mostly of *Fagus spp.* and *Abies spp*. species. Fire hazard increases significantly in old stands due to accumulated fuel from snow damage, windfall, insects, and tree aging. While lightning is a common ignition source, fires may also spread upslope from lower elevations. Effective management should focus on identifying high-risk areas and using silvicultural treatments to renew aging stands and reduce surface fuel loads. Continuous fire danger monitoring is essential to support timely suppression response. The remaining 12.5% of the country corresponds to no-fire situations (non-fire regime) such as urban areas, rocky mountain peaks, lakes, and riparian areas (Kalabokidis *et al*., 2024).

The typical **fire spread** evolution factor is wind, that it manifests each summer (mostly July and August) with the “Etesian” winds, blowing from northeaster and northern directions (depending on the latitude) with high wind speeds. These winds are also the reason of why Greece does not face severe impacts from smoke since the intensity of these winds usually push the fire plume southwards. Greece also has a very steep topography, including some of its islands, with highly rugged and mountainous terrain on the mainland. This factor, combined with strong winds, also play an important role on how fires are spread over the Greek territory. Recently, there were events where convective forces appeared, forming Pyro-Cumulonimbus clouds, but this is not necessarily the main fire spread evolution factor.

On 2023, Alexandroupolis was hit by the largest wildfire ever recorded in the EU, with around 938.8 km2 (93,880 ha) of burnt area. The fire had been active for 15 days starting from 19 August. Average wind speed was around 30-35 km/h (NE), with gusts at the 50-60 km/h range. The wildfire that originated in the forest Dadia-Soufli on 21 August was characterised by estimated average flame lengths at the head of over 40 metres with 90,000 kW/m of front intensity: these values were beyond the suppression capacity of any forest fire or emergency service, according to the ‘Technical Report on Alexandroupolis and Dadia-Soufli forest fires (Greece 2023)’ drafted by the Forest Fires Assessment and Advisory Team (FAST) of Spain. As reported, the fire maintained its activity and even increased its intensity during the night, which is a rare phenomenon. The lack of precipitation in the previous months, which had been significantly lower than previous years, and the rise in temperatures only served to exacerbate the situation. Additionally, the drying out of the surface, the several heatwaves, the drying of the atmosphere and the strong winds in Alexandroupolis in the second half of August 2023 created favourable conditions for the outbreak of this huge wildfire (Arbinolo *et al*., 2024).

On August 11th, 2024, Varnavas in Attica, experienced one of the hardest and most violent flames. High wind speeds and pyroconvective activity caused the fire to rapidly spread despite prompt aerial action, hitting 30 urban communities and scorching approximately 10,000 hectares. This incident brought attention to the growing dangers that flames near cities face.

Presence of **fire-adapted vegetation**: Approximately 50% of the forest and other woodlands area have fire-adapted habitats, and this percentage includes *Pinus halepensis*, *Pinus brutia* and *Pinus pinea* forest stands, sclerophyllous shrublands, grasslands, oak and deciduous shrub woodlands. In Attica, Peloponnese, Chalkidiki and the Aegean islands, *Pinus halepensis* and *Pinus brutia* dominates low to mid-elevation forests, often regenerating after fire due to its serotinous cones. In Crete and the Dodecanese, dry phrygana communities with species like *Sarcopoterium spinosum* and *Phlomis fruticosa* are well-adapted to recurrent fire. In northern and western Greece, *Pinus nigra* and *Quercus coccifera* occur in more humid environments, showing varied fire resilience. These patterns reflect the influence of both climatic conditions and historical land use, making fire-adapted vegetation a key feature of Greece's diverse ecological zones.

Human exposure and vulnerability to wildfire: More than 80% of the country's total population is concentrated along the coastline and/or at low altitudes, resulting in high anthropogenic pressures for land use change and increased construction activity in forested areas around large urban centres or areas of high tourism value (Chalkidiki, Rhodes, Crete, Attica, etc.). This creates complex problems for dealing with wildfires and protecting urban areas, especially for the structures surrounded by or adjacent to forest vegetation. The construction materials of houses are mostly reinforced concrete and bricks, combined with other fire-resilient building materials, thus wildfire losses are not so many from the burning of houses itself (most deaths occur in open areas). However, prefabricated houses or constructions with other rough materials are easier to catch fire. A recent example is the 2018 Attica fires where the quality of construction of buildings in N. Voutzas limited the damage to the surrounding residential area, in contrast to the construction in Mati where the quality of materials and age of structures (without ignoring the lack of urban planning) led to a fire management paralysis. In economic terms, the direct damage caused by the fires includes both damage to personal property and damage to common property.

Unmanaged vegetation in or near urban areas can allow a fire to burn under extreme weather conditions and spread into settlements within the WUI areas with devastating results. The Penteli Attica fire of July 19th, 2022, was one of the most severe and dangerous fire events (burned area provided by MODIS is estimated of 2,836 ha), because of its proximity to the residential network, with significant impacts on the environment, vegetation, infrastructures and one indirect fatal victim. The wildfire also severely scorched 54 houses, five businesses, seventeen warehouses and one religious structure, according to the Ministry of Infrastructure and Transport (European Commission, 2024)

The wildfire that ignited on July 23, 2022, in the Vatera region of western Lesvos posed a significant threat to human safety, infrastructure, and land use, as it advanced rapidly toward the settlements of Vatera, Vrisa, and Stavros. Residents and visitors were exposed to high levels due to flammable vegetation, strong northeasterly winds (4–7 Beaufort), and the proximity of residential areas to forested regions. A timely evacuation order for Vatera likely prevented loss of life; however, the event highlighted the acute vulnerability of coastal settlements located within the WUI. The fire ultimately burned approximately 2,450 hectares, including forest-woodland areas, shrubland, agricultural land, underscoring the diverse landscape impacts. In addition to the extensive environmental damage, five homes and one business were destroyed, further illustrating the socio-economic vulnerability of communities situated in fire-prone regions. The numerous flare-ups and quick spread through spotting mechanisms underscored the need for enhanced fire-adapted planning, early warning systems, and resilience-building methods in rural and peri-urban contexts (Kalabokidis *et al.,* 2024a).

Figure 40 shows the percentage of WUI for each administration (prefecture) area. The highest rates occur in the Attika region and other touristic areas on the mainland and islands. At the same time, the highest population living in the WUI per administration area exists in Attika and Thessaloniki regions (Figure 41).

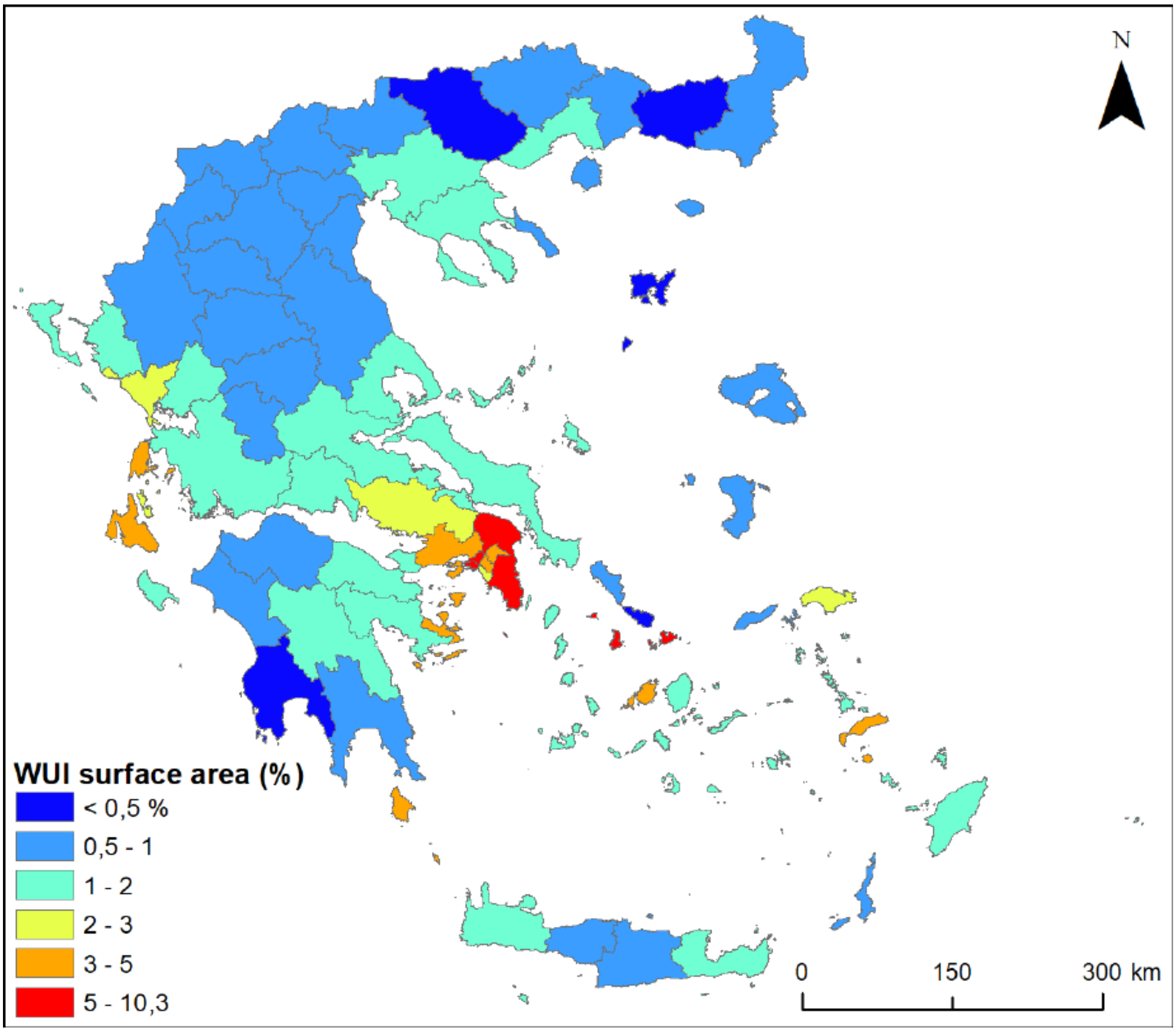

Figure 62: Percentage of WUI area extracted from CLC2018 (Data source: Mitsopoulos et al. 2020).

