also facilitate firefighting. By planning all types of fire prevention facilities, whether already established or to be determined by new legislation, as a separate forest working circle class, it will be possible to ensure that these facilities receive the necessary maintenance for at least one planning period (10 years) and that they are updated and new ones are established according to the development of the forest (Güngöroğlu et al., 2014). In this way, fire prevention activities and procedures can be aligned with forest management practices.

3. NEW BUILDING PERMITS AND ENSURING SAFE DISTANCES IN AGRICULTURAL ACTIVITIES

Turkey's forest ecosystems, especially in the Mediterranean climate zone, face the risk of fires that burn thousands of hectares of land each year. This situation threatens not only the biological diversity of forests but also the life and property safety of people living in settlements near forests. Therefore, the principle of safe distance from fire must be considered both an environmental and legal requirement in the process of issuing new building permits, planning agricultural activities, and determining any land use to be carried out on forest boundaries (Law, 1956; Regulation, 2007).

Legal Framework and Settlement Safety

The construction process in settlement areas close to forests is regulated under the Zoning Law No. 3194, the Provincial Special Administration Law No. 5302, and the Forest Law No. 6831. Article 27 of the Urban Planning Law stipulates that people registered in the village population may construct certain types of buildings in their own villages without a permit; however, this exception does not apply to areas close to forest boundaries. Articles 17 and 76 of the Forest Law stipulate that any construction within 100 meters of forests may be carried out with the approval of the General Directorate of Forests and that necessary fire safety measures must be taken (Law, 1956). In addition, the Regulation on the Protection of Buildings Against Fire (Regulation, 2007) defines in detail the standards to be complied with in terms of fire walls, emergency escape distances, material resistance, and environmental layout in settlements. These regulations provide a legal basis for preventing the spread of fire from settlements to forests and from forests to settlements.

Two-Way Protection Approach

When granting permits for new buildings, a dual protection approach should be adopted to prevent forest fires from spreading both from settlements to forests and from forests to settlements. In this context, it should be mandatory to leave a distance of at least 30-50 meters from the forest boundary, to make this area a fire safety belt free of combustible materials, to use non-combustible materials for roof coverings, and to avoid planting trees adjacent to walls or fences around the garden. These practices are based on the creation of 30–100-meter

"defensible spaces" around settlements, as in the Defensible Space Standard model developed in California, USA (California Legislative Analyst's Office, 2021; Soto et al., 2022).

Fire Prevention Measures in Agricultural Activities

Agricultural activities are a critical factor in combating forest fires. Especially in the summer months, stubble burning, combining harvester exhaust temperatures, fuel storage areas, or sparks caused by power lines pave the way for fires to reach forest boundaries. For example, according to the 2025 Şırnak Governorate Circular, it is mandatory to create 8–10-meter-wide plowed strips in grain fields adjacent to forests after harvest (Circular, 2025). Similarly, Australia's current Bushfire Management Standards (ACT ESA, 2025) and South Australia's "Integrating Bushfire Risk Reduction and Statutory Mechanisms" plan require soil cultivation, moist buffer strips, and living plant barriers to reduce fire risk at the agriculture-forest interface (March & de Moraes, 2020).

International Safe Distance Practices

Country / Region	Recommended Safe Distance (m)	Application Criteria	Source
Turkey	20–50	Communication No. 285 and OGM guidelines	Republic of Turkey (1956)
Spain	30–100	Topography and wind direction	Soto et al. (2022)
Portugal	50–100	Wildland–Agricultural Interface plans	Soto et al. (2022)
USA (California)	30–100	Defensible Space Standard	California Legislative Analyst's Office (2021)
Australia	30–70	Bushfire Code, risk zoning	March and de Moraes (2020); Gonzalez-Mathiesen and March (2014)

New Approaches and Recommendations

Today, the concept of dynamic safe distance goes beyond a fixed distance definition. Risk-based calculation methods that consider factors such as slope, wind speed, fuel load density, and resin content of vegetation suggest buffer zones ranging from 40–100 meters depending on terrain characteristics. Furthermore, GIS-based fire risk maps enable the dynamic monitoring

and planning of settlement-forest interfaces. The urban planning approach developed in Australia (Gonzalez-Mathiesen and March 2014) serves as an example in this regard.

In Turkey, fire safety elements should be addressed holistically in both new building permit processes and agricultural production planning. The implementation of 30–50-meter plowed or irrigated safety strips near forest boundaries and 8–10-meter strips in agricultural areas plays a critical role in preventing fires from spreading from settlements to forests and vice versa (Ondei and Prior, 2024).

Hüseyin YÖRÜR, Cumhur GÜNGÖROĞLU, Ufuk COŞGUN, Ahmet DUYAR, Damla YILDIZ, Mustafa AYBAR

4. DEVELOPMENT OF A NIGHT-OPERATIONAL AIRCRAFT FLEET

Water use is the most important element in fighting forest fires. The faster water can be delivered to the burning area, the shorter the time it takes to bring the fire under control (Avcı and Korkmaz, 2021). Aircraft play a major role in quickly and continuously responding to fires that are just starting and that ground-based firefighting teams cannot reach, thereby bringing the fire under control before it spreads and grows (Caner, 2021: Avcı and Korkmaz, 2021). Aircraft play an important role in forest fires in personnel transport, fire detection or reporting (especially wildfires), fire monitoring, intervention, and extinguishing. Considering the extent of areas susceptible to forest fires in our country, deploying enough planes and helicopters in many locations ensures that they can reach fires quickly in coordination with other ground teams during the initial response, thereby increasing the chances of success. Conversely, the success of fixed-wing and rotary-wing aircraft in forest fires declines even in daylight as the fire grows. At this point, aircraft cannot safely drop water or chemicals in windy conditions that fuel the fire, cannot perform successful water drops from sufficient height due to lack of maneuvering space in narrow valleys, cannot cool areas with high concentrations of combustible material, and cannot operate at night (Caner, 2021).

Pilots using aircraft in forest fires face many difficulties and limitations even if they are in the air and not in direct contact with the forest fire. Rising smoke can obstruct pilots' vision, and pilots must always be alert, especially since they share the airspace with other aircraft. Pilots and technicians participating in such operations require special training, particularly in mountainous terrain, due to uplift and downdraft air currents caused by hot and cold air differences, turbulence, low visibility conditions caused by smoke, and the need to be cautious of wind (Caner, 2021).

Enhancing aerial firefighting capabilities is of great importance. Aircraft with high night vision capabilities have been a topic of discussion for several years. It is crucial to develop an air fleet equipped with night vision and thermal radar equipment to increase observation and intervention capabilities, especially during nighttime or foggy weather conditions, and to rapidly deploy this fleet to the fire area. It is particularly important to develop an air fleet equipped with night vision and thermal radar equipment to increase observation and intervention capabilities, especially at night or in foggy weather conditions, and to quickly

deploy this fleet to the fire area. Such aircraft also provide life support to teams struggling with smoke and flames.

Figure 8. Rotary-wing (helicopter) aircraft responding to fires at night

It is almost mandatory for pilots of aircraft responding to fires to perform their duties by sight. This is because low-altitude flight and the need to respond to the correct location require them to see all obstacles on the ground as well as other air and ground vehicles. Aircraft described as having night vision, but more accurately defined as "aircraft capable of nighttime intervention," can only operate under limited conditions. Provided they have worked in the same area during the day, they can only operate effectively at night along the trail created between the water source and the two points where water is dropped on the fire. On the other hand, nighttime firefighting is only possible for pilots with night vision goggles. Intervening in forest fires that start or continue at night with water from the air poses significant risks in terms of technical capabilities. The risks involved in nighttime flights for firefighting purposes include terrain, slopes, elevations, trees, wires and poles, and weather conditions. In addition, night flights require special flight conditions that pilots perform using night vision goggles. City lights, vehicle headlights, and especially the flames of forest fires, which emit high energy, cause excessive glare and reflections in night vision goggles, making it very difficult for pilots to see. The quality of visibility during night flights is extremely low, depending on the intensity of light sources. Night flights are generally military flights, passenger transport, and cargo flights conducted on specific routes and altitudes. It is not a preferred method in terms of safety for multiple aircraft to respond to the same fire with night flights. Although our country has five

helicopters with night vision capabilities, they are only used in critical situations due to the risks involved (TOB, 2025).

Figure 9. Aircraft approaching the fire site using night vision

Figure 10. Night vision goggles used by aircraft pilots

On the other hand, aircraft equipped with thermal radar system cameras, which have EO (electro-optical) and IR (infrared) cameras mounted underneath, can be used in a forest fire to monitor specific areas, detect spot fires or new fires, provide support for a ground operation (e.g., counterfire or firebreak location), directing ground crews by identifying remaining hot spots before they grow to control the fire, and determining the location and amount of residual heat during the cooling phase. In our country, it has been observed that controlling large fires at night is easier with the guidance of one such aircraft (since it is dangerous for multiple aircraft to fly at night over the same fire), making it easier to control and extinguish fires under night conditions. At the same time, the cameras on these aircraft, using mid-wave IR (MWIR) and/or long-wave IR (LWIR) cameras can capture high-resolution thermal images during forest fire

operations, providing highly accurate map products showing live images and the location of active heat sources to the ground fire command center, and can generate KMZ, KML, and/or GIS shape files.

Hüseyin YÖRÜR, Cumhur GÜNGÖROĞLU, Ufuk COŞGUN, Ahmet DUYAR, Damla YILDIZ, Mustafa AYBAR

5. DEVELOPING INTERAGENCY COORDINATION IN FOREST FIRES

Forest fires are a global disaster type with devastating effects on ecological systems, threatening biodiversity and causing significant socio-economic losses (Kolukırık et al. 2022). Turkey, due to its location in the Mediterranean climate zone, is among the regions with high fire risk, like other countries with this climate. Factors such as high temperatures, low humidity, and strong winds in these regions significantly increase the risk of fire. (Sağlam et al. 2023; Demirbaş and Aydın, 2020). Combating such disasters is a complex process that exceeds the capacity of a single institution or organization, requiring a multi-stakeholder and integrated coordination approach. Effective forest fire management encompasses three main stages: pre-fire prevention and preparedness, intervention during the fire, and post-fire rehabilitation. In each of these stages, strong coordination among various actors, such as public institutions, local governments, non-governmental organizations (NGOs), the private sector, universities, and local communities, is crucial for the development of inter-institutional coordination.

The Importance of Interagency Coordination

Inter-agency coordination is a critical element that integrates the four fundamental stages of disaster management (prevention, preparedness, response, and recovery) (Alexander, 2020). In disaster management literature, coordination is defined as the process of aligning the resources, information, and actions of different actors to achieve a common goal (Katoch, 2006). In rapidly developing and unpredictable crisis situations such as forest fires, flexible, network-based, and collaborative management models are replacing traditional hierarchical command-and-control structures. These models enable institutions with different areas of expertise and resources to work in interaction and harmony towards a common vision and goal, achieving more efficient and effective results (Boin and Hart, 2003).

Certain fundamental components are necessary to ensure effective coordination. First, it is crucial that all stakeholders come together before a fire to conduct risk analyses, evaluate possible scenarios, and clearly define roles and responsibilities. Second, it is essential to establish standards and protocols that enable the integrated use of the human resources, equipment, and technological infrastructure (e.g., aircraft, water tankers, communication systems) possessed by different institutions. Thirdly, it is necessary to establish a robust communication infrastructure that enables the real-time and accurate flow of critical

information, such as fire risk, weather conditions, the progress of the fire, and intervention activities, among stakeholders. Finally, pre-determining an organizational structure (e.g., Incident Command System - ICS) that will enable teams from different agencies to work in harmony under a single command center during a fire and testing it through regular drills will increase operational effectiveness.

Current Situation and Coordination Issues in Turkey

Although the General Directorate of Forestry (OGM) is the primary responsible institution for combating forest fires in Turkey, the Forest Law No. 6831 and related legislation also assign various duties and responsibilities to other public institutions, local administrations, and citizens in the fight against fires. Particularly in large-scale fires threatening multiple settlements, numerous actors become involved, including the Ministry of Interior's Disaster and Emergency Management Presidency (AFAD), provincial and district police departments, municipalities, provincial special administrations, non-governmental organizations, universities, volunteers, and local residents (Savaş and Genç 2024), (Table 1).

Table 1. Areas of responsibility of key institutions involved in forest fire management

Institution	Primary Area of Responsibility	Coordination Objective
General Directorate of Forestry	Firefighting, equipment, personnel	Operational leadership
AFAD	Disaster management and crisis coordination	Emergency planning
Municipalities	Local infrastructure, logistical support	Local coordination
Gendarmerie / Police	Security, evacuation, traffic control	Public safety
NGOs	Volunteer support, awareness	Community involvement
Universities / Research Institutions	Risk analysis, data support	Scientific consulting

However, academic studies and large-scale forest fires in recent years have clearly demonstrated that fires are not limited to forest ecosystems but can simultaneously affect residential areas and agricultural lands. This multifaceted disaster structure has led to uncertainties in the sharing of duties and responsibilities; inter-institutional coordination deficiencies and organizational conflicts have caused significant disruptions in the fire management process (Tutmaz 2021, Savaç and Genç 2024).

Inter-agency confusion over authority and unclear job descriptions paves the way for coordination problems, especially during intervention. Furthermore, the inability to integrate the human resources, equipment, tools, and technologies possessed by different agencies, along with the lack of standards in this regard, leads to inconsistencies in resource management.

Solution Recommendations for Improving Coordination

A comprehensive and multi-layered approach should be adopted to ensure effective inter-agency coordination in combating forest fires. Based on literature and field experience, the following solutions can be developed:

The Incident Command System (ICS), successfully implemented in countries such as the US, Canada, and Australia, is a modular management system that enables different agencies and organizations to work together under a single command, using standard terminology and procedures. In Turkey, the legal infrastructure should be strengthened, and joint training and regular drills should be conducted for all stakeholder agency personnel to ensure the effective implementation of the ICS model in all disasters, especially forest fires. This system will prevent confusion over authority during a fire and facilitate rapid decision-making.

A central digital platform (e.g., an advanced Fire Management System) based on Geographic Information Systems (GIS) that enables real-time data flow and can be used by all stakeholders should be developed. Critical information such as fire risk maps, meteorological data, the location of resources, and the status of the fire should be instantly trackable through this platform. Furthermore, compatibility should be ensured in inter-agency radio and other communication systems, and communication gaps should be minimized by determining common frequencies and protocols. Equipment standardization should also be addressed in this context, ensuring the compatibility of firefighting vehicles and other critical equipment.

Regular assessment and coordination meetings should be held before and after the fire season, with the participation of all stakeholders at the national, regional, and local levels. These meetings will allow lessons to be learned from past experiences and enable joint planning for the future. An accreditation system should be established to ensure the effective and safe involvement of volunteers in the process, and accredited volunteers should receive basic firefighting, occupational safety, and first aid training. The tasks these volunteers will perform

during a fire and the professional team under whose supervision they will work should be planned to prevent uncontrolled activities.

