



## Fires in natural systems and their impact on the environment in Albania

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### ABSTRACT

In recent years, globally, there has been an increase in the number of fires and the destruction of nature with environmental, social, and economic impacts. Even in Albania, fires are intense and widespread, threatening residential areas, life safety, property, natural and environmental ecosystems, etc. Fires endanger natural resources, forests, pastures, and agricultural lands, destruction of nature, biodiversity, landscape, flora, and fauna, and worsen the physical, chemical, and biological qualities of the soil and air due to the discharge of carbon and harmful chemicals formed during burning, intensification of erosion, etc. However, public awareness remains at a low level and fires are a repeated phenomenon. Therefore, the objective of this paper is to evaluate the environmental impacts caused by fires, the dimensions of the spread, the consequences, the prevention measures, and the necessary legal, administrative, and technical improvements. The frequency of fires in recent years has been developing at a high rate. In 2021, 329 fires were recorded, burning a total of 31,275 ha of land, in addition to other affected areas. Studies show that about 84% of fire events in Albanian forests in 2021 were caused by anthropogenic factors. Extinguishing the fires was difficult due to the mountainous terrain on  $\frac{3}{4}$  of the surface, the type of vegetation, high slope, high temperature, and low rainfall during the summer, as well as the lack of tools. In the general area of the territory of 2,874,800 ha, natural systems (forests and pastures) and agricultural systems, which are endangered by fires, occupy about 80% of the surface. Exactly, for these reasons, the main alternative in the country remains the planning and implementation of fire prevention measures. The impact of climate change on weather conditions, towards repeated heat and droughts, contributes to favoring the spread of massive fires.

Keywords: fire intensity; climate change; soil regeneration; vegetation; erosion.

### INTRODUCTION

Global warming and climate change also come from forest fires (Steininger et al., 2020). Statistics show that the causes of forest fires in Europe are caused by humans; the Mediterranean region accounts for 95% of the world's human-caused fires (Leone et al., 2009). "Natural causes" represent a small percentage of fires in some European countries (Pausas and Vallejo, 1999). On the Mediterranean coast, more than 300 thousand km<sup>2</sup> are subject to desertification, due to burning by fires. In

2021, the largest fire in the history of California destroyed 1300 km<sup>2</sup> of burnt land. Temperatures in Turkey and Cyprus were over 50 °C and in Greece 45 °C, which is a strong signal of climate change and the increase in the release of soil carbon into the atmosphere during burning. The increase in temperatures is expected to increase the number of fires (Foldi, 2009) and their seasonal extension, increase evaporation, decrease soil moisture, increase the likelihood of large fires (Stavros et al., 2014). In the Alpine region, they can lead to heat waves and droughts

that affect the drying of vegetation, changes in human settlements and recreational activities (Müller et al., 2020a; Zscheischler et al., 2018). According to (EFFIS Report, 2020), Romania was the most affected country, followed by Portugal, Spain and Italy, and in EU countries about 340,000 ha have been burned. Uncontrolled forest fires can cause soil erosion, release greenhouse gases into the atmosphere, destroy forest habitats and reduce biodiversity (Palliser, 2012). Albania is affected by climate change and land desertification. Recently, forest fires in Albania have increased in number and intensity (Nikolav and Nemeth, 2015).

In the period 2007-2022, the burnt surfaces in Albania mark 356915 ha of forest land. Due to increased human activity and proximity to forests, these areas experience an increased probability of forest fires occurring (Modugno et al., 2016). The occurrence of fires can disturb and strongly change the structures and functional processes of forest ecosystems (Nagy, 2008). Fire has been the main means of forest clearance for agriculture and livestock (Rius et al., 2009). Forest fires have negative environmental, economic and health effects that experts believe will worsen if decision-making bodies do not take proactive measures to prevent them. Studies predict that these factors will continue to increase the risk and frequency of forest fires in the future (Worldbank, 2011). There are different ways to measure economic impact (Gould et al., 2009; Restas, 2014), however measuring environmental health impact is difficult. The environmental impact of forest fires can be categorized in many ways. The increase in the frequency and intensity of forest fires is the process of “global climate

change” (Abu-Zreig et al., 2003).

The decrease in rainfall creates a lack of moisture in the environment and the desertification of the land, a phenomenon in which Albania is included in  $\frac{3}{4}$  of the territory's surface, drying the vegetation and making it more flammable. The removal or reduction of agricultural land cover as a result of wildfires requires significant consideration for watershed maintenance and function, and biological function. Vegetation management techniques that change the physical characteristics of the soil affect hydrological functions and soil productivity (Neary, 1996). Agroforestry offers proven strategies for carbon sequestration, soil enrichment, biodiversity conservation, and air and water quality improvement for not only the landowners or farmers but also for society at large (Jose, 2009). In the total absence of irrigation and precipitation, agricultural production can be destroyed impacting soil degradation and erosion (Kucaj, 2022).