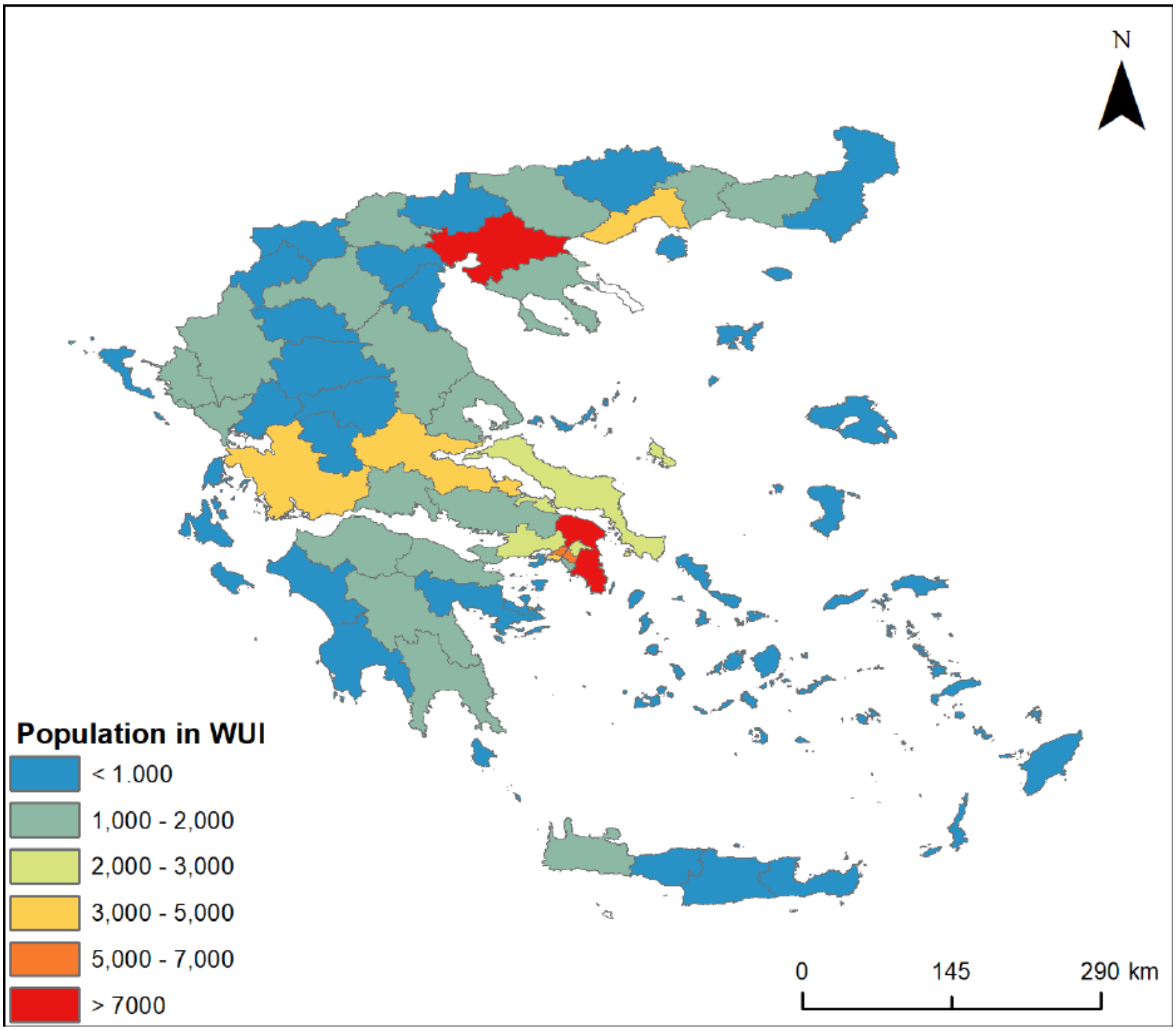

Figure 63: Population living in the WUI (Data source: WUI by Mitsopoulos et al. 2020, Population Density by Facebook 2016).

In Attica, the Municipality of Dionysos is one of the most typical examples where all types and the entire continuum of the WUI is present (Palaiologos and Kalabokidis, 2022). Thousands of homes are exposed to wildfire events, either incoming from neighbouring municipalities, or ignited within Dionysos' boundaries. The above reveal that the problem of wildfire spreading within inhabited WUI areas is complex. Factors, such as the type, continuity and density of vegetation, topography, building arrangement, existence of fuel management projects and local meteorological conditions, play an important role in the exposure of each settlement.

Wildfire **severity** *(intensity indicators if available)* and human impacts: Most fires occurring in low elevation pine forests burn with moderate to high severity due to the fuel accumulation and weather conditions. An overall increase in wildfire severity has been noticed over the past decades. For instant, Greece has seen multiple high-severity fires exceeding 100,000 hectares, including the 2021 fires in Euboea and the 2023 Alexandroupolis fire, the largest ever recorded in the EU. These fires often burned at extreme intensity, destroying mature pine forests and leading to irreversible ecological damage in Natura 2000 zones. Beyond immediate damage, long-term impacts include soil erosion, air pollution spikes, and increased vulnerability to floods and landslides in post-burn landscapes.

In 2007 and 2018, fast-moving fires caused dozens of fatalities, including 85 deaths in southern Peloponnese and 104 deaths in Mati (Attica) respectively, due to a combination of urban-wildland interface exposure, high winds, and limited evacuation time. Thousands have lost homes, farmland, and livelihoods. Wildfire-related human impacts in Greece between 2020 and 2024 show significant year-to-year variability, affecting both firefighters and civilians. The total number of casualties, including both injuries and fatalities, increased noticeably over the five-year period, rising from 13 in 2020 to 62 in 2024. Injuries were more frequent among firefighters, 33 in 2021 and 52 in 2024, reflecting the high operational demands during those fire seasons. Civilian injuries were notably lower, never exceeding 6 in any given year.

The degree of change in fire activity and fire impacts from historical patterns (hereafter referred to as "**fire novelty**"): What has happened in the last 2-5 years that is striking vs the typical patterns? The 2021 fire season was disastrous in terms of area burned (140,000 ha), from six large-scale events (>10,000 ha) and one mega-fire in Evia Island (46,000 ha). These fires burned under extreme drought conditions and paradoxically, with moderate to low wind speeds, mostly inside low elevation conifer forests (*Pinus halepensis*) and shrublands. The concurrent burst and propagation of several large-scale events lead, once again, to the collapse of the firefighting mechanism, like what happened during the 2007 fire season when more than 260,000 ha burned. As a result, wildfires of 2021 were extinguished only when they reached the sea (Evia) or previously burned areas (western Attica), with firefighting forces completely unable to successfully contain them for weeks. The large number of reinforcements from other countries helped the government officials to understand and clarify (after debriefing) that with the current firefighting operational philosophy of the Greek Fire Service, it is impossible to contain large-scale wildfires. They detected several issues, including the total dependence on airborne firefighting means (Greece had during 2021 one of the largest aerial fleets in Europe), the inability of firefighters to operate inside forested areas, the prohibition of backfires, the slow creation rates, or complete lack, of vegetation clearings for creating new fuel breaks during firefighting, and the lack of appropriately previously treated areas. This sparked a debate among political parties and the society of what can Greece do from now on to prevent future mega-fires that can have devastating economic effects not only to the local population (e.g., northern Evia, an island that has based its local economy to forest products and recreational tourism), but also to the country's economy (>4 billion euros in 2021). Another important issue is the environmental impact caused by the loss of forest carbon pools, soil loss and erosion, increased water runoff and degradation of the aesthetic quality, all having a long-lasting effect on the affected areas. The above lead the Greek Government to take a series of measures that were proposed, including legislation changes, administrative organization reforms and adaptation of firefighting operational tactics.

10.1.2. Wildfire governance

Wildfire Governance in Greece is a complex system involving multiple levels of government, legal frameworks, and institutional actors. It aims to address both wildfire prevention and response, especially as climate change increases the frequency and severity of wildfires in the Mediterranean region.

In Greece, civil protection is a shared responsibility across all levels of government. The Ministry of Climate Crisis and Civil Protection is the primary authority overseeing the disaster risk management (DRM) system. Its responsibilities include supervising the General Secretariat for Civil Protection (GSCP), the Hellenic Fire Corps, and all related civil protection structures. It also monitors climate change adaptation policies and coordinates the development and implementation of the National Disaster Risk Management Plan.

The General Secretariat for Civil Protection (GSCP) is responsible for the legislative, administrative, and operational organization of the national civil protection system. Headed by the Secretary General, the GSCP develops and oversees national civil protection policies in line with governmental directives. Together with the Ministry of Climate Crisis and Civil Protection, it also drafts the General Emergency Response and Consequence Management Plans, which outline the roles and responsibilities of all stakeholders involved in the Disaster Risk Management Cycle (DRMC).

The GSCP organizes stakeholders and civil protection authorities at the national level. Municipal Civil Protection Departments and Autonomous Regional Civil Protection Directorates oversee civil protection initiatives within their respective jurisdictions and carry out duties at the subnational level. The Hellenic Fire Corps (HFC) or Hellenic Fire Brigade (HFB), organized under a centralized command, serves as the system's principal operational arm, particularly for fire suppression.

In addition, the General Secretariat of Civil Protection issued the General Plan for Dealing with Forest Fires is the main instrument governing the planning of forest fire management in Greece, under the code name "IOLAOS 2" (the first edition dates to 2010). The purpose of the IOLAOS 2 – which is not an operational plan – is to coordinate the actions of civil protection to support the HFB in the suppression of forest fires, effectively respond to emergencies, and promptly manage their consequences. It does not include prevention measures. The IOLAOS 2 is structured along the four phases of emergency management adopted in the XENOKRATIS and named "Phases of Mobilisation of Civil Protection Capacity": Phase 1 - Standard Preparedness (preparatory actions); Phase 2 - Enhanced Preparedness (increased preparedness actions in view of a forest fire); Phase 3 - Immediate Mobilisation/Intervention (actions to support the Fire Brigade in the fight against forest fires and actions to respond to emergencies and manage the consequences of forest fires); Phase 4 - Rehabilitation/Relief (immediate relief for people affected and immediate short-term disaster remediation). The roles and responsibilities of all the authorities involved in firefighting are detailed for each of the four phases listed above. Regional and local authorities are urged to update and align their civil protection plans and response and management plans with the IOLAOS 2. Local-level operational plans to assist the Hellenic Fire Brigade shall also be developed in accordance with the guidelines of the IOLAOS 2.

The National Crisis and Risk Management Mechanism (Nat-CHAMM), established under Law 4662/2020, forms the core operational and administrative structure of the civil protection system. Supervised by the GSCP, Nat-CHAMM includes the National Coordination Centre for Operations and Crisis Management (ESKEDIK), Emergency Management Frameworks, and Civil Protection Coordination Bodies. The regional and municipal civil protection directorates act as supporting services within this mechanism.

The governance of the Greek disaster risk management system is primarily regulated by Law 4662/2020, titled "National Mechanism for Crisis Management and Response". This law restructured the GSCP, upgraded the civil protection volunteer framework, reorganized the Hellenic Fire Corps, and formalized the creation of Nat-CHAMM (Article 2). It designates the GSCP as the lead coordinating authority (Article 30a) and tasks the Hellenic Fire Corps with planning and executing fire suppression operations (Article 74).

In December 2023, Law 5075/2023 was adopted, amending Law 4662/2020. It aims to enhance the efficiency of civil protection and crisis management, restructure the National Aerial Search and Rescue Mechanism, and address urgent issues related to state assistance and disaster response. This legislation also expands the scope of Law 4989/2022 to include air transport and clarifies the operation of state aid mechanisms in the context of natural disasters.

In response to the devastating wildfires of summer 2021, Presidential Decree 70/2021 established the Ministry for Climate Crisis and Civil Protection (MCCCP), significantly restructuring Greece's institutional framework for disaster and climate risk governance. The creation of the MCCCP aimed to strengthen coordination and cooperation among the various institutional actors involved in managing climate-related risks. Together with Law 4662/2020, which restructured the national civil protection system, the establishment of the MCCCP reflects Greece's commitment to a more integrated and holistic approach to disaster risk management—one that spans the entire Disaster Risk Management Cycle (DRMC) and explicitly addresses climate change as a key threat. In addition, the adoption of the National Climate Law 4936/2022, which outlines the country's transition toward climate neutrality and adaptation, marks a critical step toward aligning disaster risk reduction (DRR) and climate change adaptation (CCA) policies. This legislation seeks to ensure that adaptation is mainstreamed across all national planning and strategic frameworks.