Lasting success in combating forest fires is only possible through an effective coordination and cooperation mechanism established between institutions. In this context, a reactive and fragmented approach to intervention must be replaced by a proactive, holistic, and strategically based management approach. The implementation of pre-fire planning processes with the active participation of all stakeholders, including public institutions, local governments, non-governmental organizations, and scientific circles, along with the standardization and harmonization of equipment and resources to be used, will increase the effectiveness of interventions. Furthermore, the implementation of modern management models such as the Incident Command System will strengthen Turkey's institutional resilience against forest fires and maximize its capacity for coordinated action. This transformation should be approached not only as a technical and operational restructuring process, but also as a new governance approach that reinforces a sense of shared responsibility among all stakeholders and institutionalizes a culture of cooperation.

Hüseyin YÖRÜR, Cumhur GÜNGÖROĞLU, Ufuk COŞGUN, Ahmet DUYAR, Damla YILDIZ, Mustafa AYBAR

6. INCREASING AND EXPANDING IN-SERVICE TRAINING FOR FIREFIGHTING PERSONNEL

Training activities and procedures are carried out by the General Directorate of Forestry (OGM) through its "Directorate of External Relations, Training, and Research." The directorate's job description includes "...preparing the training plan for the General Directorate organization, carrying out pre-service, in-service, and professional training activities..." The directorate is organized into branch offices. Within this framework, the "Education Branch Directorate" strives to guide educational organizations. The OGM conducts training related to forest fires, particularly during the period from November to March/April, which can be defined as the off-season for fires.

Review of Legal Processes Related to Education

The legal processes for all work and procedures within OGM are provided on the website "ogm.gov.tr/tr/e-kutuphane/mevzuat". In this context, the number of topics covered by the legal processes according to the legal hierarchy is indicated, including those related to forest fires. Accordingly;

1. Regulation (1/0),
2. Regulation (95/3),
3. Procedures and Principles (2/0),
4. Notifications (43/1),
5. Circulars (53/1),
6. Instructions (516/3),
7. Guidelines (10/0),
8. Protocols (79/1)

Considering all the legal processes, there are a total of 799 legal processes related to the subject. Among these, there are 9 related to forest fires (URL-1-8).

Regarding forest fires, under the heading of "Education," section 11 of Circular No. 285 evaluates the topic of education under the title *"Preventive Measures in Combating Forest Fires."* Within the scope of this section, topics such as "public education," "regulation of public-forest relations," "National Forest Fire Protection Program and Implementation" ( ), etc., are

covered more than those related to forest fire workers. On the other hand, it is seen that the provisions related to education in the regulation are located in different sections as follows (OGM, 1995).

<u>Section III</u> "*PREVENTIVE MEASURES IN COMBATING FOREST FIRES*" under the seventh subheading "7-Selection and Employment of Seasonal Firefighters and Evaluation of Their Free Time, and Clothing–Clothing Provision and Maintenance" sub-item, under the heading "7.2-Evaluation of Firefighters' Free Time"; *<u>"7/2/2- Firefighters shall undergo continuous training on forest fire-related issues and other forestry matters. The training will be organized by the Operations Manager or technical personnel appointed by him/her under the coordination of the Regional Directorate</u>*." Within the same Section III, under the topic 13-WATER-RELATED INJURIES IN FOREST FIRES (Fire Trucks, Water Tanks, Water Sources), it is noted that "... The fire truck crew will undergo special training."

<u>Section IV</u>, "EXTINGUISHING FOREST FIRES," under the heading 6- RESPONDING TO REQUESTS FOR ASSISTANCE FROM THE FIRE SITE, states, *<u>"... 1- Technical personnel from the Operations Directorate, forest rangers, and lookout tower observers will be familiar with fire-prone areas within the Operations Directorate. They will know the area. To this end, training will be conducted periodically,</u>* and *<u>observers</u>* will be required *<u>to patrol their areas of visibility, especially outside of the fire season</u>*." Another training topic is also covered under the subheading "Critique of Fires" in the same section. Accordingly, *<u>"17- Under **the Critique of Fires**, the fourth item regarding training states, "4- Many growing fires occur because they are not seen or are seen too late.</u>* For *<u>this reason, the adequacy of existing towers will be reviewed, and special</u>* attention will be *<u>paid to the hiring and training of fire lookout workers</u>*."

Another assessment regarding the training of personnel fighting forest fires is found in Circular No. 6302 of the Directorate General of Forest Protection and Fire Fighting dated 05.03.2003 and numbered B.18.1 OGM 0 00 01.02/OY: 72. Under the heading "Intervention Teams," *<u>the selection of team personnel will be based on the criterion of usefulness , the training of teams will be refreshed at the beginning of the fire season, and personnel who have not previously received training certificates will be issued "Certificates" at the end of the training.</u>*

It is noted that the circular states: "Daily morning training sessions will be conducted for the teams to ensure that team personnel remain knowledgeable and fit." Within the scope of the training:

1. *"The training of fire truck operators will be refreshed."*
2. *As part of the Training Promotion Activities; The technical training required by military units participating in forest firefighting efforts will be conducted by our organization's expert personnel before the start of the fire season.*"
3. *Planning of Military Units: The planning of military units expected to participate in firefighting will be carried out. The training of these units on forest fires will be conducted within the framework of comprehensive and practical training programs, and their ability to effectively respond to fires will be maximized before the fire season begins.*

These statements are observed (OGM, 2003)

Section Conclusion and Evaluation

As seen above, there are no assessments from various perspectives, such as what kind of training and practices will be carried out within the framework of the current legal processes in the context of OGM's fight against forest fires, how long these trainings will continue, and what level of knowledge and awareness will be developed in the training and practice areas according to the scope of the personnel's work. However, every year, the Forest Fires Training Center located at the OGM Antalya Regional Forest Directorate organizes training sessions, primarily for forest management supervisors, using simulators. It is also known that additional training is provided to selected technical personnel throughout the country who can implement "backfire" techniques in forest fires. The duration and content of the theoretical courses and the nature of the practical exercises for these training programs are prepared by the Forest Fire Training Center and submitted to the OGM headquarters. The program is then approved by the relevant OGM department, the deputy general manager, and the general manager, taking into account the relevant regulations of the Ministry of National Education. However, no pre-determined and standardized training and implementation guide has been created.

It appears that training for forest management chiefs working in 30 Forest Regional Directorates across the country can only be provided once a year and within a limited time frame by one training center. Therefore, it is necessary to increase the number of training centers. In this context, the Buca Forest Fire Training Center should be reactivated. Training and practice

should not be limited to forest management chiefs; other employees should also be able to benefit sufficiently from training and practice in a more widespread manner covering several periods of the year. To this end, *"Topic-Based Training-Practice Centers"* should be established. The training-application guide and program content for the training centers to be established should be developed in consultation with relevant stakeholders (such as the relevant Department of the General Directorate of Forestry, relevant branch offices of Regional Forest Directorates, forestry research institute directorates, and forestry faculties of universities).

The dissemination of training and application centers at the regional level should be implemented by planning an organization that will first cover the regions located in the fire belt of the Aegean and Mediterranean regions (such as Izmir, Muğla, Mersin, Antalya, Adana, Hatay, Çanakkale, Istanbul, and Bursa) and then other regions.

In these processes, Circular No. 285 must be re-evaluated in accordance with current conditions with the participation of all stakeholders.

The training and implementation programs currently in use and those to be developed considering new requirements must be reorganized in terms of quality and quantity according to basic subject groups. Programs should be developed to educate and raise awareness among the press and bureaucrats regarding the organization of forest firefighting efforts.

It is essential to establish a legal and regulatory framework for training and implementation program guides for all stages of forest firefighting efforts, including the definition of roles within and between institutions in the fight against fires.

It should not be forgotten that successful forest firefighting can only be achieved through good organization, the participation of trained personnel, and, in particular, experienced ground forces.

Under the heading of forest fire training, interest groups

1. *Education and Awareness of Forest Villagers*,
2. *Education of Urban Communities Benefiting from Forests*,
3. *Training of Civil Society Organizations in Forest Fires*,
4. *Training of Written and Visual Media Organizations on Forest Fires*,
5. *Training of Forest Fire Volunteers*,
6. *Forest Fire Training for Public Institution and Organization Employees*,

7. *Training of Personnel and Managers Responsible for Preventing Forest Fires*,

can be summarized under seven headings. In this context, Training of Personnel and Managers Responsible for Preventing Forest Fires focuses primarily on training firefighters in firefighting activities (Coşgun and Yıldız, 2023). Similarly, it is known that the training for technical personnel responsible for fire management focuses on the command and control of operations during the extinguishing stages. It remains unclear what kind of training firefighting personnel and the technical personnel at each level of management responsible for these personnel receive on fire prevention issues. The most important training for OGM personnel involved in small, medium, and large-scale forest fires should be post-fire self-criticism meetings, which should be recorded in minutes. There is an absolute need for an assessment of what was done correctly during the process and what the shortcomings were. In particular, there is a need to evaluate how the perceived shortcomings can be corrected. The aim of this work should not be to identify the guilty parties, but to take precautions in advance by anticipating approaches that will prevent negative events in the future. In other words, a proactive approach must be implemented.

7. ROLE DESCRIPTIONS, ORGANIZATION, AND TRAINING OF FIREFIGHTER VOLUNTEERS

Evaluation of the Legal Processes of Forest Fire Volunteering

The "Forest Volunteer" approach established by the General Directorate of Forestry was first introduced by Law No. 7139, published in the Official Gazette dated 28.04.2018 and numbered 30405. Accordingly, ARTICLE 14- Article 69 of Law No. 6831 has been amended as follows. *"ARTICLE 69-/4 paragraph "... Volunteers are also utilized in the fight against forest fires. The transportation of volunteers to the fire and the tools and clothing needed to extinguish the fire are provided by the forest administration in state forests and by the owners in other forests. The food expenses of personnel and volunteers participating in the firefighting activities* shall be *covered by the forest administration during the firefighting activities*." The reason for including this statement in the forestry public domain is as follows: *"Article 69—In forest fires, all males aged between 18 and 50 from nearby villages and towns are obliged to go to the fire site with tools such as axes, shovels, pickaxes, and saws that can* be *used to extinguish the fire and to extinguish the fire*." Thus, the concept of "Forest Volunteer" emerged (Atmiş et al., 2023).

Volunteer candidates, under the "Regulation on Volunteers Fighting Forest Fires" published in the Official Gazette dated 11.09.2019 and numbered 30885; To become a volunteer fighting forest fires, they can apply in person to the Forest Regional Directorate/Forest Management Directorate or online via e-Government by filling out the application form found under the Forest Fire Volunteer button on the OGM website (URL, 9).

The concept of Forest Volunteer should be examined under two main headings in terms of the relevant regulation. One of these is the evaluation of the regulation in terms of legal regulation technique. In this context, the Regulation on Volunteers Fighting Forest Fires regulates the issue of "Forest Volunteers" with its various articles. However, since the publication of the regulation, changes in forestry laws have necessitated its updating in terms of *"legal regulation technique."* This is because important legal changes affecting forest volunteers have emerged. Article 2 "Basis" of the regulation refers to Article 69, Article 71, and Additional Article 5 of Forest Law No. 6831. Article 69 has undergone various changes since the date of the regulation. It should be revised by taking these changes into account. Article 71 has been repealed. It is no longer in

force. Additional Article 5 has no relevance to the subject matter. It was written erroneously. In fact, the relevant article is: "Additional Article 5-(Addition: 9/23/1983 - 2896/60 md.; Change: 4/19/2018-7139/16 md.) ARTICLE 16- Additional Article 5 of Law No. 6831 has been changed as follows. "ADDITIONAL ARTICLE 5- The procedures and principles regarding the implementation of this Law, as well as the determination and collection of fees to be charged for the use of forest areas, shall be determined by a regulation issued by the General Directorate of Forestry."

On the other hand, the amendment to the forest law has introduced regulations regarding health problems or, in particular, death that forest volunteers may experience in fighting forest fires. In this regard, the law states: *"Scope of the LAW ON CASH COMPENSATION AND MONTHLY ALLOWANCES published in the Official Gazette dated 6/11/1980 and numbered 17152 Article 2 / (ı) (Added: 23/3/2023-7442/34 md.) Personnel and volunteers actually assigned by the General Directorate of Forestry to extinguish forest fires*, as well as *other public* officials *assigned* within *this* scope." This approach has been included in the legal regulation after our long-standing warnings. Before this regulation, only compensation payments were made to employees who died in forest fires, but now, with this regulation, the relatives of those who lost their lives are also provided with a martyr's pension, which also covers forest volunteers. This regulation is a very positive and necessary one.

On the other hand, Article 3 of the relevant regulation establishes definitions. The two definitions included in these definitions are important because they determine who can be considered "forest volunteers" and what they can do. In this context, *"**Article 3/c) Volunteer:** A person whose profession is not forest firefighting and who does not receive a salary for this task, who has the skills, training, and equipment necessary for professional firefighting, who leaves their own work when a forest fire breaks out, intervenes in the fire within the chain of command and returns to their own activities after the fire, and who is at least 18 years of age. Article 3/i) Forest firefighting operations:* All *transportation, firefighting, extinguishing, and cooling activities* carried out *from the moment the report is received until the first action is taken, for the purpose of extinguishing fires ( ) that break out in forests or other open areas and are likely to spread to the forest*. The phrase "... *who have the professional firefighting skills, training, and equipment..."* in this definition refers to individuals who can become forest volunteers. These individuals will acquire skills and equipment through training and are

expected to gain professional firefighting capabilities and skills. This expectation is quite high. This is because even forest rangers, forest fire workers, and even forest engineers who have fought forest fires for many years can find themselves in very difficult situations and even lose their lives.

Forest Manager Forest Engineer Abdullah Aydın, Forest Ranger Mehmet Ali Güzelce, Forest Ranger Mesut Aranlı, Forest Worker Feridun Kaya, Forest Worker Hasan Dağhan, and Forest Worker Mevlüt Kaplan were killed in action. Experienced forest fire workers, who were suddenly faced with a change in wind direction, lost their lives, even though they were experienced workers who had been dropped off by helicopter to fight the fire in the area. In the 2005 forest fires in our country, 11 of our workers (AKUT and forest fire workers) were also martyred. Although almost all of these people were experienced, they could not escape losing their lives. This is because forest fires (open field fires) are a phenomenon that requires instant decisions based on a thorough knowledge of the area. It is necessary to position oneself according to the location of the fire based on natural conditions and to act . Therefore, assigning "forest volunteers" to the front lines in forest fires is quite risky.

Again, articles 5/3 and 5/4 of the regulation state: "*Determination* of volunteers *Article 5/(3) Volunteer candidates are subject to theoretical and practical training in fighting forest fires. The training includes theoretical and practical instruction on firefighting, first aid, the use of personal protective equipment, occupational safety, and vehicles used in forest fires. (4) Those*

who achieve a score of 70 or higher on the exams administered at the end of the training are deemed *qualified and eligible to become forest firefighting volunteers* and are *issued participation certificates*." As can be seen here, theoretical and practical training in fighting forest fires is mentioned for forest volunteers. The provisions in this article also clearly anticipate that forest volunteers will be utilized in forest firefighting efforts. However, no information is provided regarding the nature of the theoretical and practical training, its duration, or the topics it will cover. These issues could perhaps be detailed in a "Decree" or "Circular." However, there is no official information containing an approach or program developed in this direction.