The National Risk Assessment (NRA) was developed in 2021 by the Centre for Security Studies (KEMEA), in collaboration with the Hellenic National Meteorological Service (HNMS), and the 'Demokritos' National Centre of Scientific Research, and reviewed by the

GSCP. The National Risk Assessment was built upon projects that included the Greco-Risks multi-hazard platform (currently inactive) and based on the guidelines on national disaster risk assessment developed by the United Nations Office for Disaster Risk Reduction (UNDRR) and the EU risk assessment guidelines (The World Bank, 2024).

The Law 998/1979 (voted in 1979) “Regarding protection of forests and forested lands of Greece” prohibits any fire or sustain of an active ignition (this can be translated also as “prescribed fire” and “backfire”) on the landscape and particularly, inside forests and forested lands or at a distance < 300 m from them. Although it is not clearly stated that this prohibition is about prescribed fires and backfires, interpretations of the law and the fear of punishment lead to the avoidance of these practices. The same law mentions that “under certain conditions and exceptionally, it is allowed to ignite a fire between 1st May to October 31st only under license from the Forest Service”. Regulation 55904/2019 on "Fire Protection for properties in or near forest areas", defining preventive fire protection measures as well as minimum requirements for passive and active fire protection both for buildings (new and existing) and for the areas surrounding properties.

In line with Regulation 55904/2019, the areas of the country at greatest risk of forest fires are estimated and illustrated in the map published by PD 575/1980 (GG 157/A/1980). Finally, Law 4824/2021 contains a series of rules and detailed indications regarding measures to counter fire risk, restrictions on activities that could cause fires, administrative sanctions for violation of the regulations, support for people affected by wildfires and the restoration of the natural environment after such events.

As a result, up until the year 1998 when the responsibility for firefighting was transferred from the Forest Service to the Fire Service, some fires were used to burn logging residuals during Autumn, Winter or Spring, and in rare cases, they used fire as backfires to help the Forest Service to extinguish an out-of-control wildfire. The above was more a “silent” practice of Forest Service rather than an official policy. To conclude, fire was used in forests and forested areas, but it was unregulated, rare and applied only in certain parts of the country (mountainous areas and northern Greece) where forests are dense, mostly broadleaf and with low fire risk. All this ended in 1998 with the law 2612/1998 that gave the responsibility of firefighting to the Fire Service. The Firefighting Ordinance 9/2000 published in the Government Gazette as Law 1459/30-11-2000 set stricter rules for igniting fire on the landscape (Article 2: Every ignition and conservation of ignition on the landscape, by any means, is illegal). The Forest Service could no longer use fire as they used to, and the legal risk of an escaped ignition was huge, so, no one used fire as a tool anymore. The above does not mean that prescribed fires were applied in Greece in forests and forested lands– only that fire could be used in some cases as a tool (exceptionally). Regarding prescribed fires, there was an open window for prescribed fires that were regulated and could be applied under license both prior and after 1998. These include fires to burn agricultural residuals and wheat remnants in fields outside the fire season, and under exception and strictly regulated cases during May-October (e.g., the fire risk to be very low or low) (Article 5, Law 1459/30-11-2000). Article 10 of the same law allows the burning of grasslands under license from the Forest Service, and approval by the Fire Service, if the necessary precautionary measures are taken and denoting why they will burn, with what prescribed fire technique, how long it will last and how risk is mitigated. Finally, Article 91 (FEK A', 65, 28/3/2022) regulates and enables backfires during firefighting. In simple words, it clarifies the "grey zone" of prohibition and fire use that was not clear enough in the previous laws (Arbinolo *et al*., 2024).

Ramping up fuel management to facilitate the existing suppression efforts is constrained by a host of socioeconomic regulatory factors. First, fuel reduction is regulated by the Greek Forest Service on both state (65% of all forests) and large privately owned forested lands. Private forest landowners are required to conduct detailed management plans for mechanical treatments and are prohibited from using prescribed fire (Law 998/1979, 16–4). These constraints, combined with a lack of funding, have all but precluded fuel-management activities in most of the forested areas. On state lands, forest management focuses on harvesting commercial timber production, primarily in higher elevation ecosystems, leaving the more fire-prone low elevation pine forests and evergreen shrublands largely unmanaged and prone to fuel build-up (Xanthopoulos 2004). Coordination of fuel management between state and non-forested private lands is limited. In general, the current prioritization scheme focuses on small-scale, scattered fuel-management projects around the wildland–urban interface (WUI), infrastructure and other valued resources (Henderson et al. 2005; Xanthopoulos et al. 2006; Kalabokidis et al. 2008) (Law 998/1979, 25–1).

Until the early 2000s, various laws allowed landowners to reclassify burned forests as 'non-forest' lands, thereby removing many administrative restrictions on land use (Laws 1734/1987 and 3208/2003). The lack of a national cadastre motivated landowners to use fire in this way to encroach on public or disputed forested lands and thus, increase landscape fragmentation.

In Greece, the urgency of managing forest areas, encompassing both forest management and fuel treatment, has grown significantly, especially after the catastrophic wildfires of 2021. Despite limited financial and human resources, the Forest Service has intensified wildfire prevention efforts through activities such as fuel management (e.g., vegetation clearing and agroforestry), firebreak construction, land-use planning, and investment in monitoring infrastructure like drones and detection systems. A major milestone is the near-completion of the National Forest Cadastre, with 95% of forest maps approved, aiding in land classification and fuel-type mapping — a critical advancement for effective wildfire prevention.

Greece's National Recovery and Resilience Plan "Greece 2.0" includes the AntiNero programme, which is regarded as a leading project for landscape management and wildfire prevention. It includes important partners like the Forest Service, the Hellenic Republic Asset Development Fund, and a few private contractors and runs through 2026. AntiNero integrates long-term planning, such as fire protection plans for high-risk regions including urban and archaeological zones, with urgent fire prevention measures, such as fuel treatments and road/firebreak maintenance. Measures including open water tanks, tech-equipped observation posts, reforestation, environmental education, volunteer group support, and the incorporation of grazing for fuel control are also included in the new phase.

How is the wildfire preparedness organized?

Wildfire preparedness is regulated by Law 4662/2020 on the national crisis management and response mechanism and by amendments established by Law 5075/2023. The State of Special Mobilisation, recently introduced in national legislation, is a powerful and effective instrument to improve preparedness in the imminence of a disaster.

The General Secretariat of Civil Protection belongs to Ministry of Climate Crisis and Civil Protection, gets involved with disaster prevention and response and sends each year to the competent bodies the annual "Civil Protection Action Plan for dealing with forest fire risks". The GSCP is responsible for drafting and updating guidelines for the planning, prevention, preparedness and response actions to address risks, including wildfires, and for updating the general civil protection plan IOLAOS 2. The latter includes the main actions on preparedness for forest fires described in phase 1 - Standard Preparedness (preparatory actions) and phase 2 - Enhanced Preparedness (increased preparedness against forest fires) - of the "Stages of Mobilization of Civil Protection Capacity."

The involvement of the Fire Brigade in wildfire preparedness encompasses a number of activities, including the review and update of the Operational Plans of the Regional Fire Departments, inspection and maintenance of critical infrastructure such as the rural road network, fire watchtowers, and water tanks to optimise their functionality during firefighting efforts. Additionally, cooperation with the General Staffs of the Army, Navy, and Air Force as well as the Hellenic National Defence General Staff guarantees their support when required throughout the firefighting phase through the use of aerial methods, ground vehicle patrols, and the management of aerial fire-fighting risk. The Hellenic Police also aid in preparation through patrols, aerial surveillance, traffic control, forest fire investigation, and their involvement in the precautionary evacuation of citizens. Lastly, members of the Armed Forces and the Forest Service staff the ESKEDIK to assist with aerial firefighting and ground operations as needed. The concept of prevention in practice includes many actions and measures, such as investigation of the causes of fire and statistical analysis, awareness raising and information of citizens, pre-suppression planning (fire prevention), legislative measures, forest management, a system of preparedness - risk assessment, ground patrols in the forest and fire detection by ground and air forces.

In addition to the Forest Service, several other agencies contribute to wildfire prevention and landscape management in Greece. The General Secretariat of Infrastructure handles vegetation clearing and maintenance along major road networks, while the Ministry of Culture oversees fire safety measures in archaeological sites and museums. Electricity network operators, Independent Power Transmission Operator and Hellenic Electricity Distribution Network, working with the GSCP, Fire Brigade, and Forest Service, carry out fuel clearing and pruning near power lines to prevent fire ignition. Given that 90% of Greece's electricity is distributed via overhead lines, this work is critical. Hellenic Electricity Distribution Network is also upgrading its systems by installing thermal cameras and replacing copper wires with insulated ones. Additionally, EMODE scientific units assist the Forest Service in vegetation and post-fire area clearance, further supporting coordinated wildfire risk reduction (Arbinolo *et al.*, 2024).

Annual campaigns for citizens' awareness raising and information are prepared by the General Secretariat of Civil Protection, Ministry of Climate Crisis and Civil Protection. Digital brochures, TV spots and short videos are created and explored through media, especially during fire season for fire prevention and protection.

Since 2003, the Greek General Secretary for Civil Protection issues a daily fire danger map (empirical and qualitative approach) to inform other government agencies and the public for the upcoming fire ignition hazard, covering the whole country. This map has been incorporated into the official Greek government fire management planning. This means that all agencies involved in fire management must take certain actions based on which of the five fire danger classes apply to each specific region that they have authority. The spatial scale of this map corresponds to the local Greek Forest Service (GFS) local district boundaries, i.e., 106 spatial entities, with an average size of 125k ha. This map is issued each day at noon, to portray the conditions that are valid for the next day. The information contained in this map is classified into five fire danger classes, with each GFS local district receiving one colour (green – low danger, blue – moderate danger, yellow – high danger, orange – very high danger, red – state of alert). This information is like the "Adjective Ratings" used in the US, i.e., a public information description of the relative severity of the current fire danger situation in a general area. The map is issued for the period June 1st to October 31st. The map was issued by a team of foresters and meteorologists working for the central government (Ministry of Climate Crisis and Civil Protection).

The methodology behind this daily fire danger map is a "black box". This methodology has not been published anywhere, and from what we know it is based on empirical data, combined with limited information retrieved from spatial datasets, all blended under the expert opinions of forester and meteorologist teams working on this project. The assumptions, datasets and methods used have never been documented. What we know is the following: the estimation is based mostly on the predicted weather conditions for the next 24 hours, along with the 10-hr fuel moisture sticks measurements (if available). The issuing team state that "map accuracy is linked to the accuracy of weather predictions". The only dataset the issuing team state that they use is the "state of vegetation", a product of the analysis of MODIS Terra based mostly on NDVI and "other indices", which are not specifically mentioned. The NDVI map is updated every 10 days, and its accuracy is "assessed with local observations" – not to mention what type of observations they do and how often. The value range is from 0 (no vegetation) to 1 (high density of green leaves). Finally, they use five classes of fire danger at the spatial scale of local GFS district boundaries (Figure 62). This empirical and qualitative index: 1) does not include any fire behaviour estimation; 2) shows the probability of a new ignition but not its intensity or potential fire size; 3) lacks spatial detail; 4) does not provide any accompanied or assimilated weather index, and 5) does not have any risk assessment estimation.

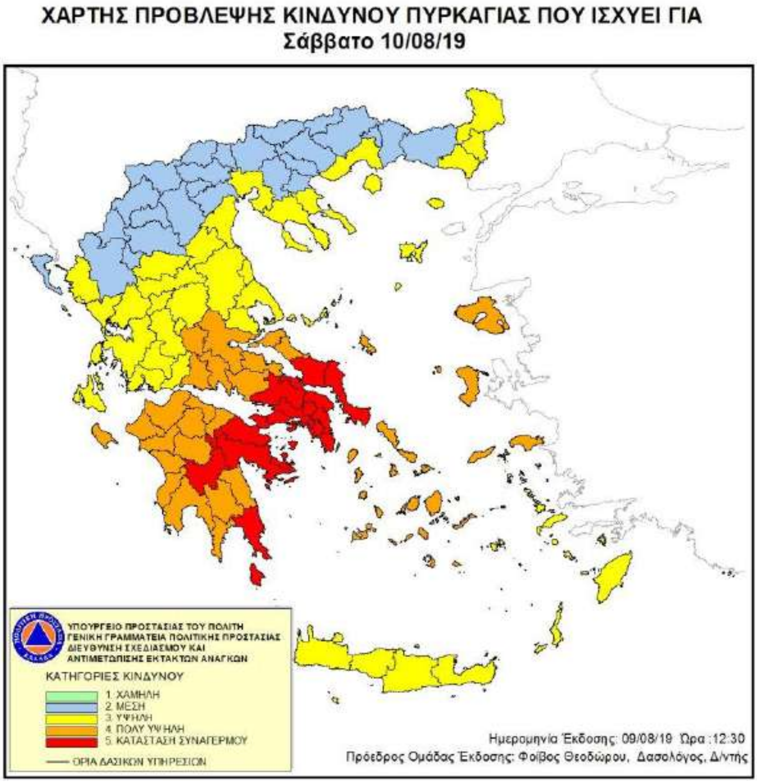

Figure 64: The official map of fire danger estimates for each local Forest Service district boundaries.

All in all, the issuing team of this map accomplished to have the central government adopting this approach and it became the official fire danger rating system of Greece, dictating a series of actions and rules of engagement of various government and non-governmental organizations that must be taken based on the rating of this index. The main advantage of this index is that the boundaries used for mapping are very coarse and makes easier the “translation” of its information to a wider audience (public) and to the fire management agencies. Also, it uses five classes and the same colouring scheme as the fire danger rating of the US. The main disadvantage is that it lacks, if not entirely, at least to some great degree the scientific justification of the methodology followed and applied, largely tied to the empirical assumptions of the issuing team.

A daily forecast of fire risk is also performed by the Institute of Astronomy, Astrophysics, Space Applications and Remote Sensing and the National Observatory of Athens using innovative artificial intelligence methodologies. These forecasts are published on the Forest Fire Risk application. However, the use of these products is not currently regulated, so they are not considered in the operational chain by public authorities (Arbinolo *et al.*, 2024).

Fire Brigade applied ignition reduction measures such as dispersion of firefighting vehicles for surveillance on areas characterized by high fuel load in forests, areas with historical high frequency of fire occurrence, and WUI areas. Based on the daily fire danger map, the dispersion of firefighting vehicles is adjusted as appropriate. In the event of very high or extreme risk in each area, the GSCP issues a press release, warning civilians living in these areas to avoid anything that carries the risk of fire.

The GSCP is also responsible for issuing alert messages via the emergency number 112 (cell broadcast messages) as well as using mass and social media (Unit 5 of the ESKEDIK). The 112 - Emergency alerts citizens in high-risk areas in the event of a fire and provides information on recommended behaviours to reduce risk before and during a fire. When a fire is imminent or has started, people receive a warning message on their smartphone in both Greek and English. The recent Law 5075/2023 includes specific provisions to strengthen the 112 Emergency number.

In the field of prevention, the General Directorate of Forests and Forest Environment of the Ministry of Environment and Energy (Law 2612/1998, Law 3208/2003, PD 402/1988, KYA 23111/2010, PD 24/2015, PD 132 /2017) has the responsibility for issuing instructions and technical specifications of projects and activities regarding forest fire protection, as well as the preparation of programmes for fire risk reduction. Forest Coordination and Inspection Departments of the Decentralized Administrations are responsible for the coordination and supervision of the preparation of all types of forest programmes at prefecture level and the supervision of their implementation (Law 2503 /1997, Government Gazette 12030/Φ109.1/1999 KYA, N.3852/2010).

By Presidential Decree No. 6 (Government Gazette 17/A/04.02.2022), the General Secretariat of Forests was established within the Ministry of Environment and Energy. The General Directorate of Forestry and Forest Environment is composed of i) the Planning and Forest Policy Directorate, (ii) the Forest Protection Directorate, (iii) the Forest Infrastructure Directorate and (iv) the Forest Management Directorate. The departments transferred to the Ministry of Environment and Energy (by Paragraph 1 of the third article of the 13.8.2021 Legislative Content Act (A' 143), which was ratified by Article 2 of Law No. 4824/2021 (A' 156), are namely: i) General Directorates of Forest, ii) Directorates of Coordination and Forest Inspection, iii) Forestry Directorates and iv) Directorates of Reforestation.

Recently, Law 5075/2023 on the Restructuring of Civil Protection established a committee for the prioritisation of urban and peri-urban forest areas, which can enhance the coordination of fire protection projects. The law also provides for the establishment of a National Register of Preventive Fire Protection Measures by the Ministry of Climate Crisis and Civil Protection (Art. 53a), which will record the obligations of citizens regarding clearing dry/flammable material from their land during the wildfire seasons. Random checks will be carried out by the Hellenic Fire Brigade and other local authorities using modern electronic means to check compliance with the fire safety measures by the owners, usufructs, tenants or sub-tenants of land and other open areas located in specific areas as detailed in the Law. These people will have to submit a declaration by 30 April each year on the fulfilment of the fire protection obligations for their properties in the National Register. Failure to comply with these obligations is punishable with a fine.

Forest fire prevention includes both agroforestry areas and wildfire urban interface so-called forest-settlement mix zones. In Greece, the houses in WUI areas are reinforced with concrete and bricks (fire-resilient building materials) and rarely are exclusively wooden. Citizens in WUI areas invest money to build solid, secure and safe houses that are used for primary residence.

Additionally, it is essential to underline that at national level, there are long-standing anchors, delays, and lack of implementation of institutional and technical measures to support prevention (completion of forest maps, good agricultural land management practices, legislation on re-forested agricultural lands, interventions in vegetation, planning legislation, procedures for approving projects, distribution of funds and the implementation of forest management measures). All these are often cited as obstacles to efforts to reduce risk especially in WUI areas.

Significant efforts are currently devoted to patrolling, with the participation of numerous entities using various means and tools. Entities involved in patrolling activities include the Fire Brigade and Fire Service, which conduct daily patrols in their respective areas of responsibility. The Natural Environment and Climate Change Agency, established by legal provisions in Laws 4685/2020, 4722/2020, and 4819/2021 and supervised by the Ministry of Environment and Energy, operates two permanent patrol units, has two permanent patrol units. Additionally, mixed patrols are conducted by the Armed Forces and the Hellenic Police, both by air and on land. During phase 4, patrols are active 24/7, involving over 1,000 people daily, particularly on days classified as risk level 4 or 5. There are also patrols by volunteer organizations under the guidance of local administrations. This involvement of numerous entities can create some degree of overlap, hence the need for an evaluation of the cost-effectiveness and efficiency of the overall patrolling system (Arbinolo *et al.*, 2024).

How is the response organized?

The Hellenic Fire Corps (HFC), also referred to as the Hellenic Fire Brigade (HFB), has been responsible for fire suppression operations in Greece since 1998. Its functions include early detection, alerting, response, and the preparation and continuous updating of operational plans for forest fire management. The HFC operates through a centralized and decentralized structure. At the national level, central services are headquartered in Athens under the command of the Fire Chief and include the National Coordination Centre for Operations and Crisis Management (ESKEDIK), the Fire Corps Aviation Unit, the Arson Crime Response Directorate (ACRD), the Fire Academy, the Firefighting Vessels Unit, and the Directorate of Inspection and Control. The assistance of other operationally involved bodies, is carried out upon request of the suppression chief officer in command and focuses primarily on the following actions: 1) Provision of water tank vehicles, construction machinery, etc. by local authorities, 2) Taking traffic related measures by Traffic Police to facilitate the movement of fire engines and the vehicles of other agencies, 3) Preventive power outage for the safety of suppression personnel, 4) Facilitation by Hellenic Cost-Guard of the transport by sea, personnel and equipment involved in fire suppression, 5) Provision of personnel and equipment by the Greek Army, 6) Dispatch of ambulances and other first aid units.

At the regional level, the HFC maintains a wide operational footprint composed of:

- 13 Regional Fire Administrations and Operational Centres
- 54 Prefectural Fire Service Administrations
- 127 Local Fire Services and Stations
- Special Disaster Response Units (SDUs)
- 16 Special Forest Fire Operational Units (EMODE)
- Fire Units, Fire Garage Stations, and Volunteer Fire Stations and Volunteer Fire Brigades.

This extensive network allows the HFC to deliver rapid and coordinated responses to wildfires and other emergencies across the country.

The General Plan for Dealing with Emergencies Due to Forest Fires (5th edition, April 2023. aims at the immediate and coordinated response of the involved agencies, and consists of the General Staff (Strategic/Political), the Crisis Departments (Operational), and the Executive Agencies (Tactical), for: a) supporting the Fire Service in their job of extinguishing fires and b) effective and immediate management of incidents due to forest fires and the immediate management of their consequences, actions pertaining to the protection of the health and property of citizens, as well as the protection of the environment, and the country's resources. The cooperation, collaboration and operational interoperability of all above agencies is required on all levels.

The Incident Management Levels are:

- The Tactical Management Level, which is managed by a chief officer (the senior-most officer) who is at the incident site, coordinates the intervention team's actions, while at the same time collaborating with the involved agencies. A pyramid chain of command is formed, informing his/her immediate officer who has the role of Operational Level Commanding Officer. The tactical level is usually represented by the local Fire Service Commanding Officer or the prefecture's Fire Service Commanding Officer.
- The Operational Management Level is the link between the Tactical and the Strategic Management levels. It is responsible for deploying the action plan and

has the General Management, control, and coordination of the incident, as well as the collaboration with the involved agencies. The local prefecture's Fire Service Commanding Officer is assigned Commanding Officer, and in exceptional cases the role is assigned to the Fire Service's local Coordinator/General.

- Political/Strategic Management Level includes decisions and directions for the realization of the Fire Service's mission are taken at the political level by the Minister or Vice Minister of Civil Protection or the General Secretary for Civil Protection. The decisions and directions for the realization of the Fire Service's mission is represented by the Chief of the Fire Service, who is substituted by second-in-command of the Fire Service.