Article 6 of the Regulation has been established for the purpose of organizing training and activities. Accordingly, *"Training, supervision, and working procedures for volunteers ARTICLE 6/(1) For use in fires that break out in state forests, volunteers fighting forest fires shall be provided with tools, equipment, materials, and personal protective equipment determined by the Directorate every two years, and these shall be recorded in the ORBIS system. In fires occurring in privately owned forests, these needs shall be met by the forest owners. (2) The living expenses of volunteers participating in extinguishing fires in state forests shall be covered by the relevant forest management directorate during the firefighting activities, and in other forests, by the owners. (3) The duties of volunteers within the team are determined by the volunteer commander through task distribution. (4) Volunteers intervene in a forest fire they participate in as a team and within the chain of command. (5) The work of volunteers is supervised and monitored by the forest management directorate to which they are affiliated. (6) In addition to training on fighting forest fires, volunteers* participate *in other training and drills deemed appropriate by the Directorate General and relevant to their duties*. This article and its related paragraphs do not cover topics such as the content and duration of the training or the stages involved.

The duties are specified in Article 7 of the Forest Volunteer Regulation. These duties are as follows: "*Duties of Volunteers ARTICLE 7 – (1) The duties of volunteers are as follows: a) Upon notification of a forest fire, immediately proceed to the scene as a team with personal protective equipment, vehicles, and equipment. b) Respond to and extinguish fires. c) Responding to any accidents or entrapments requiring technical rescue during forest fires, conducting all search and rescue operations and first aid services. ç) Performing duties with*

an understanding of protecting state property and ensuring its long-term usability. d) Maintaining personal protective clothing and ensuring it is kept clean and organized. e) To maintain and clean tools, equipment, and vehicles. f) To *participate in other training and drills organized by the Department*. Here, clauses 7/a, b, and c fully state that forest volunteers can directly intervene in forest fires and, moreover, can perform the tasks and operations specified in clause (c), which is a very separate area of expertise. However, this is not a subject that even forest engineers or existing forest fire workers can consciously accomplish. It is an expression that goes beyond its purpose and is included in the regulation.

A technically significant approach is also evident in Article 8 of the regulation. Accordingly, *"**Rights of Volunteers ARTICLE 8 –** (1) The provisions of the Regulation on Compensation to be Paid to Those Who Die or Become Disabled or Injured During Forest Fire Extinguishing Operations, published in the Official Gazette dated 11/12/2004 and numbered 25667, shall apply to volunteers who die, become disabled, injured, or sick while actively participating in forest fire extinguishing operations.(2) The costs of food, drink, transportation, and accommodation for volunteer personnel during the training and drill activities they participate in shall be covered by the General Directorate of Forestry. (3) The General Directorate of Forestry shall issue certificates of appreciation to forest firefighting volunteers who demonstrate outstanding success and usefulness. (4) Approved photo ID cards shall be issued free of charge to forest fire volunteers, and new volunteer cards* shall *be issued to volunteers who declare in writing that they have lost their volunteer card*, subject *to the decision of the commission*." As mentioned above, the section on compensation in Article 8/1 is also subject to the 2023 regulation, which provides not only compensation but also a martyr's pension. Therefore, the relevant paragraph in this provision must also be taken into account when amending the regulation.

The Role, Organization, and Training of Forest Fire Volunteers

Changes were made with the "Regulation on Amendments to the Regulation on Volunteers Working in the Fight Against Forest Fires" published in the Official Gazette dated 19.09.2025 and numbered 33022. These changes are evaluated below.

1- Article 71 in the Basis section of the aforementioned amended regulation has been removed. However, the wording in the "Basis" section of the old regulation continues in the "Appendix 5" section of the amended regulation.

2- The term "volunteer" has been replaced with "volunteer fighting forest fires" throughout all sections of the same Regulation.

3- Paragraph (j) has been added to Article 3 of the amended new regulation: "j) Other volunteers: Within the scope of fighting forest fires; persons who, for the purpose of mutual aid and logistical support, without personal gain and without any financial expectations, voluntarily use their physical strength, time, knowledge, skills, and experience to contribute to the efforts to extinguish forest fires." However, this scope is open to debate.

The changes introduced by the new regulation have failed to address the shortcomings. The deficiencies in the regulation have been outlined above. The aim here is to highlight the significant technical shortcomings in the regulation, which forms the legal basis for the forest volunteer program. Another purpose is to outline the duties and training levels envisaged for individuals who will become forest volunteers. While the regulation includes duties that require important and vital responsibilities, it has been stated that the type, standards, and duration of the training and practices will be specified. Therefore, as it would be speculative to make an assessment regarding training and practices, this topic has not been addressed.

In order to address the aforementioned shortcomings, the regulation in question needs to be re-evaluated. However, for this to be possible, evaluations must be made in light of the "Forest Volunteer Roles" and "Forest Volunteer Organization and Training" approaches outlined below.

Role Definitions of Forest Volunteers: The "forest volunteer" program established by the General Directorate of Forestry can be seen as a highly positive initiative, particularly in terms of creating a society that is sensitive to forest fires. It can even be considered important in terms of shaping public opinion regarding the relationship between forest fires and society. However, expecting forest volunteers to be on the front lines fighting forest fires in extremely difficult terrain and natural conditions poses a very serious risk.

As mentioned above, individuals who are unfamiliar with the area and do not know about nature and forest fires, but only have a love of nature, should not be given the task of fighting fires in extremely specialized frontline forest firefighting operations. As seen in a detailed examination

of the regulations, it is not fully known what level of training and practical experience will be provided to forest volunteers.

It would be appropriate to utilize forest volunteers in forest fires, particularly as "logistical" or support providers. In this context, the roles of forest fire volunteers include:

Providing support in terms of informing the community before a fire and raising awareness of behavior,

Providing various forms of support during the firefighting stages and process (directing teams arriving from outside to the fire site, providing technical equipment, food supplies, etc.),

Monitoring and evaluating post-fire restoration efforts, contributing to the assessment of restoration success, and actively participating in the process of introducing the community to developments in the restored areas.

The OGM has developed a very positive approach to Forest Volunteers. This includes meeting the requirements for personal protective equipment (PPE) and other needs for forest volunteers. According to the OGM, there are 130,000 forest volunteers. This data is very important. It is essential to take advantage of the power of this social capital by ensuring that it is applied in real life. However, this power should be utilized in forest firefighting efforts not by fighting on the front lines, but by taking advantage of its other characteristics.

Organization and Training of Forest Volunteers: It may be quite difficult to organize 130,000 forest volunteers across the country to contribute to various activities. However, when these volunteers are classified according to their living environment, age, gender, and education levels, the distribution of roles can be achieved more easily. In this process, selecting three main activity groups and sub-activity groups for each volunteer to contribute to will determine where and in what areas each volunteer can be effective. When volunteers are also evaluated by region and locality in terms of age, gender, and education level, teams and team leaders will be formed. Bringing each group together can be organized by forest management directorates and forest management offices. At this stage, communication links between groups and teams will need to be established. At this stage, each group leader will be able to form a group with their own team via a telephone network. It will be sufficient for forest management offices and/or forest management directorates to establish a telephone network only with group leaders. Thus, groups can be quickly organized for sustainable training, awareness-raising, and forest fire

logistics efforts. The coordination of forest volunteers can lead to confusion regarding authority and responsibility. Access to and direction of the fire area, the intensity of traffic of firefighting teams and equipment, and organization regarding the resolution of communication and logistics issues are also important in terms of occupational health and safety. These issues create various problems in practice (Górriz-Mifsud et al., 2019; Oral and Turan, 2023; Köçer and Aslan, 2023).

On the other hand, for training and implementation activities, OGM units (Forest Fires Directorate, forest regional directorates, forestry research institutes, and forest management directorates where forest fires are prevalent) and forestry faculties of universities must come together to establish infrastructure programs that will be utilized to create ***"Training and Implementation*** Guidelines.***"*** Education-Practice Guide programs should be developed separately for all ages, gender, and education level groups and roles in society. These programs must be standardized for the work in the stages mentioned above. Thus, the education and practice guide program developed for all processes can be implemented simultaneously and sustainably throughout the country. With the implementation of this process, the OGM will no longer need to protect itself from misinformation in society. In other words, the OGM will become ***the "Forest Fire Community Relations Ambassadors***.***"*** Accurate information can be continuously provided to the entire community in a transparent manner through volunteers. In fact, OGM has sufficient resources to implement this process. An understanding of governance aimed at producing solutions ***for "forest fire community relations"*** is necessary, along with institutions and organizations that can demonstrate the will to coordinate and take responsibility at the corporate level.

In many parts of the world, particularly in Canada, the United States, and some European countries, it is possible to find a wide variety of educational programs related to forest fires. A few examples are selected below.

1) https://fire-res.eu/about-fire-res/ (FIRE-RES): FIRE-RES is a **4-year project** (2021-2025) led by the **Forest Science and Technology Centre of Catalonia** in Spain and funded under the European Union's H2020 research and innovation program.

2) https://www.unesco.org/en/articles/preventing-forest-fires-through-collaborative-research-and-education-durmitor-national-park:

3) https://www.nifc.gov/about-us/what-is-nifc: The National Interagency Fire Center is a unit formed by bringing together many local and regional agencies and organizations in

the United States. It deals with forest fires and other emergency issues at the national level.

4) https://www.plt.org/about-us/mission-history/: The gains achieved because of PLT educational practices and the educational process are noteworthy in this context; PLT for Student Academic Development; It has been proven that PLT materials for Student Academic Development provide statistically significant gains in students' content knowledge and attitudes toward the environment. The average knowledge gain achieved by 2nd-8th grade students exposed to PLT **_for two to three weeks_** _is equivalent to at least seven months_. The website https://www.plt.org/educator-tips/wildfires-causes-effects-educational-activities highlights how educational topics are approached in PLT studies.

This example demonstrates the scientific benefits of even a few weeks of training for school-age students. Considering that in our country, only a few hours of training are conducted on important days, our perspective on raising public awareness about forest fires becomes clear. On the other hand, it is highly inadvisable to utilize individuals who will be assigned to forest firefighting duties after only one week of training (the content and duration of which are not specified in the regulation) in the actual firefighting phase. The subject requires more careful consideration from the perspective of occupational health and safety.

Section Conclusion and Evaluation

Forest firefighting efforts encompass all technical and administrative activities aimed at controlling, cooling, and completely extinguishing fires that occur within or outside forest boundaries, tend to spread freely, and can damage the forest ecosystem as a whole or in part, with the least possible damage and in the shortest possible time (Coşgun, 2022).

Efforts to obtain and utilize support from volunteers in forest fires in Turkey have attracted attention in recent years. It is important to select volunteers to be assigned to forest fires and to determine their duties to prevent volunteers from putting themselves or others in harm's way. In this regard, developed (Şafak, 2024) and/or to-be-developed recruitment scale sets can be utilized.

Various studies have been conducted on the training and management of forest fire volunteers. In this regard, the study "Evaluation of the Volunteer System in the Context of Fighting Forest Fires" is noteworthy in terms of examining the conditions in our country (Şafak, 2025). In terms

of the criteria that volunteers should meet to be eligible as forest volunteers in the context of the tasks mentioned above in the fight against forest fires, it would be appropriate to categorize them into difficult, moderately difficult, and light tasks, etc., as specified in NIFC (2024), and to define their duties accordingly. In addition, OGM must design test sets for individuals' performance criteria according to the job descriptions for forest fire volunteers. While the regulations that need to be made regarding protection against possible risks during volunteer activities (individual accident insurance, occupational accident and occupational disease insurance, etc.) is a subject of debate, this process has been overcome by the addition of clause (1) to Article 2 of Law No. 2330 dated 1980 with Law No. 7442 issued in 2023. (Arslan, 2018; Doğan-Yenisey, 2020; Erdoğan and Uyan-Semerci, 2020; Yentürk, 2020).

Decisions were made to resolve issues related to the volunteer system at the Forest Fires in the Climate Change Process Workshop organized by the General Directorate of Forestry (OGM) in Turkey (OGM, 2021). For these decisions to be implemented, the necessary legal regulations must be arranged, excluding subparagraphs (b) and (c) of Article 7/1 of the regulation.

8. UPDATING FIRE RISK HAZARD MAPS AND DETERMINING FIRST RESPONSE DEPLOYMENT PLACES

Risk assessment is essentially the evaluation of the likelihood of events occurring and the nature and intensity of the spatial and temporal undesirable effects associated with their magnitude. The importance of risk assessment lies in the integration of risk-based probabilities and information related to their management with decision support systems through tactical and operational synthesis. An important feature of forest fire risk analyses is that they involve factors with multiple variables of uncertainty related to ignition, fire behavior, and fire management based on natural or human causes. For example, the probability of ignition is related to the temporal variation of temperature and wind data, which affect the moisture content of fine fuel; the properties of combustible materials that affect flammability; topographic features; the amount of sunshine depending on canopy cover, which affects the moisture change of surface fuels; and the presence of ignition sources based on human activities (Güngöroğlu, 2017). In terms of fire behavior, risks are generally assessed by the probability of burning a specific area over a certain period, the fire line intensity, which expresses the heat energy

released per unit area per unit time, and the characterization of fire effects (Thompson and Calkin 2011). To ensure successful forest fire management, it is recommended that effective fire decision support be established (Rodrigues and Riva 2014). It is essential that the uncertainties underlying this support can be explained with high accuracy. To achieve this, it is important to first identify the uncertainties that jointly reveal spatial ignition and fire behavior risks, understand their causes, implement fire prevention measures, and make high-quality alternative decisions to reduce the likelihood of ignition.

Particularly after the 2020s, it has been observed that some of the OGM-affiliated operational directorates have been conducting fire risk and hazard mapping as part of fire management. It is known that this has been included in the scope of the World Bank-supported IDOP project to be carried out more systematically, especially in regional directorates where first and second-degree fire-sensitive forests are located, and that tenders are currently being issued for this purpose. This is generally seen as a welcome development. However, it is important that fire risk and hazard identification is accompanied by pre-fire management measures. Strengthening fire management with a decision support system that only contributes to firefighting efforts during a fire will not be sufficient on its own. The key is to reduce the uncertainties that create risk and mitigate the potentially dangerous consequences before they occur. Risk and hazard maps, especially pre-fire fire breaks and fuel breaks, YARDOP facilities, other forest roads, fire ponds and reservoirs, and first response team deployment locations, ensuring that the first response during a fire occurs within a maximum of 10-15 minutes and that these facilities are connected to other road networks to facilitate rapid access for external support. To ensure this type of management, fire risk and hazard maps should be continuously updated, considering that the uncertainties that create these maps may change.

9. CLEAR DEFINITION OF FIRE COMMAND AND AUTHORITIES

The forest firefighting system in Turkey has been structured within the framework of institutional experience and legal regulations accumulated over many years. The "Fire Command" institution, one of the cornerstones of this system, is a key mechanism that determines both operational management in the field and inter-agency coordination (Regulation, 1976). Fire command is a technical command unit defined by legislation, developed through practice, and brought into line with international standards.

Legislation-Based Definition and Legal Framework

The legal basis for the fire command is determined by Article 69 of Forest Law No. 6831 and the "Regulation on the Duties of Officials in the Prevention and Extinguishing of Forest Fires" (Regulation, 1976). According to these regulations, the technical command and control of forest fires is carried out by "the highest-ranking forest official at the scene of the fire among those participating in the firefighting efforts"; the authority to decide that the fire has been completely extinguished also belongs to this official. In cases where no technical personnel are present in the field, the Forest Ranger (OMM) who first arrives at the fire acts as the temporary fire chief (Regulation, 1996). This temporary authority mechanism ensures that decision-making processes continue uninterrupted in emergencies. Fire command is not only a technical command position; it is also a coordination office that includes administrative, legal, and security responsibilities. In this context, inter-agency coordination during forest fires (AFAD, Gendarmerie, Police, municipalities, etc.) is provided by the highest local administrative authority, while the fire commander exercises technical command (Sen, 2023). Thus, the principle of "single command – multi-agency coordination" is guaranteed at the legislative level.

Scientific Approaches and Operational Hierarchy

Çar and Akyol (2024), in their model proposals for the Turkish forest fire management system, suggest that the Forest Management Directorate (OİM) scale should be at the center of the fire command institution. In a survey conducted by the researchers with 326 participants, 67% of the participants stated that the fire commander should be the director of operations, while 58.5% stated that the front commander should be the chief of operations. This finding emphasizes the

importance of a command chain based on local knowledge in fire management (Çar & Akyol, 2024). The same study proposed a two-tier command system consisting of a "regional directorate as a strategic planning center" and a "forest management directorate as a tactical implementation unit."

Security Dimension: Hybrid Threats and Environmental Terrorism

Studies indicate that forest fires are not only natural disasters but also carry hybrid threat elements that have gained importance in recent years. Dağıstanlı and Gencer (2023) argue that some forest fires in Turkey may be linked to terrorist acts and therefore fire management should be approached not only as a technical but also as a security-based coordination process. Using the concept of "environmental terrorism," the authors evaluate forest fires as deliberate actions aimed at causing psychological and economic damage. In this context, fire management has become a field of responsibility that transcends the boundaries of traditional forestry, intersecting with intelligence, internal security, and environmental policies.

Compliance with International Standards: ICS and ERCC Models

Turkey's forest fire command system shares significant parallels with international disaster management models. In the Incident Command System (ICS) model used in the US, the Incident Commander (IC) is responsible for the entire incident; functions such as resource management, security, communication, and planning are delegated to subunits, but the final decision-making authority rests with the IC (FEMA-Federal Emergency Management Agency, 2023; NWCG- National Wildfire Coordinating Group, 2024). In the European Union, under the Union Civil Protection Mechanism (UCPM), the Emergency Response Coordination Centre (ERCC) operates alongside, rather than above, national command structures to facilitate cross-border resource coordination (European Commission, 2024).

Training, Certification, and Competence

For the sustainability of effective fire management, fire officers must undergo standardized training and certification processes. It is recommended that OGM's current in-service training be structured in line with ICS modules. National certification programs equivalent to the levels of "Basic Command (ICS-100)", "Expanding Incidents (ICS-300)", and "Advanced Command (ICS-400)" should be developed (FEMA, 2023).

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Duties and Responsibilities of the Fire Chief

Fire commanders are the primary command units responsible for the technical, administrative, and operational command and control of forest fires. Their duties and authorities are defined by both Forest Law No. 6831 and the OGM's implementing regulations. Their main duties and responsibilities can be summarized as follows:

• Technical Command and Control: Assigning tasks to all teams at the fire site, managing the tactical planning process, and determining suppression strategies (OGM- General Directorate of Forestry, 2024).

• Safety and Occupational Health: Ensuring the safety of personnel in the field, restricting access to hazardous areas, and monitoring the use of appropriate personal protective equipment (Çar and Akyol, 2024).

• Communication and Coordination: Maintain uninterrupted communication with the operation, tower, operations center, AFAD, Governor's Office, and other institutions; ensure air-ground vehicle coordination.

• Resource Management: Organizing the distribution of fire trucks, bulldozers, aircraft, fuel, and personnel; activating support rings when necessary (NWCG, 2024).

• Conclusion of the Extinguishing Process: Manage the "containment," "cooling," and "fully extinguished" phases and officially declare the fire extinguished (FEMA, 2023).

• Recording and Reporting: Prepare reports on the course of the fire, resources used, response time, and damage status, and submit them to higher authorities (OGM, 2024).

• Management of Volunteer and Public Participation: Assign tasks to volunteers, ensure their safety, and manage their participation in accordance with the provisions of the Regulation on Volunteers Engaged in Forest Fire Fighting (Regulation, 2019).

• Inter-Institutional Coordination: Work in coordination with the police, gendarmerie, municipality, AFAD, and other institutions under the coordination of the highest local administrative authority (Sen, 2023).

• Training and Drills: Plan, conduct, and evaluate pre-season training and drills; support the continuous professional development of personnel (Çar and Akyol, 2024).

• Risk Analysis and Preventive Measures: Planning pre-fire measures by evaluating GIS-based risk maps, conducting field inspections throughout the fire season (OGM, 2024).

Section Conclusion and Evaluation

The Forest Fire Command institution in Turkey has a strong framework, both legally and scientifically. However, some structural improvements are needed at the national level. First, the definition of "the highest-ranking forest official at the fire site" in the legislation should be clarified at the operational level based on identity (Operations Manager, Technical Commander). Second, the temporary command procedure (recording the transfer from the OMM to the technical commander) should be formalized in writing. Third, support rings and risk zones should be linked to GIS-based plans (Çar and Akyol, 2024).

Finally, the role of fire commander is not merely a technical position; it is a multi-layered leadership field encompassing strategic, security, and governance dimensions. In a period of increasing hybrid threats, forest fire management must now be rethought within the triangle of nature conservation–security–disaster management (Dağıstanlı and Gencer, 2023). If Turkey's current model is developed in line with ICS and ERCC standards, a fast, safe, and accountable fire management system based on the "single command – multiple agencies" principle will become permanent.

10. SUPPORTING SCIENTIFIC RESEARCH ON FOREST FIRES IN UNIVERSITIES

For the process related to forest fires to be carried out in a healthy manner, collaboration between applied and scientific research must be implemented effectively. It is known that the share allocated to research and development in our country has increased significantly over the past twenty years. However, this increase is expected to reach even higher levels. The expectation that public institutions and organizations, private organizations, and universities will increase their share allocated to research and development continues.

R&D Studies and Forest Fires

The joint implementation of research and development studies with application units also directly affects social development. In this context, the Protocol signed between the Ministry of Agriculture and Forestry, and the Council of Higher Education (YÖK) is extremely important. The purpose of the Protocol is stated as *"ensuring that the processes agreed upon by the parties in their areas of responsibility, such as infrastructure, personnel, training, R&D, activities, student and farmer training, and agricultural extension services, are carried out in cooperation."* The forestry sector is also included within the scope of the stated purpose. This is because there are two directorates generally related to forestry under the responsibility of the Ministry of Agriculture and Forestry. The first is the General Directorate of Forestry (OGM) and the other is the General Directorate of Nature Conservation and National Parks (DKMP). The main topics to be carried out in cooperation within the framework of the Protocol are as follows:

1. Shared use of infrastructure,

2. Staff training,

3. Research and development,

4. Students,

5. Activities,

6. Farmer Training and Agricultural Extension Services

7. Other

has been determined. When examining the content of these items, it is seen that the elements of the two units support each other in almost every area, working hand in hand on projects, research, etc. for the development and welfare of society. Although the minister of the relevant ministry who signed the protocol has changed, the protocol is still in force. However, it is difficult to say that effective cooperation has been achieved within the framework of the protocol over the past five years. Data is quite limited in this regard. Furthermore, collaborative projects established with OGM and DKMP are almost non-existent. In this context, it is known that the OGM Firefighting Department conducts project-based studies with some academics from METU and other universities. However, it is also seen that detailed information sharing with the relevant public on these projects is limited. Information can be obtained about academics involved in some international projects. It is also known that some projects are carried out with civil society organizations within the framework of topics related to the working areas of OGM and DKMP. Among the project topics carried out by OGM, DKMP, and academics, the topic of forest fires is the most limited.

Another indicator and/or data source is the master's and doctoral theses conducted at universities on forestry-related topics. In this regard, when the relevant database is examined under the heading "forest," it is seen that there are 2,000 studies. There are 163 studies on the topic of "forest fires." On the other hand, there are a significant number of articles in international and scientific journals (Science Citation Index (SCI)), e-books, and other publications.

OGM Forest Fires Organization

Until recently, the Forest Fires issue was handled by the OGM as the Directorate of Forest Pest Control and Forest Fires, but these two areas of work have now been separated. Forest Fires and Forest Pests have been separated and made into separate directorates (URL 10). Again, in the recent past, the branch directorate responsible for aviation issues within the Directorate of Forest Fires was also transformed into the "Directorate of Aviation," and regional units were established (URL 11). OGM's specialization in adapting to these current developments and its reflection in the regional units of the organization has been closely monitored. On the other hand, within the 12 forestry faculties at our universities, the topics of forest fires and combating forest pests are conducted under the chair of the "forest protection" department. Considering the current conditions, a distinction between "Forest Fires" as a sub-department covering pre-

fire, fire process, and post-fire aspects has not been established. In other words, different sub-departments such as Forest Fires, Forest Fire Informatics, Remote Sensing, and Technologies have not been created in forestry faculties. Although some courses exist, they have not been established as separate departments. In this regard, there is an urgent need to establish at least two separate departments.

Our universities also face a significant paradox regarding forest fires. A large proportion of SCI publications on forest fires have been produced by universities outside the Aegean and Mediterranean regions. This is because the number of academics with satisfactory practical experience in forest fires in the relevant departments of forestry faculties, especially in these regions, is quite limited.

Another aspect related to forest fires is the Regional Forestry Research Institutes affiliated with the OGM Directorate of Foreign Relations, Research, and Education in terms of scientific studies. Among these institutions within the OGM, the Aegean Forestry Research and Western Mediterranean Research Institute Directorates are the institutions that conduct the most research on forest fires. However, the institutional and TÜBİTAK research result reports produced by these institutions are not sufficiently evaluated by OGM beyond being published as scientific articles. In recent years, these institutions have also suffered from a rapid loss of experienced staff.

Section Conclusion and Evaluation

One of the conditions for developing and underdeveloped countries to advance technologically and socially is their ability to achieve "efficiency" and "R&D" breakthroughs at the national level. Although our country has made progress in transferring resources to R&D, this is not considered sufficient. More resources are needed. For R&D studies to develop, the private sector, public institutions, and universities must be coordinated and managed in cooperation. At this stage, universities have a leading role to play. However, it is imperative that resources to fulfill this role are also created. For the first time in Turkey, Karabük University, among public universities, has established and implemented a new structure called the "Public Policy Research and Development Center (KAPGEM)" based on its sense of responsibility to serve society and its social capital of scientists, including.

KAPGEM's mission is defined as "developing scientific and innovative policies addressing the social, economic, and cultural needs of our country; providing solution-oriented contributions to local and national administrations; supporting public administration and policy processes through academic studies; and promoting national and international cooperation in knowledge production." In this context, KAPGEM was established to examine the public policies of the Turkish government, ministries, and public institutions and organizations, and to develop policy recommendations and models. To serve this purpose, KAPGEM conducts studies under 28 main topic headings. The objectives of KAPGEM are:

•   Conducting national and international research, analyzing public policies, and developing alternative solutions to problems that exist or are likely to arise in the field of public policy,

•   • Provide the necessary scientific environment for solution-oriented, applied approaches in projects from a social and institutional perspective, and conduct, commission, and coordinate scientific research by collaborating with public and private sector organizations conducting research in these areas.

•   Developing projects, offering solutions to local, regional, and global issues in Turkey and around the world; contributing scientifically to the public policy work of the Republic of Turkey and its government in this regard. Therefore, it has been accepted that *"universities do not only have the responsibility to carry out academic work; they also have a serious responsibility to provide strong support for Turkey's future vision by producing scientific solutions to social problems."* The reports prepared with this understanding were created *with the awareness that they should be "more than just an academic analysis; they should serve as a guided roadmap for the strategic future of our country*." One of the concrete studies carried out with this responsibility and awareness is the "*Forest Fire Prevention Policies* Report." The reports prepared are the products of Karabük University's R&D studies.

Universities must strive to increase their budget shares with the understanding of using their limited R&D resources more effectively. This is because they need to contribute with an instinctive sense of responsibility to overcome the social problems in their region. In this context, various R&D studies are being supported regarding forest fires. The forest fires that occurred in Karabük province are unprecedented in the region's 87-year forestry tradition in

terms of the large area they affected. With the impact of climate change, forest fires are spreading rapidly and could be a disaster for forest villages, which are intertwined with natural habitats and forest areas. The establishment of the *"Rural Development and Forestry Issues Research* Center*"* under the umbrella of Karabük University should be ensured, marking another first, as a structure that can contribute to protection and development by integrating with studies that can enhance development opportunities in rural areas.

11. SOCIAL AWARENESS CAMPAIGNS

It is an undeniable reality that it is difficult to avoid forest fires and the damage they cause. A conscious society is one of the most important factors in reducing the risk of forest fires. Public awareness campaigns are extremely necessary for Turkey, which is in the Mediterranean climate zone and has a high potential for forest fires. The best way to fight fires is to prevent them from starting. In this regard, it is of great importance to raise awareness by educating and raising awareness among individuals living in areas susceptible to forest fires (Ünlü, 2025). The causes of forest fires, which are primarily human-induced but also natural, remain unexplained, and the most striking point is that fires are usually human-induced because they occur during times of peak human activity (Doğanay and Doğanay, 2011). The fight to prevent forest fires is based on educating people and raising their awareness (Abay et al., 2022). In addition to the effective use of legal tools against forest fires, which have recently caused deep sorrow throughout the country (Cesur and Bulut, 2023), educating and raising awareness among citizens about forest fires is important and indispensable (Cesur and Bulut, 2023). However, it is necessary to effectively plan education, in addition to determining the tools and methods to be used for education and the correct selection of actors (Haznedar et al., 2023).

Awareness-Raising Activities Conducted to Prevent Forest Fires

One of the three fundamental strategies implemented in Turkey to combat forest fires is pre-fire (prevention) activities. Since policies on forest fires particularly involve forest protection, attention must be paid to the measures planned to be taken before a fire occurs (Haznedar et al., 2023). It is known that different awareness-raising activities are organized for target audiences within the scope of forest fire prevention. Within the scope of recent developments in forest fire prevention efforts, public service announcements have been prepared for children and adults, new posters have been prepared for billboards in areas sensitive to forest fires, information and warnings about forest fires have been provided, and awareness-raising activities have been carried out using three-dimensional films (OGM, 2019). Furthermore, the education of the public has been ensured through mobile education teams launched in 2014 as a continuation of the project (Ministry of Agriculture and Forestry, 2025). In-service training for personnel included methods of informing the public, training in the use of GPS-localization tracking systems and first aid, and regular training for firefighting personnel to improve their

professional skills and techniques. Informative seminars have been organized for military units on the behavior patterns of forest fires, extinguishing techniques, and ensuring coordination during fires (Abay et al., 2022). Camps have also been organized for young people, and cooperation has been established with local media in fire-prone areas (Ministry of Agriculture and Forestry, 2025).