The incident management levels have changed and tailored according to the incident category (common or small scale, serious, very serious and critical).

In fire suppression activities, firefighters' volunteers are involved according to the operational plan. The local administration authorities are obliged to support these teams with the necessary equipment and means. Furthermore, during a fire event, the Hellenic Fire Service informs the Forest Service, and a representative fire analyst scientist (or a team) is present at the event. The fire suppression strategy prioritizes on limitations of impacts, since most fires ignited close to WUI, thus the fire suppression take a "suppress only in critical areas" approach. The fire suppression strategy focuses on early attack and aerial means and tries to suppress simultaneously all flanks. The fundamental suppression approach is to "suppress all fire", without even considering "suppress only in critical areas" (=let it burn) since important legal and administrative issues can arise for those that will give an order to let a fire burn. The Greek Fire Service has the appropriate personnel for fire cause investigation. Despite this, the strategy focusses on early attack and heavy use of aerial means, with the field responders' strategy failing to gain support inside the agency. Regarding whether the suppression strategy is searching opportunities to extinguish or tries to suppress simultaneously all flanks, it depends on the decisions made by the local branches of the Greek Fire Service. There are cases where both strategies were implemented in different regions. Most of the ignitions' causes are known after investigation except in cases where the incendiary device does not leave any residuals (i.e., lighter, candle etc.). Overall, less than 50% of all fires have a known cause, and the system does not have the capacity to uncover all the causes for ignitions.

How are the post-fire actions organized?

The assessment and recording of burnt areas in Greece are particularly important and necessary for i) the management of flora and human activities (e.g. grazing), ii) the management of surface runoff to prevent flooding, iii) the planning of restoration interventions, iv) reducing the quantity and quality of water resources (drinking water and irrigation water), v) addressing erosion and possible land degradation and vi) preventing land use changes (encroachment, illegal housing development). Post-fire rehabilitation also includes measures to restore normality in local communities, ensuring the continuity of economic activity and reconstruction of areas affected by forest and rural fires.

The main institutional actors involved in the recovery phase in the aftermath of wildfire include the Directorate General for Natural Disasters Response and Recovery (under the Ministry of Climate Crisis and Civil Protection), the Secretary General of Spatial Planning and Urban Environment (under the Ministry of Environment and Energy), Natural Environment and Climate Change Agency, the Forest Service and the Arson Crimes Response Directorate. The Directorate and Secretary General deal with restoration of urban areas or buildings; the former is responsible for the restoration of buildings damaged by wildfire events, while the latter sets the guidelines and approves the specific urban master plans, which are also drafted for areas affected by a disastrous event (e.g. the Mati fire). Natural Environment and Climate Change Agency and the Forest Service, instead, have a crucial role in the restoration and conservation of degraded ecosystems. Specifically, Natural Environment and Climate Change Agency is responsible for planning and implementing post-fire measures for the restoration and conservation of biodiversity – mostly fauna – over the areas of the Natura 2000 network (Arbinolo et al., 2024).

The Fire Brigade provides information on the total burnt areas and the categories of use/land cover categories without specifying the forest character of the burnt areas. The Forest Service, instead, is responsible for the restoration of all the Greek ecosystems in the long-term, which include anti-erosion measures and reforestation. Furthermore, in specific cases, the Forest Service is supported by the EMODE units, which also play a role in managing burned areas and clearing away burned fuels.

Forest Service (FS) has the obligation for imposing a prohibition on hunting and grazing in burnt areas for the next two to five years immediately after the fire and mapping the burnt forested areas. Then, FS prepares studies of flood and erosion control action, procedures for financial support and implementation of the post-fire project. Two years after the wildfire, the FS will carry out on-site investigations in the area to estimate physical reforestation. If technical reforestation is considered necessary, the corresponding procedures are initiated, although their implementation often depends on the availability of funding. As a result, even in areas in need of reforestation, the necessary actions are rarely implemented – typically only in affected regions near urban centres or after large wildfires that mobilize public and governmental interest. In such cases, funding is secured either from the central Government or through donations. The usual absence of fault or blame on the owner's part (i.e., land tenure where ignition occurred) when a fire is extinguished, limits that the restoration will be done through compensations from the Government through procedures followed by municipalities and regions. Furthermore, in specific cases, the Forest Service is supported by the EMODE units, which also play a role in managing burned areas and clearing away burned fuels.

Public opinion and political pressures often lead to arbitrary and massive reforestation interventions without planning, scientific design and documentation. There are no financial provision, measures or practices to guarantee activities in the medium term affected (e.g., suspension of grazing, beekeeping) in the burnt areas.

Regarding insurance, it is not mandatory and although there are available insurance packages in the free market, they are rarely employed for structures, but with a higher cost, and there are no incentives to enforce the owner to sign such contracts, while for forests and agricultural fields there are only exceptions of owners that insured their property. There is no law that requires homeowners to insure their properties against wildfire or other natural hazards. Insurance remains voluntary, except in cases where either a loan is in place, and the bank requires insurance coverage or insurance is a prerequisite for participation in state-funded recovery programmes. However, several policy discussions and proposals have emerged, particularly following the devastating wildfires of 2021–2023, aiming to strengthen resilience and promote insurance coverage in high-risk areas. More specifically, Law 4662/2020 entitled as "National Crisis Management and Risk Mechanism" does not mandate insurance but establishes a framework for identifying High-Risk Zones (Zones of Potentially High Risk), which could eventually be used to implement risk-based insurance policies or building restrictions. Law 4915/2022 created a dedicated ministry, the Ministry for Climate Crisis and Civil Protection, responsible for resilience and disaster preparedness. While it doesn't introduce compulsory insurance, it proposes tax incentives for property owners who insure their homes against natural disasters. It encourages also the adoption of preventive measures (e.g., vegetation clearing, firebreaks) for properties near forested areas. Recently, the Greek Government announced a financial motive to those insuring their homes (i.e., a 10% or 20% reduction in annual property tax), which is activated during 2022 and 2023 respectively. For productive forests and agricultural lands, owners lack motivation to ensure their production and crops, as in the event of wildfire damage, the state provides compensations following the procedures and regulations set by the Greek Agricultural Insurance Organization (ELGA). In this context, Law 5075/2023 strengthens the state aid mechanism for agricultural holdings affected by the 2023 fires. It ensures that the aid received by agricultural holdings in accordance with the applicable regulations, as compensation for damage to crops and livestock caused by the fires of summer 2023, is tax-free, protected from seizure, and cannot be reallocated by the State or third parties. This measure gains further importance considering the low insurance penetration in Greece regarding extreme weather events. In particular, the protection gap is widest in cases of wildfires and earthquakes, where insurance coverage rates are among the lowest (0–25%). Because Greek legislation does not require natural hazard insurance for residential and commercial properties, there is a greater reliance on public compensation systems following disasters.

10.2. Vision for wildfire-resilient landscapes in 2030

During the first CWI meeting, took place in Thessaloniki October 3rd, 2022, the Living Lab leader (Prof. Kostas Kalabokidis) presented the project's goals, consortium synthesis and collaboration, as well as expected results for Fire Management in Greece and Europe. Emphasis was given to the concepts of EWE and Fire Resilience, Integrated Fire

Management in the Greek Living Lab. An extensive round table discussion took place during the first CWI meeting to diagnose anticipated challenges on three phases of management (preparedness & prevention, detection & emergency response, and post-fire restoration & adaptation), especially to:

- identify the current situation and anticipated critical factors for integrated fire management and wildfire resilience, and

- agree on a common vision for wildfire-resilient landscape and the key areas of intervention to achieve resilient landscapes in Greece by 2030.

10.2.1. A 2030 wildfire-resilient landscape in Greece

During first CWI meeting, discussion on forest fires and climate change held among FIRE-RES partners and stakeholders highlighting the clarification of terms “Extreme Wildfire Events” and “wildfire-resilient landscape” in the Greek Living Lab.

EWE has been defined, based on the findings of the D.1.1, as a wildfire with large-scale complex interactions between fire and atmosphere conditions, that results in fast, intense, uncertain and rapidly changing fire behaviour. Extreme wildfires are difficult to predict. They may pose an increased threat to crews, population, assets and physical values and may cause negative socio-economic and environmental effects and difficulties to decision making process.

FIRE-RES interprets resistance as a measure of the degree to which the ecosystem, or an ecosystem variable, is changed from its equilibrium state following a disturbance, while it interprets resilience as the time required for a perturbed ecosystem or ecosystem variable to return to its equilibrium value. It was mentioned that the FIRE-RES project aims at reducing the immediate impact of fire (increase resistance) when the impact is negative environmentally and socio-economically. Adaptive strategies to climate change should seek higher ecosystem resistance and resilience to fire.

Main challenge is the establishment and implementation of an integrated forest management system that will ensure cooperation between relevant stakeholders on issues relating to all phases.

10.2.2. Resilience in fire preparedness and prevention

- Main challenges
  - ✓ Gathering of scientific information and reliable statistical data and creating one infrastructure of thematic and spatial databases on fires derived from all involved organizations/institution and linked to European Forest Fire Information System (EFFIS). This information will be necessary for fire prevention and protection strategies.

  - ✓ Forest and landscape management for fire risk mitigation by using both modern technology and new materials, techniques and good practices.
  - ✓ Fire as a management tool. The challenges and limitations of the use of prescribed burning for fire resilient landscapes were discussed. Prescribed burning is one of the most important tools used to manage fire today in US. Prescribed fire may be designed to create a mosaic of diverse habitats for plants and animals, to help endangered species recover, or to reduce fuels and thereby prevent destructive wildfire.
  - ✓ Setting up programmes for regular cleaning of rail and electricity networks in or near rural and forest areas
  - ✓ Legislative regulation for the scientific implementation of prescribed burning in Greece. Development of know-how practices to control combustion.
  - ✓ Improve education and raise awareness of the population about fires. Environmental Education for children.
  - ✓ Societal engagement, especially in WUI areas.

- Vision for 2030 for the key aspects mentioned above
  - ✓ Managed landscapes with fuel treatment projects at the appropriate spatial scale, considering the temporal factor of their effectiveness.
  - ✓ Enhancement of agroforestry practices to reduce biomass removal costs and support people living and working inside forested areas.
  - ✓ Introduction and application of prescribed burning and regulation of illegal fires set for agroforestry practices and agriculture since some of them are beneficial.
  - ✓ Development of educational programmes/strategies for the whole society to enhance citizens’ involvement in the problem of forest fires and to improve training for fire preparedness and prevention.

10.2.3. Resilience in wildfire emergency management

- Main challenges
  - ✓ Fire as an emergency management tool. The challenges and limitations of the use of backfires were also discussed. Backfire is a method of wildfire suppression and in today's era, characterized by fires of increasing intensity that are impossible to deal with by direct attack of the front, backfire is in many cases an important forest firefighting tool. Backfires are already applied by some special trained units of the Fire Service, but they need to be extended across all Fire Service branches to increase resilience in wildfire emergency management.

- ✓ Maintenance and utilization of the network of fire lookouts operated by the Greek Forest Service to strengthen the fire detection capabilities, detection and early warning of fires.