Interest Groups for Awareness and Sensitization on Forest Fires

It is noteworthy that although priority measures to reduce the number of forest fires are included in the fight against forest fires, and there are many activities related to forest fire training and awareness, there are still some shortcomings in these areas (Avcı and Korkmaz, 2021; Coşgun and Yıldız, 2023). When evaluating forest fire statistics in our country, it is essential that all stakeholders are educated to prevent forest fires (Coşgun and Yıldız, 2023). In this context, awareness-raising, awareness-building, and training on forest fires should include different interest and stakeholder groups such as villagers, city dwellers, non-governmental organizations, the media, forest fire volunteers, local governments, other public institutions and organizations, law enforcement agencies, and managers and personnel responsible for fighting fires (Coşgun and Yıldız, 2023). The formation of a conscious society and the provision of fire-resistant living requirements are directly linked to socio-economic development (Güney, 2024), and if forests or settlements are to be made resilient, the focus should be on people (Güngöroğlu et al., 2024). Success can be achieved in awareness-raising efforts through the effective use of social media and public service announcements in the fight against forest fires (Avcı and Korkmaz, 2021). The media has an important role to play in informing and raising public awareness about environmental issues such as forest fires, identifying those responsible, and communicating proposed solutions. However, it has been observed that forest fires are removed from the media agenda once they are extinguished or lose their impact (Budak and Baloğlu, 2025). Especially during critical periods when fires are likely to occur, announcements that raise awareness in society should be increased through all press and media outlets.

Raising public awareness about forests, forest fires, and climate issues is of great importance, especially for children, who are the guarantee of the future (Şahin, 2025), and it is considered beneficial to raise awareness among young people and contribute individuals with high awareness to society (Cesur and Bulut, 2023). In this context, teachers, who play an active role in raising awareness among children and young people, need to be aware themselves in order

to adequately educate their students on these issues and to inform and raise their awareness (Haznedar et al., 2023). It is extremely important that national media and public service announcements frequently cover these topics so that the annual training provided to both students and the local community remains in their memory (Avcı and Korkmaz, 2021). Educating and raising awareness among the local community about forest fires can help them better understand the risk of forest fires and play an active role in fighting fires (Çar and Akyol, 2024). It is particularly necessary to continuously warn local communities about the importance of field and garden cleaning, as well as the dangers of stubble burning (Avcı and Korkmaz, 2021).

Section Conclusion and Evaluation

Combating forest fires and managing fires should focus not only on extinguishing activities at the time of the fire but also on prevention and risk reduction processes. Effective fire management requires public awareness, and increasing social awareness is critical to minimizing the effects of fires (Bilgili et al., 2021; Ünlü, 2025). Among the objectives of raising awareness, the most important is to convey the reasons for protecting forests and how protection can be achieved. The underlying purpose of educational activities is not only to provide individuals with scientific knowledge but also to instill in them a desire to protect forests and take responsibility. Regardless of the cause of forest fires, it is crucial and necessary to raise awareness that protecting against fires is everyone's responsibility and to ensure that people become more sensitive to this issue in order to prevent fires (Tadesse and Seboko, 2013). In a SWOT analysis conducted as part of a study to propose solutions for forest fires in Turkey, "*Having the capacity to increase public awareness and consciousness regarding vocational training for forestry activities*" was seen as a strength (Güngöroğlu et al., 2024). This strength should be turned into an opportunity, and instead of imposing entry bans to prevent people from approaching forests at certain times, the need for forests in terms of goods and services and the many contributions of forests should be explained regularly not only at the elementary school level but also to all interest and stakeholder groups in society (Bek and Akyol, 2022). In short, the planned social awareness, awareness-raising, and education initiatives regarding forest fires are long-term endeavors. Success can be achieved when the information gained about forest fires is embraced and translated into action. It is recommended that mechanisms be established to ensure the continuity of these efforts, that training and awareness-raising activities be

repeated, that media-driven sharing to raise awareness in society be increased, and that monitoring and evaluation studies be conducted at regular intervals.

12. COORDINATION OF FIREFIGHTING PLANS IN LARGE FIRES

Turkey is highly susceptible to forest fires due to its location in the Mediterranean climate zone. Heat waves, low humidity, and increased fuel load associated with climate change have significantly increased the frequency and level of destruction of major forest fires, especially since 2021. Therefore, a multi-level coordination and preventive planning-based approach has become essential in firefighting activities, not just emergency response (Çar and Akyol, 2024). The current institutional structure of the General Directorate of Forestry (OGM) is built on a hierarchical coordination model between Regional Forest Directorates (OBM) and Forest Management Directorates (OİM) to ensure effective intervention in large forest fires. However, this system needs to be restructured in the context of changing climate conditions, hybrid threats, and increasing social risks (Dağıstanlı and Gencer, 2023).

Institutional and Conceptual Framework

A two-tiered coordination model stands out in the management of forest fires. Çar and Akyol (2024) base this model on a balance between 'central strategic planning and local tactical implementation'. The Regional Directorate Fire Management Center is responsible for coordinating air and ground operations, the communication chain, and providing logistical support. In contrast, fire commanders operating at the OIM level carry out field management, personnel safety, frontline organization, and operational decision-making processes. This model is similar to the European Union Civil Protection Mechanism (ERCC) and the United States National Interagency Fire Center (NIFC) systems; in both systems, real-time information sharing and resource transfer between strategic and operational levels are fundamental (European Commission, 2024; NIFC, 2024).

Planning Support Teams and Resource Management

In large forest fires, intervention by a single operating directorate with its own resources is often insufficient. Therefore, a model of 'primary' and 'secondary' support rings based on geographical proximity and response time is proposed (Çar and Akyol, 2024). The primary ring includes neighboring operations that can reach the scene within 1–3 hours, while the secondary ring consists of regional reserve forces and distant operations. This model shortens the response time to the fire (OGM's 'Golden Hours' principle) and ensures the efficient use of human and

equipment resources . Furthermore, resource management supported by digital maps and Geographic Information System (GIS)-based inventory data should be carried out based on scenario-based risk areas before the fire season (AFAD, 2023).

Security Dimension and Hybrid Threats

Dağıstanlı and Gencer (2023) state that some of the major fires in Turkey may be related to terrorist activities, assessing forest fires not only as an environmental issue but also as a 'hybrid threat' element. This situation necessitates the integration of forest fire management with security policies. In this context, 'Forest Fire Intelligence Coordination Units' (OYİKB) should be established within the OGM; a 'Fire Threat Assessment Protocol' involving data sharing between the Gendarmerie, Police, AFAD, and OGM should be implemented.

Technological and Strategic Elements

Technology and data-driven strategies are critical in modern fire management. GIS-based risk mapping enables priority measures to be taken in areas with a high probability of fire (Barmpoutis et al., 2023). Artificial intelligence-supported air and ground monitoring systems produce dynamic risk predictions, particularly by analyzing parameters such as wind direction, humidity, and temperature. Domestically produced aircraft, sensor systems, and drones minimize dependency by reducing response times (Dağıstanlı and Gencer, 2023).

Volunteering and Social Participation

Volunteer participation in combating forest fires is not only an important element of social solidarity but also of operational success. Çar and Akyol (2024) state that 70% of volunteers in Turkey support the institutional continuation of the system but expect managerial guidance. Therefore, volunteer teams should be assigned under the command chain of the forest administration, trained, and equipped.

Policy and Regulatory Recommendations

The legal framework of the fire management system needs to be updated. The 'Communiqué on the Principles of Prevention and Extinguishing of Forest Fires' should be revised to define the 'large fire' class; the primary and secondary support rings model should be integrated into the legislation (OGM, 2024). In addition, integrated data sharing should be ensured between

OGM, AFAD, and the General Directorate of Meteorology; the 'Forest Fire Data Sharing Directive' should be issued.

Section Conclusion and Evaluation

Effective coordination in large forest fires is not merely a matter of technical planning; it is a multidimensional process involving security, socio-economic, and institutional management components. OGM's current hierarchical structure should ensure direct information flow between the strategic center and the operational field; it should effectively integrate volunteer and local support networks.

13. INCREASING THE EFFECTIVENESS OF FIRE WATCH TOWERS

When examining the process related to forest fires in Turkey, there are three main stages: prevention, suppression, and rehabilitation. Within these phases, prevention efforts are seen to be at the forefront of the fire control organization. At this point, intervention before the fire spreads, in short, before it spreads, is critical (Asri et al., 2015; Kudu, 2019; Başlı and Güngöroğlu, 2023). Effectiveness in combating forest fires is possible through the earliest detection of the fire, early notification (Savaş, 2022), and the earliest intervention (Gülci et al., 2016). Monitoring and controlling potential fire areas is one of the most important points for establishing a fire control organization. To this end, facilities incorporating various fire monitoring methods are used, and fire towers and systems play a significant role in providing the specified service (Asri et al., 2015; Kudu, 2019; Başlı and Güngöroğlu, 2023; Coşgun et al., 2023). With the establishment of the first firefighting organization in Rome, fire observation towers were constructed during that period, thus taking the first step towards an early warning system (Savaş, 2022).

The Role of Fire Watchtowers in Early Detection and Effective Intervention

Being prepared for forest fires requires an appropriate management style and approach. The main issue in fighting fires is early intervention, and the prerequisite for this is early detection (Çelik and Özdemir, 2020). The first step in identifying fires in our country is effective surveillance from observation towers (Savaş, 2022), and success can be achieved by taking the necessary measures in a timely and appropriate manner, using resources effectively and economically, and utilizing advanced technologies at every stage of the fire (Topaloğlu, 2013). Compass binoculars, which are advanced camera systems, are also used to receive early warnings and increase surveillance effectiveness, especially in areas that are highly susceptible to fires. Compass binoculars are used not only to locate and monitor fires but also to identify the factors that cause them (Küçükosmanoğlu et al., 2015). Furthermore, monitoring forest fires with advanced video cameras controlled remotely from observation towers has been found to be more reliable than human observers (Asri et al., 2015).

Integration of Fire Watchtowers with Smart Systems

Turkey's digitalization efforts, following global examples, are comprehensive, and artificial intelligence applications are becoming widespread in firefighting. There are 776 fire surveillance towers in Turkey, 235 of which have smart surveillance systems with 368 cameras providing 24/7 monitoring (URL 12; URL 13). It has been reported that these systems, integrated with artificial intelligence, have reduced the average fire detection time to less than 10 minutes. Depending on the density of smoke and wind direction, the system coordinates are immediately transmitted to the center (URL 14). Thus, fires are not only responded to but also quickly detected through a powerful response capacity created by artificial intelligence-based systems, and risks are managed through early warning and preventive strategies. Mobile towers have been proposed for sensitive, risky, valuable forest areas that are interconnected or complementary to each other in areas with high fire risk (Çelik and Özdemir, 2020).

A "Photovoltaic Solar Energy" system has been installed on some surveillance towers along with the camera system, and the use of "Mobile Fire Surveillance Systems" has been initiated. These systems operate on solar energy and are positioned outside the field of view of existing and risky towers to carry out surveillance (OGM, 2019). The "Innovative Approaches in Forest Fire Fighting Working Paper" notes under the subheading "New Developments in Forest Fire Surveillance, Communication, and Intervention Organization" that fire watchtowers need to be modernized to detect forest fires and notify intervention teams as quickly as possible. Regarding modernization, cameras are being installed in observation towers for remote detection of forest fires and automatic fire detection systems, and unmanned observation towers (smart towers) and locally produced mobile fire observation towers (unmanned and solar-powered) are being used (OGM, 2019).

Suitability and Viewing Capacity Performance Success of Fire Surveillance Towers

Observation towers are buildings constructed at vantage points in forests to enable monitoring of the forests by human observation or camera surveillance. These points are typically high hills, though occasionally they may be located at lower elevations where they still provide a commanding view of the forest (Başlı and Güngöroğlu, 2023). During early intervention in forest fires, there is a need for fire observation towers that are correctly positioned, equipped with the necessary and sufficient equipment, and have a commanding view of the area in order

to be able to observe the fire at its onset. However, it is necessary to determine the effectiveness of pre-built fire observation towers and to measure their rate of service or their ability to meet the need by performing visibility analyses. Through the use of advanced technologies (e.g., GIS), it is possible to identify areas where fire towers can provide high-level surveillance and to ensure maximum visibility by reviewing existing towers (Topaloğlu, 2013). Fire management plans developed for areas with high forest fire incidence have determined that tower visibility areas are below 70%. Similarly, Cosgun et al. (2023) found that the viewing capacity of 49 towers in their study areas was below 70%.

According to the Turkish *Forestry* Directorate's (OGM) Circular No. 285, "Principles *of Application in the Prevention and Extinguishing of Forest Fires*," towers must be constructed so that they can see 100% of the forests in flat areas and at least 70% of the forests in rugged areas within their visibility range, and the smoke height must be assumed to be 100 meters (OGM, 1995). Considering the time interval required for smoke height to reach "100" meters from the moment a forest fire starts, analyses assuming smoke height to be "0" have also been included, as it is thought that this would negatively affect fire control organization (Coşgun et al., 2023). Furthermore, due to the use of cameras and unmanned aerial vehicles for surveillance, it is possible to consider partially reducing the number of surveillance towers, provided that the centrally located towers are preserved (Başlı and Güngöroğlu, 2023). Surveillance towers have functions other than actual surveillance, such as communication and command and control. It is possible to reduce the number of towers, but they should not be eliminated. The number of towers with high overall visibility should be increased, and the functionality of all existing towers should be improved. The lightning rod systems on observation towers should be checked for proper functioning, repaired and maintained every year before the fire season, and the water needs of the towers should be well planned (Başlı and Güngöroğlu, 2023; Küçükosmanoğlu et al., 2015). Maximizing the current performance of fire towers will reduce the damage that fires can cause (Topaloğlu, 2013).

Section Conclusion and Evaluation

Early intervention in forest fires requires early detection, and fire observation towers are among the most effective and efficient fire monitoring methods. The number of towers with high visibility should be increased by utilizing advanced GIS methods and artificial intelligence-equipped smart systems. Furthermore, it is crucial to identify the most suitable locations for

additional towers to compensate for towers with insufficient visibility (Asri et al., 2015; Cosgun et al., 2023). Considering current technologies, areas where tower visibility capacity can be optimized should be re-evaluated to identify alternative tower locations (Cosgun et al., 2023). With surveillance towers integrated with smart systems, fires will be detected early and extinguished before they spread through early intervention. In this context, Turkey should continue its steps towards digitalization in surveillance towers, following global examples, and should follow applications and systems aimed at modernization.

14. ESTABLISHING FIRE CRIME EXPERTISE

Knowing the causes of forest fires is extremely important. This means ensuring that the crime and the perpetrator are found. However, from this perspective, it is first necessary to define this issue. Criminalistics *is* generally *defined as "the technique of finding crimes and criminals by utilizing all other scientific means."* This is generally used in the process of finding crimes or criminals committed in society, whether common, serial, or professional. It is particularly used as *"accident investigation expert"* in investigations to shed light on accidents occurring in airways.

With the exception of those caused by natural causes (such as lightning), all forest fires that occur in forest areas are human induced. Therefore, it is necessary to find the people who commit this crime, whether knowingly or unknowingly, and bring them before society. Identifying and punishing those responsible for forest fire crimes and bringing them to justice is an element that can encourage society to question its psychological attitudes towards forest fires.

General Definitions Regarding Technical Capacity for Fires

Internationally accredited professional competency standards for firefighting have been established, and duties and responsibilities have been defined in detail. However, the harsh reality at the national level is that accredited professional competencies in the firefighting sector have not been standardized. In 2016, the Professional Competency Authority defined only levels 3-4-5-6 firefighters. However, the fire department is an institution based on the discipline of fighting fires after they occur, rather than fire protection and prevention. There are many stages leading up to the occurrence of a fire, and the fire safety sector encompasses many sub-headings. The most important issues in firefighting are fire protection, fire prevention, and fire-resistant design (URL 15).

Some occupations in the fire safety sector and their brief descriptions are listed as follows: **Fire Inspector**: The occupational definition in the draft occupational qualification is that a Fire Inspector is a qualified person with the knowledge and skills to carry out occupational health and safety, environmental protection, and quality improvement activities; to investigate, evaluate, and report on incidents and incident sites related to fire, explosion, and flooding; and

to carry out professional development activities. The work carried out by Fire Inspectors covers firefighting and fire incidents defined within the scope of city, forest, maritime, and coastal safety services. During the investigation and assessment processes, they can direct the team, consisting of personnel who carry out applications such as security, data/information and document collection, image and sound recording, measurement, etc., according to the content and course of the work. The investigations, evaluations, and reports produced are aimed at providing input for legal, administrative, and financial processes, technically explaining the causes and course of the incident.

Fire Scene Investigation Specialist or Expert Witness: A person whose opinion is sought because they have the specific or technical knowledge to conduct investigations of the scene after a fire, investigate the causes of the fire, collect evidence, and prepare reports.

Fire Safety Specialist: A person who will carry out proactive work for fire prevention and protection, assess risks, implement risk reduction, supervise and implement the measures taken, establish a fire safety management system in the working environment, and ensure its continuity.

Fire Risk Analyst: A person with the technical knowledge and skills to analyze and report on fire risks in businesses in accordance with the *"Protection of Buildings Against Fire"* regulation and other relevant standards such as TSE, NFPA, BSI, etc.

Fire Trainer: Within the scope of occupational health and safety training organized in Article 1 of the Annex to *the "Regulation on the Procedures and Principles of* Occupational Health and Safety Training *for Employees"* published in the Official Gazette dated 15.05.2013 and numbered 28648, as specified in the periods below

    a) At least once a year in workplaces classified as highly hazardous.

    b) At least once every two years in workplaces classified as hazardous.

    c) At least once every three years in workplaces classified as low-risk.

Authorized to provide theoretical and practical fire safety training; fire basics, precautions to be taken before a fire at the workplace, hazards at the fire site, and recognition and use of firefighting equipment, as well as the correct behavior to adopt during a fire. This person must have the knowledge and experience to provide training on these topics and must have obtained

the authority to provide training on the subject by participating in training courses offered at various universities and obtaining a *"fire trainer training"* certificate (Official Gazette, 2013).

Institutional and Technical Capacity or Standards for Forest Fires

Forest fires develop in open areas, specifically in environments where two of the three elements of the fire triangle—combustible material, oxygen, and heat—are present in unlimited quantities (combustible material and oxygen). Compared to other fires, forest fires release more energy. In forest fires, the topography of the burning area, wind speed in the fire area, the spread of forest fires compared to urban fires, sudden changes in direction, etc., can create very critical problems.

There is also no clear occupational health and safety approach for those working on forest fires. Consequently, there is no definition of personnel who could be involved in analyzing forest fire crimes and conducting investigations at the crime scene to identify possible sources of crime and perpetrators. The General Directorate of Forestry lacks the institutional and technical capacity to develop evidence-based case solutions, particularly for forest fires that originate in agricultural areas and spread to forest areas, as well as those that arise directly in forest areas. This is because there are no job descriptions for personnel working in this area. It is therefore impossible to discuss the establishment of job standards for personnel without job descriptions.

Rural security issues in our country are handled by the Gendarmerie General Command, which is affiliated with the Ministry of Interior. In this context, the areas of responsibility of the Gendarmerie *are*: *"Areas outside the jurisdiction of the police, which are outside the boundaries of provincial and district municipalities or where there is no police force. However, areas within municipal boundaries that are deemed appropriate in terms of service requirements may be designated as areas of responsibility for the Gendarmerie."* In terms of areas of responsibility, 93% of Turkey's land area and 21% of its population are under the responsibility of the General Command of the Gendarmerie for the provision of security and public order services. Accordingly, the legal authority investigating a significant portion of crimes related to forest fires in rural areas falls under the responsibility of the Gendarmerie law enforcement forces. However, the gendarmerie does not have accumulated knowledge and experience on issues such as forest ecosystems, forest fires, etc. Therefore, the examination of the natural area where the forest fire occurred can only be carried out with the knowledge and experience necessary to

read and interpret the ecosystem at the site of the forest fire. Civil investigators, such as <u>Forest Fire Crime Inspectors</u>, who can work in coordination with the gendarmerie, will be able to gather information from the local community more easily . All statements related to the fire area must be evaluated. This requires serious effort, labor, and cost, as well as expertise.

The OGM is a large organization with the ability to take action by assessing conditions according to current requirements. It is known that the OGM has a presence in areas across the country where even the Gendarmerie is not present. As an example of this approach, the OGM Aviation Directorate has been established. It has also organized itself in rural areas where forest fires are prevalent (such as the Antalya, Muğla, and İzmir Forest Regional Directorates). Therefore, it will be able to organize itself by providing a similar initiative to shed light on crimes causing forest fires and bring the perpetrators to justice.

OGM statistics show that forest fires are classified as follows in forest fire assessment reports for the years 2015-2024: i) Negligence, Carelessness, ii) Intent, iii) Accident, iv) Natural Causes (lightning), and v) Unknown Cause (Table 2).

Table 2: Distribution of Forest Fires by Cause (2015-2024)

Years	NEGLIGENCE/CARELESSNESS							INTENTION					ACCIDENT				Natural Causes	Unknown Cause	TOTAL
	Stubble	Landfill	Hunting - Shepherd's Fire	Cigarette	Picnic	Other	TOTAL	Terror	Arson	Opening	Other	TOTAL	Energy	Traffic	Other	TOTAL	Lightning		
2015	204	40	68	151	107	99	669	12	79	3	43	137	81	6	41	128	257	959	2,150
2016	280	48	80	175	95	196	874	15	89	7	46	157	68	5	43	116	310	1,731	3,188
2017	183	27	58	163	71	115	617	10	74	3	62	149	66	5	32	103	260	1,282	2,411
2018	136	22	27	92	47	280	604	6	28	3	55	92	60	3	26	89	413	969	2,167
2019	184	36	12	46	28	428	734	0	42	1	81	124	94	7	48	149	372	1,309	2,688
2020	205	32	53	45	24	607	966	4	30	2	36	72	133	20	37	190	312	1,859	3,399
2021	165	20	42	64	14	517	822	0	8	0	102	110	124	17	38	179	353	1,329	2,793
2022	72	37	49	42	10	470	680	0	4	0	82	86	98	20	32	150	356	888	2,160
2023	137	36	83	56	9	602	923	4	5	1	82	92	142	22	46	210	399	955	2,579
2024	259	44	226	104	33	839	1,505	0	98	0	29	127	240	67	48	355	726	1,084	3,797
Total	1,825	342	698	938	438	4,153	8,394	51	457	20	618	1,146	1,106	172	391	1,669	3,758	12,365	27,332
Percentage	21.74	4.07	8.32	11.17	5.22	49.48	30.71	4.45	39.88	1.75	53.93	4.19	66.27	4.58	3.16	6.11	13.75	45.24	100.00

Source: OGM, 2024a

According to OGM statistics, the proportion of forest fires ***with "unknown causes"*** among those that occurred in the last ten years is 45.24%. ***In this ten-year period, the perpetrator of almost every second fire is unknown.*** This situation also indicates that there is almost no deterrent effect for those who commit crimes. Leaving aside the issue of intentional crime, it is seen that half of all forest fires other than those caused by natural causes are of unknown origin,

while the other half are caused by negligence/carelessness and accidents . Identifying the perpetrator and bringing them to justice will enable ~~people~~ active in forest areas to act more responsibly, which in turn could lead to fewer fires. Today, climate change has shown that any forest fire can spread rapidly and threaten many settlements by spreading over a large area. For these reasons, it is necessary to find the perpetrators of forest fires more often. Because every fire can quickly turn into a disaster, causing great loss of life and property. This is a great potential for every fire.

Section Conclusion and Evaluation

In order to prevent forest fires, the *"forest fire investigation expertise"* studies included in pre-fire measures can be a powerful tool in changing individual behavior patterns in society by identifying the criminal elements and perpetrators responsible for forest fires and presenting them to the public. However, job descriptions created by the General Directorate of Forestry (OGM) on important issues such as occupational health and safety, risks and threats related to forest fires, and forest fire investigation expertise are either non-existent or extremely limited. Therefore, it is imperative to examine the scope of occupational health and safety, especially for forest fires. This is because as risk and threat analyses are carried out for the processes, the criminal elements that may emerge can also be identified in broad terms within this scope.

The "Forest General Directorate Occupational Health and Safety Internal Directive dated 11.05.2024 and numbered 11818128" addresses the issue of fires in buildings and other areas (OGM, 2024). Upon reviewing the current legislation, no occupational health and safety procedure established for forest fires has been found. The OGM relies heavily on labor in combating forest fires. Although certain measures and practices related to occupational health and safety have been implemented to date, the issue has not been given the necessary importance. This is because the sole objective is to extinguish the fire. The enactment of the Occupational Health and Safety Law No. 6331 has imposed significant responsibilities on employers and employees. With the entry into force of this law, it has become necessary to define job descriptions, identify hazards and risks, and establish measures to address them in forest fires. Combating forest fires should not be considered solely as extinguishing the fire; it should be considered as what needs to be done before, during, and after the fire, and risk and threat analyses should be carried out accordingly (Sayın et al., 2014).

The Occupational Health and Safety Workplace Hazard Classification Directive was published and entered into force on December 26, 2012. This directive has been amended 15 times during the process. The directive classifies workplaces according to Annex 1 (Official Gazette, 2012). According to the Communiqué on Amendments to the Communiqué on Workplace Hazard Classes Related to Occupational Health and Safety, dated 13/03/2025 and numbered 32840 in the Official Gazette; the activity with code 02.40.04, *"Forest protection activities against pests (insects and diseases)"* has been classified as "Very Dangerous" (Official Gazette, 2025). However, code 02.40.05, *"Forest protection activities against fire and illegal logging (unauthorized cutting),"* has only been classified as *"Dangerous"* (Official Gazette, 2025). Based on this aspect alone, it can be said that the hazard classifications of forest fires are incorrectly determined in terms of occupational health and safety.

It can be said that the perceptions of institutions regarding forest fire-related work and operations are incorrect. According to the ILO, forestry is generally defined as a *3D (dirty, difficult, and dangerous)* sector. In other words, it is defined by the English initials of the words heavy, dirty, and dangerous (Poschen, 1993). Therefore, forest fires in forestry must be classified as a ***"Very Dangerous"*** occupation.

It is evident that occupational health and safety efforts related to forest fires in forestry are insufficient. Some studies in this context include: *"A Study on Working Conditions and Work Accidents in Production Jobs in Forestry"* (Memencioğlu, 2006), *"Examination of Health and Occupational Safety Issues of Workers Fighting Forest Fires"* (Akay et al., 2008), "Examination of Health and Occupational Safety Problems of Workers Fighting Forest Fires" (Akay et al., 2009), *"Evaluation of Anthropometric Data and Working Postures as Accident Risk Factors in Forestry Production Work"* (Enes, 2008), *"Case Study on Health Examinations of Forest Workers in Forestry Production Work"* (Melemez et al., 2012), *"Forest Fires in the Context of Occupational Health and Safety"* (Coşgun, 2022) and *"The Place and Importance of Occupational Health and Safety in Forestry"* (Coşgun and Yıldız, 2022), *"Determining Criteria Using AHP and ANP Methods to Evaluate Occupational Health and Safety Practices in Forest Fires: The Case of Turkey"* (Tezcan and Eren, 2024). The topic of hazards, risks, and necessary precautions that may be encountered in forest firefighting operations has also been examined at the article level (Sayın et al., 2014). However, while most of these studies focus on forestry production operations, very few concern those working in fires. Furthermore, these studies do

not aim to identify the hazards and risks faced by personnel working in forest fires. Therefore, the necessary importance should be given to research on this subject. In forestry work, risks can generally be categorized under the headings of physical risks, chemical risks, biological risks, and psychological risks (Ünver and Acar, 2011).

As forest fires are not sufficiently addressed in the context of occupational health and safety, no mention is made of identifying the crimes and criminals that cause forest fires. If the risks and necessary precautions regarding forest fires can be determined, it will be easier to identify the causes of forest fires. This is because if the precautions that could prevent forest fires are clearly established, it will be possible to determine which risks and hazards led to the fires despite these precautions, thereby identifying the perpetrators of the fires in question.

The General Directorate of Forestry (OGM) must establish a ***"FOREST FIRE CRIMINAL INVESTIGATION EXPERTISE"*** within the Directorate of Forest Fires, the Board of Inspection, or the Directorate of Aviation (because accidents occur in aircraft, especially helicopters, during forest fires).

Within the Forest Fire Investigation Expertise unit:

1. Forest Fire Investigation Inspector,

2. Forest Fire Investigation Expert,

3. Forest Fire Risk and Threats Safety Specialist

and their duties and responsibilities must be defined, and the legislation and organizational structure must be determined in a very short time. ***The "FOREST FIRE INVESTIGATION EXPERTISE"*** is one of the most important steps to be taken in terms of ***pre-fire measures*** to prevent forest fires and reduce the annual number of forest fires.

15. DEVELOPMENT OF NEW EQUIPMENT FOR GROUND CREWS

In areas with a high risk of forest fires, increasing the operational effectiveness of ground crews involved in prevention, first response, and extinguishing activities is critical to achieving sustainable improvement in fire management. In this context, it is necessary to develop new equipment that is suitable for field conditions, ergonomically designed, durable, multifunctional, and supported by technological components. Such innovative systems not only reduce response times but also provide significant improvements in personnel safety, coordination, and resource efficiency. Field experience shows that most existing equipment is inadequate in terms of weight, energy consumption, and functionality. Therefore, new tools developed using modern material technologies, sensor-based monitoring systems, and modular mechanical designs will create a significant increase in capacity in terms of speed, safety, and effectiveness in firefighting. The five innovative system proposals detailed below have been designed considering the terrain conditions and fire dynamics specific to Turkey's forest ecosystems.