- ✓ Increase the effectiveness and the efficiency of forest firefighting. Better tactics that involve ground personnel using all sorts of equipment and methods to faster create reliable fire breaks during the event is essential. The Greek Fire Service must transcend from the dogma of fighting wildfires by throwing water alongside the road network and gain an active engagement inside the forested areas and with flexible small units that can intervene in remote areas and deep into the woodlands. These techniques are already in place in some parts of Greece, but they need to be extended across all Fire Service branches to increase resilience in wildfire emergency management.

- Vision for 2030 for the key aspects mentioned above
  - ✓ Early detection of new ignitions by applying new technologies (UAS, solar aircrafts etc.) and supporting the current fire lookout network, while enabling fire spread modelling in every region of Greece for informed response.

10.2.4. Resilience in post-fire management and adaptation

- Main challenges
  - ✓ Ecosystem restoration and protection of burned areas is very important to protect society from other risks that may follow (e.g. floods, landslides, etc.).
  - ✓ Informed/ up-to-date vegetation and stand information, with better knowledge of the forest ecology, traits and succession dynamics, to support restoration and adaptation activities.
  - ✓ Short-term and long-term forest restoration management to ensure that the form and structure of the future forest in the affected area will meet the standards and desired form set by the society and the Forest Service. Such management can increase future fire resiliency of the forest and create a better adapted to fire ecosystem. Management should be applied on the right scale and at the right time (e.g., thinning of the saplings). Priorities should be set right after the fire and decide in which cases within the fire perimeter they should be imposed and how.

- Vision for 2030 for the key aspects mentioned above
  - ✓ Establish a common monitoring protocol to estimate fire severity (official mapping of fire size burned), linked to European Forest Fire Information System (EFFIS)
  - ✓ Establish procedures and guidelines for evaluating post fire impacts on ecosystem and society, as well as the effectiveness of integrated fire management actions for future management decisions.

✓ Develop fire-resilient construction protocol for WUI areas.

10.2.5. Other resilience aspects

- Main challenges
  ✓ A Wildland-urban interface where vegetation is managed to enhance community resilience, and structures that will meet certain criteria around their home-ignition zone, as well as their building standards, to enhance structure resilience.

- Vision for 2030 for the key aspects mentioned above
  ✓ Establish a common monitoring and action protocol that will be applicable for the different WUI cases of Greece that will enable homeowners to assess the risk of their property with the help of experts, rating different criteria and evaluating the overall property's resilience (structure and surroundings), and proposing measures that owners can apply to increase their resilience, subsidized by "green" funds or by the Government.

  ✓ Enforcement of mandatory insurance for all residencies of WUI to alleviate the cost of compensation in case of a destructive fire event from the Government to the private sector, a policy that eventually can mobilize homeowners to undertake more measures to enhance their property's resilience.

10.3. Gaps to reach that vision

Based on methodology and tools for Open Innovation Campaign kickstarting (OIC) proposed by partner INESCTEC (WP6), Greek CWI members, during their second meeting held on February 21st, 2023, were actively and cooperatively exchanged challenges for three fire management phases. More specifically, CWI members, divided into three groups – one for each phase, have chosen a problem to address, thought about causes and the context of the problem, and considered solution(s) and barriers. Then the scientific community converted this information into key challenges and promoted the corresponding Work Package leader. In this way, three main challenges have been prepared, one for each phase of a fire management cycle: Preparedness – Prevention, Detection-Response and Restoration-Adaptation.

10.3.1. Preparedness and prevention phase

A challenge titled: "*Effective forest fuel management and treatments*" was proposed. This challenge is associated with the management of forest fuels in public and/or private forests, regarding:

- Planning of biomass removal or prescribed burning methods to break the forest fuel continuity.

- Cost estimation of fuel management operations.

- Set the management criteria and objectives depending on the area (forest or wildland-urban interface).
- Assessment of forest management effectiveness on changing fire behaviour (cost-benefit analysis) and sustainability.

This challenge is going to address several issues:

A major portion of the road network is obstructed by the high density of biomass on both sides of the roads. This has a deleterious influence on wildfire preparedness, prevention, and suppression. Furthermore, forest road maintenance is disorganized, at the discretion of local authorities, or in response to reports from forest rangers to the Forest Service and inspections by the Fire Service. There are also insufficient resources and planning to maintain/clear the complete network of current roads within a forest. Furthermore, local governments lack a coordinated and transparent plan for carrying out road network development and management, in conjunction with Forest and Fire Service authorities, either in the short or long term.

The prices of carrying out biomass treatments and road opening/maintenance have increased since more time is required to carry out the endeavour after years of abandonment, and the amount of workload to be done per unit area is high. There are also increased expenditures for logging residue disposal, rearrangement, and removal. Usually, they are not burned or removed by the contractors. This is because of delayed financing approval, usually concurrently with the beginning of the fire season. Chipping, lopping, and scattering/disposal in the forest apply additional costs. Pile burning at gathering locations or near forest roads is one option, although it has difficulties when used during fire season.

The placement of biomass management projects is entirely dependent on the actions of the whole society. Any complaints or requests made by citizens or institutions regarding the location of biomass management projects are gathered and examined by the Forest Service, in collaboration with the Fire Service. The seriousness of each request/complaint is then assessed, and a priority is assigned. When planning the projects that will be applied for the following year, the Forest Service prioritizes certain areas to prevent legal responsibilities and claims in the event of a fire.

The potential solutions indicated during the Challenge Design workshop were:

- Establishment of a department entirely dedicated to the annual recording of the forest road network and its accessibility, maintenance and improvement parameters.
- 10-year funding planning for fuel management projects at Forest Service branch level.

- Implementation of effective fuel management measures by informing stakeholders and society. Press releases and information campaigns need to be done by relevant ministries, public agencies, universities etc.
- Establishment of forest workers teams, e.g. like the hotshot fire crews, integrated into the Forest Service to carry out fire prevention work outside the fire season, while working as forest guards/patrol units during the summer.

10.3.2. Detection phase

Detection plays a crucial role in the management of forest fires. CWI members have agreed to some potential solutions to enhance fire detection:

- Better spatial accuracy and detail of fire ignition risk and spread indices that may be connected to the ENGAGE Fire Service operational system.
- The capacity to transmit comprehensive cartographic and live camera stream images of the fire front in real-time and online (using, for example, thermal cameras) to the coordination centre.
- A more extensive network of remote automatic weather stations connected to the ENGAGE operating system. Access to current weather stations offered by other organizations (like the National Observatory of Athens).
- Proposing the installation of a meteorological station at each fire station to facilitate fire risk and behaviour simulations or the creation of a meteorological database at the Prefectural Administration level.
- Establish a mobile meteorological station near the operating base at the scene of the incident so that it can collect microclimate parameters in real-time and contribute to any simulations and early warning.

10.3.3. Response phase

A challenge titled: “A more effective forest fire suppression” was defined in our meetings. A key challenge that firefighters and emergency services are facing is tactical and operational readiness. This emphasizes the ability to have the appropriate people, tools, vehicles, and expertise available at the appropriate time and location. It is commonly accepted the important role of initial attack and effective suppression in fighting wildland and WUI fires, in the shortest possible time and with the lowest possible damages (area burned, human casualties etc.).

A critical problem identified at this phase is the first attack due to accessibility difficulties. It varies from region to region in Greece, depending on specific characteristics, such as islands, mainland areas, high altitude areas, e.g., Mount Athos (a UNESCO World Heritage site) etc. Despite the Forest Service's efforts to maintain and open forest roads, when necessary, much of the rural road network (which is a responsibility also of the local governments) is extremely difficult to access for fire fighting vehicles, delaying timely access and hindering effective overall response to a fire event.

The issue of the initial attack may have additional criteria in addition to accessibility, such as:

- Initial assessment of the problem (measure up).
- Optimal allocation of resources to the event.
- Appropriate initial coordination.
- Optimization of first attack sites.
- Training and drills to practice the difficulties of the first attack.

Challenges have some potential solutions agreed by the GR CWI:

- Development of a methodology that considers the wildfire history and the unique characteristics of Greece, while systematizing and standardizing environmental parameters, initial attack techniques (in a spatiotemporal context), and suppression. To improve suppression efficiencies, this system will identify locations that call for a different strategy for the first attack and extinguishing means. Additionally, it will result in fewer empirical suppression efforts.
- Creation of unbiased indicators for the assessment of suppression actions.
- A comprehensive and well-maintained road network, infrastructure.
- Personnel with modern technology training.

10.3.4. Restoration and adaptation phases

During the Challenge Design workshop, a challenge titled "Study and organization of post-fire rehabilitation and post-fire reconstruction of affected forest areas and settlements" was decided. Extreme Wildfires generate relevant and diverse impacts such as increase in soil erosion (with the help of intense rains), reduction of the seed bank, increase in depopulation in rural areas, loss of important sites and heritage areas (cultural, property, populations protected at European level etc.) or psychological impacts on the local population that are not adequately addressed. So, the planning and implementation of environmental, regional, technological and economic actions with priorities on holistic protection and restoration of burned forest areas and fire-affected populations is very challenging. CWI identified that there was a greater need for:

- Initiatives to prevent soil loss, erosion and flooding in burned coniferous forests (higher priority) and broadleaf forests (lower priority), mapping of burned areas and effective declaration of reforested/replanted areas.

- Addressing socioeconomic impacts on citizens and the community (such as those created by the mega-wildfire in Evia in 2021).

- Application, monitoring and preservation of post-fire restoration measures areas, especially in the wildland-urban intermix and interface (WUI).

- Observing and maintenance of post-fire restoration efforts in places, particularly in the wildland-clarification of the Technical Services' function in the Regions and Municipalities regarding issues of adaptation and rehabilitation.
- Clarification of the Technical Services' role in the Regions and the Municipalities on adaptation and rehabilitation issues.
- Upgrading and strengthening of the Forest Service to have enough staff to restore and protect burned areas.
- Indicators, activities and measurements for local sustainable development, fire ecology and management, water economics, erosion, flooding, and agricultural challenges.
- Researching the impacts of fires on non-market values and animals, agricultural lands and the urban environment.

The potential solutions, indicated during the Challenge Design workshop, are presented below:

- The use of technology to map burned areas, fire intensity, and ecological repercussions (in conjunction with pre-fire conditions).
- Continuous observation of burned regions.
- Post-firewood, branch and log barriers that are constructed parallel to contours, small wooden dams in ravines, and small concrete dams for erosion and flood prevention in burned areas.
- Reforestation, if required, two years post-fire. Natural regeneration generally manifests significantly better in the absence of unsuitable people interventions, such grazing or intense logging activities.
- Reforestation in WUI areas, as well as on the plots and courtyards of dwellings and tourism facilities, using local-adapted species and following the standards for fire protection and fire resistance.
- Guidelines, directives, protocols and approvals from relevant authorities (e.g. Forest Service, Local Authorities) for landscaping burned areas around settlements, residential areas, infrastructure etc.
- Steps and techniques to offer short- and medium-term financial help for the wildfire-affected industries (tourist, business, agriculture, etc.).
- Plans for action depending on the fire impacts.