Multi-Functional Firefighting Shovel

The multi-functional firefighting shovel is an innovative hand tool that combines different intervention requirements in forest fires in a single body. Offering the functions of a shovel, spade, hoe, slapper, and chisel, this design provides ergonomic use with its heat-resistant boron steel head and lightweight carbon-aluminum alloy handle. The head can be fixed at 45°, 90°, and 135° angles, and its serrated edge allows for cutting thin branches. It can be used as a scraper to cover burning surfaces when necessary. Its foldable design increases portability while offering a lighter and more durable alternative to classic shovels. With these features, it significantly improves field performance for both first responders and emergency response teams.

Personnel Health and Location Tracking System (Fire Tracking)

The Personnel Health and Location Tracking System is an integrated platform that simultaneously monitors the health status and location of teams working in forest fires. The system aims to increase personnel safety in challenging field conditions, identify potential health risks in advance, and provide real-time location information to the command center.

Fire Tracking will be designed in the form of an IP67-rated wristband or chest strap. The device collects biophysical data such as heart rate, body temperature, oxygen level, and movement intensity via sensors. The data is transmitted to the command center via GPS/RTK-based communication modules. Thus, the real-time location, movement route, and proximity to hazardous areas of each personnel can be monitored on a GIS-based map interface.

Task assignments, emergency calls, and geofence alerts can be performed via the mobile application. The system automatically alerts when personnel cross safety boundaries or when health data reaches critical levels. This enables early intervention and effective coordination.

In conclusion, the Fire Tracking system offers a human-centered digital security solution for teams working in forest fires. It both enhances personnel safety and strengthens the OGM's digital monitoring capacity in disaster management.

Portable Fire Pump

The portable fire pump is a compact and highly efficient motor pump system that enables rapid water extraction from natural water sources such as rivers, ponds, or water pools. Lightweight Featuring an aluminum or stainless-steel body, the system operates with a 4–6 HP gasoline or battery-powered motor. It has a 2–3-inch hose connection and delivers high performance even in turbid water thanks to its clog-preventing strainer system and floating suction filter. Its

foldable carrying handle, vibration-absorbing feet, and IPX4-rated body ensure safe use in challenging terrain conditions. With a flow rate capacity of 200–600 liters per minute, it speeds up water replenishment for fire trucks or backpack pumps, saving time during the firefighting process.

Field Observation and Emergency Supply UAV

Developed for both observation and logistical support in fire areas, this unmanned aerial vehicle (UAV) monitors the fire line, hot spots, and personnel locations in real time with thermal and high-resolution imaging systems. Featuring a carbon-composite body, the system has a carrying capacity of 5–10 kg in a 4- or 6-rotor configuration. Thanks to its modular cargo compartment or magnetic release mechanism, it can safely deliver emergency supplies such as water, medicine, food, radio batteries, or protective equipment to specified coordinates. It can perform parachute-assisted delivery when necessary. GPS/RTK-supported autonomous flight, obstacle detection sensors, and portable ground station features make this system safe to use even in challenging terrain conditions. This reduces logistics time to minutes in hard-to-reach areas.

Self-Propelled Dead Cover Clearing and Chain Breaker Machine

This multi-functional terrain vehicle is designed to perform the tasks of clearing dead vegetation and removing plant obstacles in a single step during fireline creation. The chain shredder drums

at the front shreds brush, small branches, and herbaceous cover with mechanical chain blades, while the rear fan-equipped ejection unit blows this material outside the firebreak with a powerful air stream. The tracked movement system provides balance and mobility on sloping and rocky terrain. With 8–10 HP motor power, adjustable speed, blowing direction, and height control, it can adapt to different ground types. Compared to manual strip clearing methods, this system significantly reduces both time and labor, thereby accelerating the firebreak creation process.

Section Conclusion and Evaluation

These five innovative systems to be developed aim to increase speed, safety, and coordination in the forest fire response process. The designs are proposed based on the principles of ergonomics, portability, energy efficiency, and multifunctionality. The implementation of these systems with local production and prototype support will contribute to increasing technological capacity in firefighting, strengthening personnel safety, and improving operational efficiency.

Furthermore, evaluating this equipment within the scope of OGM R&D programs or TÜBİTAK-supported projects will enable the institutional dissemination of innovative and domestic technologies in fire management, laying the groundwork for sustainable development in Turkey's disaster response technologies.

16. PRIORITIZATION OF SETTLEMENTS IN AREAS WITH HIGH FOREST FIRE RISKS AND HAZARDS

It is known that the main strategy of forest management in our country in combating forest fires is based on suppressing and extinguishing fires (Güngöroğlu et al., 2024). Global warming, climate change, and changes in population and land use in forest areas with fire-prone Mediterranean climates have led to changes in forest fire regimes and the emergence of fires reaching disaster levels (Chas-Amil et al., 2013). On the other hand, there are signs that the disadvantages of a forest fire management strategy that focuses solely on responding to fires will prove insufficient in the face of weather conditions associated with fire meteorology caused by climate change (Podur and Wotton, 2010). This situation increases the risk and threat of fires in forest areas where human activities are concentrated—various types of settlements (villages/neighborhoods, tourist facilities, mining, solid waste storage facilities, mining, etc.). In such interfaces, forest fire management activities tailored to the pre-fire, during-fire, and post-fire phases, but with distinct objectives, are needed to reduce fire hazards (Güngöroğlu et al., 2025). Forest fires develop in open areas and are integrated with ecological systems specific to their location. In this respect, fires occurring in forest interior and edge interfaces are a direct component of forest fire management, just like fires occurring in forested areas. The two are closely linked in terms of the ignition and fire behavior risk characteristics described in Policy Item 8. Transition zones between forest and urban areas must be spatially identified, mapped, and linked to relevant local forest fire management efforts. To this end, forest management directorates and departments affiliated with the forest administration must first be classified according to forest fire risk levels and mapped. This classification should be used as a guide for prevention efforts targeting communities living near forest areas in regions with high forest fire risk. Such preparation will enable these areas to be included in forest fire management, allowing for the identification of pre-fire risks and hazards and the determination of the characteristics of fire prevention facilities (fire break and fuel break zones) to be established in light of these. This will enable a more comprehensive approach to defense and evacuation measures for settlements during a fire. With this approach, evacuation action plans for residential areas should be developed against forest fire risks and hazards, citizens should be informed about the issue, residential areas should be equipped with tools and equipment capable of responding to

forest fires, and basic first aid response training should be provided in residential areas. In addition, forest management units must urgently increase maintenance work to reduce the load of combustible materials in forests adjacent to or near residential areas. Only in this way can the physical resilience of neighborhoods/villages and facilities be rapidly increased.

17. FOREST FIRE RISK MAPPING AND STAKEHOLDER PARTICIPATION

The approach to ensuring the physical resilience of settlements against forest fires aims to provide local solutions for forest fire management in rural urban areas (neighborhoods or villages, towns, etc.). This will enable central and local administrations affiliated with the public administration to share their duties and responsibilities in fire management, while also allowing large and small-scale local administrative units (neighborhoods or villages, towns, metropolitan cities, etc.) to become strategic stakeholders responsible for reducing forest fire risks in their own administrative areas. This approach will bring about a fundamental paradigm shift in forest fire management, demonstrating that residential and facility areas with a high risk of ignition should be part of forest fire management. On the other hand, increasing the participation of stakeholder organizations in fire management will ensure the continuity of combustible material management practices that can prevent large fires that could reach disaster levels in fire-sensitive areas.

While it is crucial for forest administrations and local authorities to cooperate in implementing appropriate measures within their areas of responsibility to ensure physical resilience in forest interior and adjacent settlements, facilities, etc., it is also important to conduct training, awareness, and sensitization activities for those living, working, or visiting the area to prevent fire risks and hazards arising from land use. (Figure 11).

Figure 11. Training local stakeholders on fire risks and hazards (Güngöroğlu et al. 2025)

In addition, forest management directorates and departments should be classified and mapped according to forest fire risk levels. This classification should be used as a guide for prevention efforts targeting communities living in close proximity to forest areas in regions with high forest fire risks and hazards. The involvement of public institutions and organizations, universities, and NGOs in creating and implementing education, awareness, and sensitization efforts aimed at reducing fire risks and hazards with stakeholder participation will increase the impact of dissemination.

18. ESTABLISHMENT OF A DISASTER TRANSPORTATION NETWORK

Forest fires are a global disaster that disrupts ecological balance, threatens biodiversity, and causes serious socio-economic losses. In recent years, there has been a marked increase in both the frequency and intensity of these fires; as a result, their environmental, economic, and social impacts have become more visible worldwide. It is known that the total economic cost of forest fires within the European Union alone exceeded $60.5 billion in the last twenty years, with over 600 people losing their lives and hundreds of thousands of thousands of being forced to leave their homes during the same period (Gonzalez, 2021). It is widely accepted that the most influential factor in the increase in such extreme fire events is climate change, which is expected to extend fire seasons and increase the number of high-risk days four to fivefold by 2050 (Ruffault et al., 2018; Lucas et al., 2007).

The prevention and effective management of fires is not limited to intervention activities during a fire but also encompasses pre-fire preparation processes and related infrastructure planning. In this context, the "Disaster Transportation Networks" to be established in critical areas between forested areas and settlements are of strategic importance in firefighting. Forest fires not only threaten the safety of residential areas and communities; they also pose serious risks to various infrastructure elements, particularly transportation systems, which play a key role in emergency response and the continuity of daily life. Disruptions to this infrastructure cause significant economic losses, limit disaster response capacity, and can jeopardize public safety (Der Sarkissian et al., 2020). On the other hand, road infrastructure is considered a fundamental component of forest fire management because it enables rapid access to the fire area for first responders, facilitates the creation of safe evacuation routes, and in some cases acts as a line that limits the spread of the fire.

The Importance of Disaster Transportation Networks

Disaster transportation networks are a critical infrastructure component for rapid and effective response to natural disasters such as forest fires. These networks prevent fires from spreading and help bring them under control by ensuring that firefighting crews, equipment, and other

emergency resources reach fire areas in a timely manner. They also assist in evacuation planning and the creation of emergency transportation routes (Figure 12).
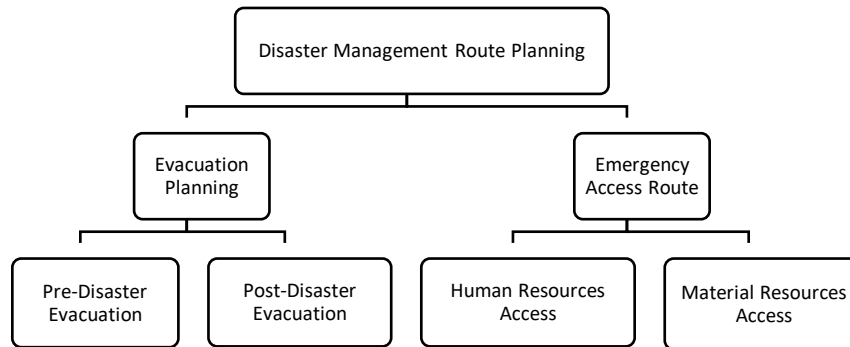

Figure 12. Disaster Management Route Planning Flowchart

Disaster transportation networks facilitate access to forested areas before a fire, enabling more effective preventive activities (e.g., fuel reduction, creation of firebreaks). During a fire, these networks allow first responders to quickly reach the scene. Rapid response is vital for controlling fires while they are small and preventing them from turning into major disasters. Research shows that longer response times significantly increase the spread and damage caused by fires (Podolskaia et al. 2019).

When fires threaten residential areas, disaster transportation networks provide reliable routes for the safe evacuation of civilians. They also play a key role in ensuring the uninterrupted supply of logistical support, such as water, fuel, food, and medical supplies, necessary for firefighting operations. An effective logistics network is indispensable for the sustainability of long-term firefighting operations (Arango et al., 2024).

Planning and Design Principles for Disaster Transportation Networks

The effectiveness of disaster transportation networks depends on proper planning and design. In this process, many factors must be taken into account, such as the topographical features of fire-prone areas, vegetation cover, the existing road network, proximity to settlements, forest stand characteristics, and climatic conditions.

Disaster transportation networks should be designed with sufficient width and appropriate slope to facilitate firefighting operations. In particular, roads that meet standards should be created so that firefighting vehicles (fire trucks, machinery) can move comfortably, maneuver, and pass

safely. Integrating these roads with firebreaks contributes to strategies for slowing the spread of fire and bringing it under control (Bilici et al. 2006).

Transportation networks should be planned in conjunction with firebreaks and safety zones. Firebreaks are areas cleared of vegetation within forests to stop or slow the progress of a fire. Disaster transportation networks provide easy access to these firebreaks, enabling firefighting teams to strategically position themselves. They also facilitate access to safe assembly and waiting areas for teams and civilians during a fire.

Integration of Disaster Access Networks with Geographic Information Systems (GIS)

Geographic Information Systems (GIS) are an indispensable tool for planning, mapping, managing disaster access networks, and supporting decision-making processes in firefighting operations. Thanks to its capabilities in collecting, storing, analyzing, and visualizing spatial data, GIS is used in a wide range of applications, from fire risk analysis to the optimization of intervention routes (Kalabokidis et al., 2013; Bonazountas et al., 2007).

GIS enables the analysis of many factors, such as topography, vegetation types, fuel load, wind direction and speed, and humidity, to identify areas at risk of fire. The risk maps created as a result of these analyses guide the planning of disaster transportation networks, giving priority to the most critical areas. Fire risk mapping ensures the most efficient use of resources (Novo et al., 2020).

During a fire, GIS-based network analysis tools can be used to determine the fastest and safest transportation routes to fire areas. These analyses provide real-time route optimization by considering dynamic factors such as road conditions, slope, traffic density, and the direction of fire spread. Thus, the response teams' travel time to the scene is minimized, and the firefighting capacity is increased (Jana et al., 2025).

A digital application module is crucial for the effective management of disaster transportation networks and the coordination of firefighting operations. This module accelerates the flow of information between field teams and headquarters and supports decision-making processes. The application module enables teams in fire zones to transmit their locations, the current status of the fire, weather conditions, and available resources to the center in real time. This information increases the situational awareness of fire management centers and allows for rapid strategic

decision-making. Accessible via mobile devices, these modules also enable field teams to access up-to-date maps and route information.

Integrated with GIS data, the module can include decision support systems such as fire spread models, risk analyses, and resource allocation optimization. These systems help determine the most appropriate intervention strategies by simulating fire scenarios. For example, they can answer questions such as which roads need to be opened, which areas need to be evacuated, or which resources need to be directed were. The Training and Simulation Application module can provide simulation environments for training firefighting teams. Through these simulations, teams can experience intervention strategies for different fire scenarios and develop their ability to determine the most effective routes using disaster transportation networks. Such training improves the performance of teams in real fire situations.