10.4. Steps and milestones: the roadmap

10.4.1. Progress achieved during the project (at CWI level)

With the goal of promoting integrated wildfire resilience and management, the Community of Wildfire Innovation (CWI) is a cooperative network of stakeholders that includes researchers, practitioners, local government officials, fire management organizations, and community representatives. The Greek CWI was created as a component of the Living Lab approach of the FIRE-RES project with the goal of promoting innovation, information sharing, and collaborative solution development to tackle the growing problems caused by intense wildfire occurrences.

CWI provides a participatory platform where stakeholders collaboratively identify critical issues throughout the wildfire management cycle, from preparedness and prevention to response and post-fire recovery, by bringing together a variety of knowledge and local experience. The development, testing, and application of novel tactics and technology suited to the distinct socio-ecological settings of wildfire-prone regions are encouraged by this welcoming community.

At the heart of the Community of Wildfire Innovation (CWI) lies a collaborative, participatory process grounded in co-design, co-implementation, and co-evaluation. This approach ensures that wildfire management strategies are not only technically sound but also socially accepted, locally relevant, and practically feasible. Firstly, co-design involves stakeholders—fire services, forest agencies, scientists, local communities, private owners and policy-makers—working together from the outset to identify wildfire challenges, share knowledge, and define priorities. Solutions are developed collectively to ensure they reflect real needs on the ground. Secondly, co-implementation means that proposed innovations, tools, and strategies are tested and applied in real-life contexts with the active involvement of CWI members. This ensures shared ownership, practical feedback, and adaptation of solutions to local conditions. Lastly, co-evaluation ensures that outcomes are assessed jointly. Stakeholders monitor the impact, effectiveness, and usability of innovations, and provide insights for improvement, replication, or policy integration. This cooperative approach enhances the effectiveness and long-term sustainability of wildfire resilience programmes while fostering cross-sector collaboration and mutual trust. It combines disparate efforts into unified, community-led solutions and converts hierarchical policies into communal tactics. Figure 65 outlines the steps the Greek Living Lab followed to progress from the status quo (December 2021) to a common-agreed vision for Integrated Forest Fire Management.

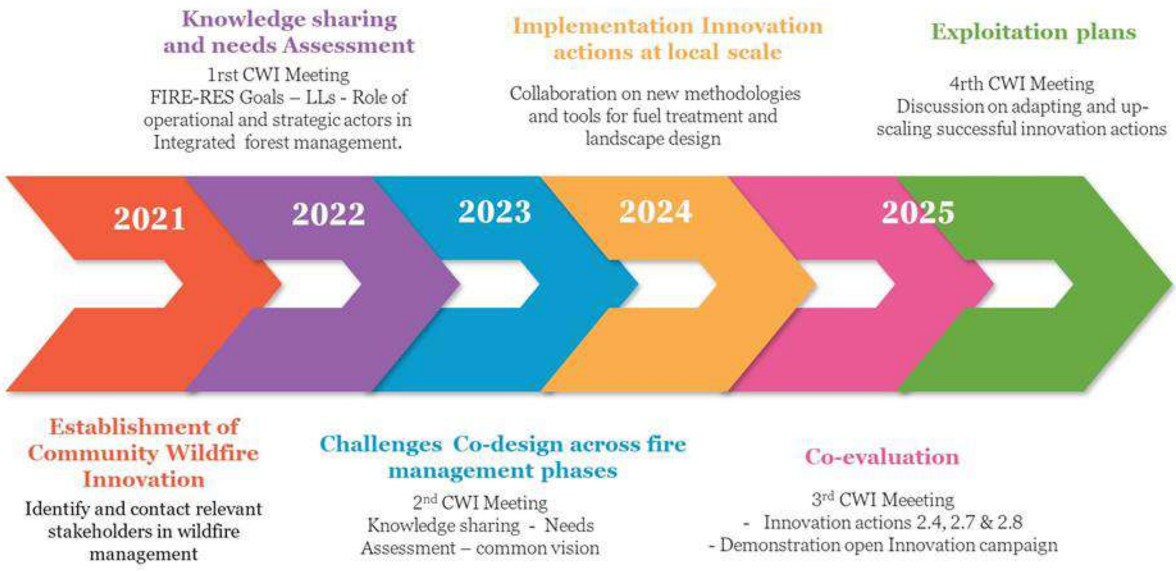

Figure 65: Roadmap of the Greek LL – From stakeholder engagement to innovation adoption.

The first CWI (Community of Wildfire Innovation) meeting took place on Monday, October 3rd, 2022, in Thessaloniki, Greece, bringing together 23 participants, with 22% female representation. While twelve participants attended in person, eleven joined remotely via Zoom due to COVID-19 concerns and the ongoing fire season, which made physical attendance challenging for those in operational roles. The meeting began with a warm welcome from Prof. Kostas Kalabokidis, the Living Lab leader, who introduced the FIRE-RES project, its partners, and the overarching objectives and anticipated outcomes. General Coordinator of Fire Brigade Operations in Northern Greece, Lieutenant General Marios Apostolidis, also addressed the attendees, highlighting the importance of the project for his agency and its potential to strengthen their fire management mission. A round of introductions followed, giving stakeholders, as many meeting for the first time, the chance to connect and establish a basis for collaboration.

During the meeting, the UAEGEAN team firstly elaborated on the goals of the FIRE-RES project, emphasizing the importance of EWE and the need for enhanced fire resilience in Greece and across Europe. Secondly, presented the Integrated Fire Management approach and described the ongoing innovation actions taking place in the Greek Living Lab areas: Lesvos Island, Kassandra-Chalkidiki, and the Peloponnese. Lastly, further detailed the active role of stakeholders in the co-design, co-implementation, and co-evaluation of the Living Lab roadmap. The session concluded with an in-depth roundtable discussion to explore challenges across the wildfire management phases—preparedness and prevention, detection and emergency response, and post-fire restoration and adaptation. This collaborative dialogue aimed to assess the current situation, identify key factors affecting fire resilience, and lay the groundwork for a shared vision to achieve wildfire-resilient landscapes in Greece by 2030.

The 2nd CWI meeting was held on Tuesday 21 February 2023 via zoom, with some CWI members physically attending from Mytilene, Greece (audience of 15 persons). The main objective was to create a framework of challenges that are expected to be implemented in the context of an Integrated Forest Fire Management in Greece and by extension in Europe. Stakeholders engaged in a participatory process based on the Challenge Design workshop proposed by partner INESCTEC (WP6). More precisely, CWI members, separated into three groups - one for each fire management phase - have selected an issue to tackle, assessed the problem's context and causes, and evaluated potential solutions and obstacles. By identifying needs and gaps, CWI members prepared and set three main challenges, each corresponding to the phase of a fire management cycle:

- Preparedness – Prevention: "*Effective forest fuel management and treatments*"
- Detection-Response: "A more effective forest fire suppression"
- and Restoration-Adaptation: "Study and organization of post-fire rehabilitation and post-fire reconstruction of affected forest areas and settlements"

These challenges, proposed by the Greek Living Lab, were first used to create the FIRE-RES Dashboard, which displays the challenges identified by each Living Lab across Europe and Chile. They were then incorporated into the Open Innovation Campaign, inviting companies worldwide to propose innovative solutions to address the specific problems each Living Lab faces in achieving integrated forest fire management for EWE.

The 3rd CWI FIRE-RES meeting was held in Mytilene from April 28 to 30, 2025, and focused on exploring integrated strategies and innovations for enhancing fire resilience in a Mediterranean landscape like Greece. Twenty stakeholders attended the meeting and actively participated in its sections. The first day opened with key presentations on holistic wildfire governance, including (i) achievements and prospects of the FIRE-RES project in Greece, (ii) evidence-based policy planning through fuel management scenarios in the Peloponnese, Greece (IA 2.4), and (iii) the introduction of the FIRE-RES IA 2.4 webGIS platform. A field visit to the public forest of Kratigos was carried out, providing an opportunity for Greek CWI members to exchange knowledge and experiences on forest fuel management methods and scenario planning for fuel treatments. The discussion highlighted the diversity of practices applied in mainland and island regions, drawing attention to the specific challenges faced in insular areas, particularly regarding the collection and removal of pruned biomass. These differences underline the need for context-specific approaches to wildfire prevention and fuel reduction.

In-depth and extended discussion was carried out regarding the potential for upscaling and exploiting the Innovation action IA2.4 "Optimizing Landscape Configuration and Fire Management Policies to Minimize Expected Losses from Extreme Weather Events (EWE)". The usefulness of the IA2.4 tool in developing forest ecosystem management scenarios and assessing investments was highlighted, along with its value/ contribution as a supportive tool in decision-making processes with real-world applicability. Subsequently, the demonstration of innovation solution for managing EWE and especially the detection is co-evaluated with CWI. Members of the Forest Service and the Fire Brigade expressed that this innovation tool would greatly benefit from a system that can employ spatial modelling to simulate management scenarios at multiple scales, including project, forest, district, and national level. These services currently face challenges in prioritizing land management based not only on forest fuels availability but also in the area's proximity to cities, roads with high traffic, areas with high numbers of visitors and high fire intensity. The practical value of the IA2.4 tool was emphasized, particularly in supporting scenario-based forest ecosystem planning and investment assessment. This innovative tool may also be of particular interest to hotel owners, especially those with properties located within or near forested areas.

On April 29th, 2025, during the 3rd CWI meeting, an Innovation Day was held, featuring a field demonstration of the *EmberEye* innovation tool in Tsamakia Forest, located within the city of Mytilene urban area, and an afternoon workshop at the premises of the Mytilene and North Aegean Regional Fire Brigade Headquarters. The event was attended by over fifty (50) participants, including CWI members, local stakeholders, and EMODE Fire Brigade personnel (firefighting special units). Attendees had the opportunity to observe the tool in action, engage in discussions regarding its effectiveness and practical applications, and contribute to its evaluation as part of the co-assessment process. The demonstration fostered valuable feedback and strengthened collaboration between innovation developers and stakeholders/ end-users in the context of integrated wildfire management.

Figure 66: Innovation Day for Fire Detection (3rd CWI Meeting/ April 29, 2025)- Demonstration in Tsamakia Forest (left); Results and discussion at the Regional Fire Brigade Headquarters, Mytilene, Greece (right).

Next, the 4th CWI meeting was held in Athens, Greece, on May 26-27, 2025, during the WP2 "Adaptive Territorial Management" Workshop. This focused central gathering of over 40 key stakeholders aimed to assess the progress of Innovation Action (IA) 2.4 across Greece and discuss on exploitation planning for scaling its scenario-based planning approach across Europe. A keynote address by Dr. Alan Ager (a senior USDA Forest Service research scientist) explored scenario-based approaches to optimizing forest and fuel management in anticipation of future fire regimes. Case studies from the Living Labs in Greece and Portugal illustrated how innovation is being translated into real-world fire resilience actions. Topics included the use of scenario-based planning tools for fuel treatment allocation, web-based platforms for landscape-scale risk optimization, seasonal fire danger forecasts for adaptation planning, and strategies for post-fire restoration and community engagement. This meeting gathered representatives from the Centre for Security Studies (KEMEA) of the Hellenic Ministry of Citizen Protection, Civil Protection agencies, Hellenic Forest Service, Ministry of Climate Crisis and Civil Protection, the Fire Brigade Headquarters - Forest Protection Directorate, and private forest companies to exchange knowledge and best practices for the development of landscapes resistant to forest fires.

Figure 67: WP2 "Adaptive Territorial Management" Workshop, May 26-27, 2025, Central Premises of the National Observatory of Athens, Thissio,Athens, Greece.

During the 4th CWI meeting, it was noted that the challenges initially proposed by the 2nd CWI 2024 meeting on "Effective Forest Fuel Management and Treatments", as part of the prevention and preparedness phase, have been largely addressed through our IA 2.4. Participants discussed the potential for national adoption of IA 2.4 to enhance integrated forest fire management (IFM) in WUI areas. Presenters highlighted the value of a platform capable of prioritizing fuel treatments at a local scale so as public investment can be guided in wildfire resilience at national level. Furthermore, CWI members highlighted the importance of extending the application of IA 2.4 to support more effective forest fire suppression strategies, another challenge raised during our 2nd CWI meeting in 2024. By providing timely, data-driven insights into fuel distribution, access constraints, and risk hotspots, the scheme can help firefighting teams plan, optimize resource deployment, and improve operational coordination during emergencies.

Building on the momentum and shared vision established during the 4th CWI meeting, the FIRE-RES project was further elevated at a major high-level dissemination event held on

July 1st, 2025, at the Greek Prime Ministry. During this occasion, the UAEGEAN team was invited to present the FIRE-RES project outcomes at the Office of the Minister of State, within the Department for the Coordination of Government Policy. The meeting marked a critical milestone in national policy engagement. The goal of the meeting was for the Government officials to understand how our project can improve the prevention and management of wildfires in Greece. We emphasized the need to accept a scenario planning framework at central level to help allocate funding and choose the locations of future fuel treatment projects, similarly to the work performed in IA 2.4. The team highlighted IA 2.4 as a powerful decision-support tool and emphasized its potential to shape data-driven planning, enable targeted interventions, and inform legislative reforms. Discussions focused on the institutional adoption of scenario planning as a formal component of Greece’s wildfire governance framework. In addition, we discussed potential legislation changes and agreed on the need to legalize prescribed burning to achieve the national fuel management goals set. This series of events significantly advanced the integration of FIRE-RES innovations into the national policy dialogue, reinforcing the project’s role in shaping long-term wildfire resilience strategies.

10.4.2. The IA demonstration results at LL level

IA1.3 Early-warning indicators of EWEs

Accurate and timely warnings are essential to prevent and mitigate the impacts of EWE. In IA1.3 we used advanced probabilistic modelling to forecast the daily occurrence of EWEs at an 8 km resolution across Europe up to 9 days in advance. Our model significantly improved the current estimation of EWE probability while providing key insights into the environmental and climatic drivers of EWEs. Compared to the Fire Weather Index (FWI), our model increased precision by a factor 5 for EWE predictions at the NUTS3 level and by a factor of 10 at 8km resolution. To assess further assess it operational relevance, we evaluated the model’s forecasting skill in a test area. Our results demonstrate that EWE forecasts up to nine days in advance outperformed FWI- based nowcasts, emphasizing the model’s potential for operational use and its superiority in anticipating EWEs compared to current fire danger rating systems

IA2.1 Data acquisition for landscape design

Methods for a near-real-time updating of remote sensing-based fuel and vegetation maps have been the topic of subtask 2.1.1. The transferability of models developed using Sentinel-2 imagery in the Norway-Sweden Living Lab was tested in Lesvos. A ResNet convolutional neural network, trained to classify dead trees due to bark beetle infestations, was applied, aiming to detect *Dendroctonus micans* and *Tomicus piniperda* attacks. The evaluation was conducted using a shapefile provided by the Greek LL. An XGBoost model for detecting harvested forest areas was also tested and evaluated, comparing its results against the Global Forest Watch (GFW) tree cover loss data for 2023 and 2024.

The models showed limited performance when applied directly to Lesvos. The ResNet did not detect all beetle-affected areas in the shapefile, but it identified other regions with visible tree mortality (confirmed via Google Maps). The XGBoost model showed weak results, overpredicting harvested areas compared to GFW. Both models would benefit significantly from fine-tuning and calibration using local data.

The results and lessons learned from the application of subtask 2.1.1 will be further documented in D2.10 to be finalized in October 2025 (M47).

IA2.4 Landscape and fire management policies to minimize expected losses - Component 1 (Peloponnese Fuel Treatment Study)

The wildfire fuel treatment analysis for the Living Lab in Greece focused on the Peloponnese region, covering 600,000 hectares eligible for intervention. The study evaluated the effectiveness of spatially optimized fuel treatment plans against conventional allocation methods (random or proximity-to-road), across eight management objectives, including community and protected area fire risk reduction, biomass and carbon conservation, ignition probability reduction, and hazard mitigation. Initial findings (SET0) confirmed that optimized spatial allocation significantly outperformed traditional methods. For example, optimization achieved 21% attainment for protected area exposure sources and 13% for community exposure sources, compared to only 3–4% under conventional strategies. In the 10-year implementation plan (SET1), three focused scenarios were developed. The plan targeting community exposure sources reduction (178,000 ha) reached 17% attainment by year ten, with strong gains in protected areas exposure (20%) and moderate progress in biomass, carbon (~12% each), and hazard reduction (7%). For protected areas exposure sources (57,700 ha), attainment peaked at 21% by year ten, while other objectives lagged (<11%). The ignition probability plan (282,000 ha) achieved a 12% final attainment, though it also significantly advanced community and protected area objectives, showing interlinked benefits. An equity-based approach (SET2) distributed treatment evenly across forest service districts but yielded lower attainments: up to 10% for community exposure and 12% for protected areas. Objectives like biomass, carbon, and ignition probability remained under 6%, showing inefficiency in uniform allocation. Trade-off analyses (SET3) revealed that spatial optimization can balance multiple objectives but not without compromises. Community exposure sources vs. biomass and sinks showed clear trade-offs, while community exposure vs. protected area sources and protected areas sources vs. sinks had minor or no trade-offs.

IA2.4 Landscape and fire management policies to minimize expected losses - Component 2 (Lesvos Island)

This study focuses on three adjacent managed forests in southern Lesvos Island—Agiasos, Ampeliko, and Vasilika—dominated by *Pinus brutia* and representing key areas for biomass estimation and fire risk management. These forests vary in size, structure: Agiasos (3,178 ha, 66 stands), Vasilika (2,132 ha, 29 stands), and Ampeliko (808 ha, 12 stands). The stands range in age from seedlings to over 100 years old and are managed under forest plans emphasizing selective thinning (5–30%). Forest roads, streams, and ridges helped define stand boundaries. Forest inventory involved plot-based data collection and canopy metrics derived from Sentinel-2 and Copernicus data. Thinning practices were adapted to local stand structure, with intensive thinning in areas dominated by large trees and selective thinning elsewhere. Fire risk assessment integrated FSim and XFire simulation tools, combining ignition probability, flammability, and fire spread. A Mixed-Integer Linear Programming (MILP) optimization was used to select thinning strategies for 2025. Two approaches were tested: one constrained to thinning no more than 10% of the total area (allowing fractional thinning per plot), and one selecting 11 full plots prioritized by thinning year. Both approaches achieved comparable reductions in fire risk (0.3105 and 0.3087 average fire risk, respectively), with overlapping high-risk plots identified. The binary (11-plot) method offers better operational feasibility, while the 10% approach offers finer spatial targeting. The model supports informed, spatially explicit decisions for wildfire mitigation through thinning.

IA2.7 Landscape design strategies (Kassandra)

Forest growth and management impacts were assessed in the Kassandra municipality (33 000 ha), focusing on key ecosystem services such as timber and mushroom yield, carbon storage, scenic quality, and reduced wildfire vulnerability. The impact of two scenarios—corresponding to Scenarios 1 and 2 defined for Soriguera — was evaluated: the first involved optimization of forest management without restrictions, being focused on maximizing the combined yield of weighted services. The second scenario considered the allocation of firebreaks by local stakeholders to mitigate fire spread, while the rest of the management alternatives, on non-fuel break areas aimed at maximizing the yield of ecosystem services. Scenario 1 emphasizes biomass accumulation and mushrooms production, increasing the amount of standing biomass through less intensive forest management, but aiming at maximizing those goals had a negative impact on fire risk and increased management cost. Scenario 2 enhances fire resilience and economics at the expense of some ecosystem services. Further evaluation of Ess weight on the planning problem should be evaluated to reach a consensus plan. Still, it is clear that considering goals that cause an accumulation of biomass on the landscape, have to be carefully considered on areas where the risk of fire is an issue.

IA2.8 Environmental Services trade-off assessment (Kassandra)

Forest growth and yield simulations were completed for a forest landscape in Kassandra, encompassing 393 management units. Management prescriptions were defined based on local practices and were evaluated for key ecosystem services: timber and mushroom production, carbon storage, scenic quality, and wildfire vulnerability reduction. Data preparation is finalized, and the development of the Pareto frontier-based trade-off analysis is in progress. A stakeholder consultation (with CWI) was also held to gather opinions on fuel treatment intensity and spatial configuration. These insights will be incorporated into the final formulation of the optimization model.

IA5.6 High Altitude Pseudo Satellites (HAPS)

In the HAPS simulation, Greece's HAPS deployment involves two units in May and June, escalating to four units from July through September. In addition, there were up to 2 HAPS at Pan-European level to cover the peaks in the Southern Living Labs. This strategy successfully ensures that 97.4% of the burnt area is monitored and that HAPS arrival times remain a bit over 3 hours. The average burnt area of unmonitored fires was above 100 ha in both July and September. This challenge is primarily due to a few very large and fast-burning fires that, despite HAPS allocation, burn out before the platforms can arrive and initiate monitoring.

IA5.10 Pan-European system to define management priorities

The innovation action "Pan-European System to Define Management Priorities for Mitigating Fire Impact" aimed to design a prototype system for identifying strategic fuel management priorities based on multiple criteria.

To develop this system, we began by defining a set of relevant criteria and assessing the need to model and map these variables. Among the most critical variables were fuel accumulation and potential fire behaviour, which, at the start of the project, were not adequately covered by existing information. During the initial years, the University of Padova mapped all fuel-related variables necessary to estimate fuel accumulation and simulate fire behaviour. This effort resulted in four scientific articles and the development of a server where the information is publicly available for download (https://www.cirgeo.unipd.it/fire-res/app/). Technosylva used this data to simulate high-intensity fire behaviour across the EU. Simultaneously, ISCI developed a multi-criteria decision support system calibrated to the generated data. This system can assign priority scores once the data is harmonized, and criteria are weighted accordingly. Currently, a strategic prioritization exercise is underway for the Iberian Peninsula, demonstrating the supranational capacity of this analysis and illustrating how large-scale, policy-oriented frameworks are most suited for this system. After the Iberian exercise is completed, the multi-criteria system, programmed as a QGIS plugin, will be publicly available.

Looking ahead, we plan to develop a dedicated server where users can easily download relevant data for such analyses. This platform will also store new data, especially concerning values and risk assessments, alongside existing datasets.

10.4.3. Next steps until 2030

The exploitation's strategic goal is to integrate scenario-based planning into landscape-level resilience planning and wildfire prevention for Greece and contribute to broader EU-level standardization by 2030. Figure 66 shows the strategic priorities that need to be followed to reach the main objective of exploitation plan.