This comprehensive approach offers a sustainable solution for reducing the destructive effects of forest fires and protecting our natural resources. Future research may examine the potential effects of climate change on transportation networks and the integration of AI-supported autonomous response systems into these networks.

19. PREVENTION OF AGRICULTURAL SOURCE FOREST FIRES

Agricultural-related forest fires have been examined i) in terms of legal processes, and ii) in terms of Forestry General Directorate statistical data and scientific studies. Today, forest fires have become a social and ecological problem that causes concern on a global scale. Billions of dollars are spent globally to mitigate the effects of the damage caused by fires to human health, property, tourism activities, and ecosystem goods and services (Bowman et al., 2009). Since 1990, forest fire events declared as disasters have caused the deaths of 2,700 people, injuries to 11,700 people, and displacement of 182,000 people worldwide, with economic losses reaching $167.2 billion (EM-DAT, 2023). Over the last decade (2013-2022), there has been a significant increase compared to the previous two decades (1993-2012), with the ten-year average rising from $17 billion to $44 billion (approximately a 160% increase) (Güney, 2024). Forest fires may be inevitable, but the destruction of homes, ecosystems, and lives is not (Calkin et al., 2014). Furthermore, when homes and people are threatened by fire, firefighting personnel are also exposed to dangers on the fire line due to aggressive suppression responses. To mitigate these negative effects of fires, a paradigm shift is needed to develop new strategies rather than simply adopting strategies focused on increasing firefighting resources (Moreira et al., 2020). In this sense, some communities have begun to adopt strategies they have developed to increase their resilience to fire. A fire-resilient community is defined as a "socio-ecological and cultural system" that accepts the existence of fire, where significant damage is reduced through "management of living spaces, community participation, and effective response" (Tracker et al., 2023). There are generally two different views on forest fires. The first is an extinguishing-based approach that involves extinguishing the fire in any way possible. The second is an academic perspective on natural resource management, which suggests that fire can also be beneficial and should be used when necessary. Communities striving to adapt to fire and increase their resilience should use both approaches depending on the situation (Güney, 2024).

Legal Process in Agricultural Forest Fires

The issue of creating fires by burning stubble in agricultural areas has been addressed within the framework of Environmental Law No. 2872. In this context, the principles regarding soil protection and pollution prevention are as follows in **Additional Article 1** of the law **(Added: 26/4/2006- 5491/23 md.)**: <u>"c) Burning stubble, destroying pastures and meadows, and any</u>

activity that causes erosion is prohibited. However, in regions where a second crop is planted, controlled stubble burning may be permitted within the framework of an action plan prepared by the governor's office and under the responsibility of the governor's office." Within this scope, "*The administrative fines to be applied from January 1, 2025, as stated in this paragraph, have been included in the text in parentheses in black font with the Circular No. 2025/1 of the Ministry of Environment, Urbanization and Climate Change published in the Official Gazette dated 12/24/2024 and numbered 32762.*" With this amendment, "l) Those who burn stubble in violation of paragraph (c) of the first additional article of this Law shall be subject to an administrative fine of 20 Turkish lira **(556.71 TL)** per decare. If the act of burning stubble is committed in areas adjacent to forests and wetlands or in populated areas, the penalty shall be increased fivefold." Pursuant to this provision, if the burned areas are adjacent to forested areas, a penalty of 1,100 TL per decare applies. However, the commission of this offense must be proven in order to establish that the owner of the burned area committed the offense and can be punished with the specified penalty. It is known that, despite the prohibition of stubble burning, stubble fires still occur in rural areas in everyday life. Defenses such as the landowner not knowing or recognizing the arsonist often prevent the imposition of penalties due to the formation of crimes with unknown perpetrators. For areas under the responsibility of gendarmerie officers in rural areas, cases may be closed with an "unknown perpetrator" approach, as files must be closed within a certain time frame.

Forest General Directorate Forest Fire Assessments

There is a conflict between forest areas and the current activities of the population living in rural areas. It is important that people in these areas, referred to as settlement areas, do not exhibit behavioral disorders that could cause forest fires. Following the largest forest fire in the history of the Republic, which occurred in 2008 in the areas of the Serik and Taşağıl Forest Management Directorates of the Antalya Regional Directorate of Forestry, the OGM developed the concept of "Establishing Forest Resistant/Resilient to Forest Fires." The concrete manifestation of this approach is the "Rehabilitation of Burned Forest Areas and Establishment of Fire-Resistant Forests Project" (short name: YARDOP), which was reorganized by repealing the circulars dated 10.02.2010 and numbered 6665 and dated 01.08.2012 and numbered 6859, and published by the OGM Silviculture Directorate (OGM, 2014). Circular No. 6976 was published by the OGM Silviculture Department (OGM, 2014). Article 3 of the circular consists

of the "Definitions" section. Section (d) of this section is titled "Fire Prevention Facilities." Within this scope, the facilities in question are: *"1) Fire Intervention Facility (YMT): Facilities constructed preferably on main and secondary ridges perpendicular to the prevailing and/or dangerous wind direction during the fire season, 2) Facility for Separating Settlements from Forest Areas (YOAT): Facilities constructed from the boundary between residential areas and forest areas towards the forest, 3) Agricultural Land and Forest Area Separation Facility (ZOAT): Facilities constructed from the boundary between agricultural land and forest areas towards the forest. 4) Transportation Facility: Facilities constructed by exposing mineral soil to a standard that will enable the transportation of firefighting vehicles and effective intervention in fires in YARDOP projects, 5) Thinning Area: Areas where strong thinning, clearing, and pruning are carried out without allowing overgrowth, with the aim of limiting the potential fire intensity (severity) and preparing the environment for effective firefighting efforts,* where *the risk of active crown fire is reduced by preventing the spread of fire between neighboring trees, where cutting residues, the understory and ground cover (combustible material accumulation) are cleared and removed,* where *the crown base of trees is raised by pruning*, and where *trees of fire-resistant species are preserved*. Paragraphs 2, 3, and 4 of this circulars contain definitions of how fire prevention measures should be established between forests and residential areas. Article 4 of the circular emphasizes the "Basic Principles." Accordingly, *"Within the scope of these studies, during the construction of fire-preventive facilities (YMT, YOAT, ZOAT) consisting of fire-resistant species, especially along roads, settlements, and agricultural areas, priority will be given to leaving and protecting naturally occurring species that are resistant to fire, but in necessary cases, work requiring species change may be carried out. For fire prevention facilities (YMT, YOAT, ZOAT) established with natural species and origins suitable for the growing conditions of the region, no species change report will be prepared according to the principles of Circular No. 298,* and *implementation* will be carried out *according to the YARDOP project*." Therefore, it can be seen that OGM is working to develop fire prevention approaches that aim to make forest areas more resilient from a silvicultural perspective and to control the relationship between forest and rural settlement areas as preemptive measures against forest fires. The technical specifications related to these preventive facilities are included in the circular.

Hüseyin YÖRÜR, Cumhur GÜNGÖROĞLU, Ufuk COŞGUN, Ahmet DUYAR, Damla YILDIZ, Mustafa AYBAR

Within the scope of the YARDOP project, regardless of whether ZOAT or YOAT facilities exist, fire resistance management classes with varying widths depending on fire behavior conditions must be established in forest areas adjacent to settlements and agricultural areas in operations that are highly susceptible to fire. It is suggested that the fire resistance function can be integrated into sustainable forest management by separating forest areas adjacent to forest-settlement or forest-agricultural interfaces as a separate management class (e.g., fire prevention management class) (Güngöroğlu et al., 2024). It is known that many countries have implemented such areas between forest areas and rural settlements. Various examples have been discussed (Güngöroğlu et al., 2025). It is considered important for ensuring life and property safety that combustible material reduction operations are carried out not only in forest areas but also in areas adjacent to settlements within and near forests, applying YOAT and ZOAT. Fuel reduction operations carried out around these forest-settlement and forest-agricultural land interfaces will both fulfill the maintenance work of the forests in these areas and significantly reduce the threat of forest fires to private properties and the potential spread of fires. At the same time, it can play a role in preventing fires that may occur as a result of living activities in settlements from spreading to forest areas. However, for the forest-settlement interface (FSI), it is a complex process involving the collective assessment of variables related to the flammability of the structure (building) itself, in addition to the flammable materials in the surrounding forest and the vegetation in the structure's ignition zone (Cohen, 2008). On the other hand, reducing combustible materials around structures in YOAT areas will also facilitate fire management by ensuring that firefighting crews are not directly involved in protecting the structure from flames. Property owners can also take various measures against forest fires. In this context, property owners in YOAT and ZOAT areas can establish "*defensive* areas" and "*property protection* zones" because of combustible material reduction measures they can take, and various other fire prevention measures can also be implemented (Yılmaz et al., 2012). As is known, there is no legal regulation in our country regarding combustible material management practices by property owners in YOAT and ZOAT areas. Property owners' own practices regarding combustible material reduction in these areas are also insufficient. A study revealing the knowledge, opinions, and experiences of two different populations (forest villagers and residents of summer resorts) in Mersin Province, which are components of the public, regarding forest fire management (Yılmaz et al., 2012a); the most common measures taken by property owners to protect their properties from forest fires and reduce the risk of

forest fires around their properties were "*reducing the amount of combustible material (vegetation, debris wood, etc.) around properties*" (77.6%), "*pruning trees around properties*" (65.5%), and "*having a clearly visible property number sign on the street*" (55.9%). On the other hand, it is known that the technical opinion of forest engineers is that the way to reduce the damage caused by forest fires is to reduce the combustible load through silvicultural practices (Yılmaz et al., 2012b). In this context, creating buffer zones in the direction mentioned above for fires that start in non-forest areas in rural areas and spread to forest areas, and implementing silvicultural measures around these buffer zones, could reduce rural/agricultural forest fires or mitigate their effects.

According to the "2024 Forest Fires Assessment Report" prepared by the General Directorate of Forestry (OGM), the approach emphasized above may have contributed significantly to the fact that 28.5% of forest fires that occurred during the specified year were classified as "Cause Unknown" (OGM, 2024). In other words, approximately one in every three fires was determined to be "unknown cause." Considering the average for the years 2013-2022, the share of "unknown cause" forest fires in the total number of forest fires is 48.5% (OGM, 2014). The cause of almost every second fire is unknown.

On the other hand, the ten-year average for forest fires classified as "Negligence and Carelessness" between 2013 and 2022 is 29.22%. The share of this category in the total forest fires in 2024 is approximately 40%. This data is also quite noteworthy. Because of this group;

1. Stubble (%17),
2. Landfill fires (3%),
3. Hunting-Campfires (15%),
4. Cigarettes (7%),
5. Picnic (2%),
6. Other (56%)

Here, when considering the share of stubble fires for 2024, it is seen that almost one in four fires classified under "Negligence and Carelessness" are caused by stubble fires (OGM, 2024). Considering the ten-year data covering 2013-2022 , the rate of forest fires caused by stubble burning is 27%. In other words, these data reveal incidents resulting in the burning of forest areas, particularly due to stubble burning in agricultural areas (OGM, 2022).

Hüseyin YÖRÜR, Cumhur GÜNGÖROĞLU, Ufuk COŞGUN, Ahmet DUYAR, Damla YILDIZ, Mustafa AYBAR

On the other hand, the Antalya Forest Regional Directorate's study on the ability/effectiveness of forest fire towers to detect forest fires examined 2,504 forest fires that occurred between 2008 and 2020. As a result of this examination, the rate of fires starting in agricultural areas and continuing in forest areas is 21.37%. In other words, only one in every five fires in the Antalya region during the specified period originated from agriculture (Cosgun et al., 2023).

Section Conclusion and Evaluation

The approach to extinguishing forest fires in our country and even in Mediterranean countries prevents fire policies from being sustainable and often causes them to be counterproductive. However, in recent years, especially in international documents, the need to shift from short-term firefighting policies to longer-term policies *that "integrate fire and forest management strategies and aim to address the structural causes of fires"* has been recognized (EFI, 2010).

Forest fires have various social and economic causes. Climate change, especially in recent years, has created the most suitable environment for forest fires to rapidly turn into disasters. This situation is not unique to our country. It applies to all countries in the Mediterranean climate zone. A study conducted on approximately 1.5 million fire data points covering a twenty-one-year period from 1992 to 2012 in the United States showed that 84% of fires were human-caused (Balch et al., 2017). Among human-caused forest fires, fires that start in activity areas and spread rapidly to forest areas create serious negative consequences if behavioral awareness cannot be established among communities living near forest areas. There are 7,000 rural settlements in our country with a population of approximately 20 million. The vital activities of this population living near forest areas must be carefully analyzed, with particular emphasis on pre-fire precautions. To this end, *"Social Awareness Campaigns"* must be swiftly implemented to develop educational, practical, and behavioral processes that will facilitate the evolution of our social structure from *"homo sapiens"* individuals to *"Eco-Sapiens"* individuals.

CONCLUSION

The topics presented in this study address some of the issues encountered in fire prevention measures before a fire and firefighting during a fire. Pre-fire measures include involving forest-settlement interfaces in forest firefighting, increasing fire safety roads and strips in forested areas, ensuring safe distances in new building permits and agricultural activities, and improving

inter-agency coordination. Increasing and expanding in-service training for firefighting personnel, defining the roles, organization, and training of fire volunteers, updating fire risk hazard maps and determining first response points, supporting scientific research on forest fires at universities, conducting public awareness campaigns, and increasing the effectiveness of fire observation towers. Establishing fire investigation expertise, developing new equipment for ground crews, Prioritizing settlements in areas with high forest fire risk and hazard, Forest fire risk mapping and stakeholder participation, Preventing agriculture-related forest fires. In addition, issues and proposed solutions to prevent the spread of fires during a fire; developing a night-equipped air fleet, clearly defining the role and authority of fire command, coordinating firefighting plans for large fires, and establishing a disaster transportation network.

Among the pre-fire measures, increasing stakeholder participation in risk management by developing the physical resilience of settlements and social awareness and identifying fire risks in advance is more prominent. In addition, it is recommended to develop fire safety roads and lanes in line with current conditions, strengthen inter-agency coordination, increase scientific research, and further develop fire investigation expertise to reduce the causes of fires. The constraints and opportunities regarding the development of a night-equipped air fleet, which is constantly discussed in public, the definition and determination of the powers of the fire chief for better management of the firefighting organization during a fire and establishing a disaster transportation network to facilitate the access of ground vehicles for firefighting.

Hüseyin YÖRÜR, Cumhur GÜNGÖROĞLU, Ufuk COŞGUN, Ahmet DUYAR, Damla YILDIZ, Mustafa AYBAR

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Hüseyin YÖRÜR, Cumhur GÜNGÖROĞLU, Ufuk COŞGUN, Ahmet DUYAR, Damla YILDIZ, Mustafa AYBAR

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KAPGEM

KAMU POLİTİKALARI ARAŞTIRMA VE GELİŞTİRME MERKEZİ

ABSTRACT TO BE WRITTEN