Albania is at high and continuous risk of forest fires, especially in the dry summer season June-September. More than 95% of fire events are small (less than 100 ha burned) and account for more than 40% of the total area burned, while large events are relatively rare. Albania is characterized by the difficulty in extinguishing fire.

The technology and equipment for tracking and extinguishing fires has been slow to develop, which, together with the difficult terrain in  $\frac{3}{4}$  of the territory such as mountains, hills, makes it very dangerous to try to extinguish the fire in many areas. In addition, the level of awareness of the population is low in terms of contributing to the prevention and extinguishing of fires.

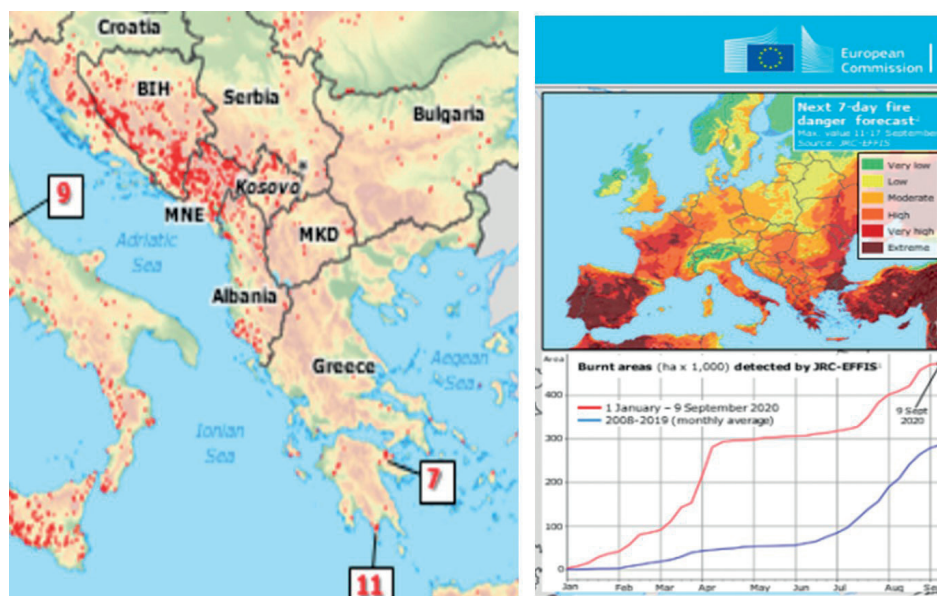


Figure 1. EFFIS forest fire from 1 January 11 September 2020 (EFFIS Portal, 2020).

## MATERIALS AND METHODS

In this study, the dynamics of fires, their intensity and extent in natural systems (forests and pastures), in agricultural lands in Albania, the causes of fires and the economic, social and environmental consequences were dealt with.

The methodology followed in this study was carried out with the annual and multi-year data reflected by INSTAT and EFFIS institutions for the period 2007-2020, in Albania, Figure 1. Observations and measurements were carried out in the field for indicators and the degree of damage to plant cover, variety and biodiversity with the help of topographic maps and satellite images.

Also, an in-depth analysis of the territory and the consequences of the fires, through field measurements and laboratory analysis of the soil in the Orikum Administrative Unit, Vlora Municipality, has been done. Quantitative and qualitative data collected in the field evaluate the consequences of fires in the loss of biodiversity, landscape, burning of organic matter, soil microflora, soil erosion, typologies of fires and seasonality. Data have been collected on the reduction of carbon accumulation capacity calculated for burned surfaces, the impact of the form of forest-pasture property on the engagement of communities in the prevention and extinguishing of fires, the impact of changes in critical climatic and weather conditions. Literature review on the causes, models and impacts of forest fires, focusing on the importance of environmental, economic and social impacts in Albania.

The last seasons of fires in Albania, mainly during the years 2007, 2011, 2012, 2017, 2021 and 2022 were some of the most destructive seasons of fires in all forms such as “normal fire” and “massive fire” that takes place on the surface and volume significant and “large-scale fire” for which the participation of services or other operating structures is also required, as happened in Albania in 2021 with support from EU countries. The monthly climatic bulletin of Albania (IGEO, 2021) was used to evaluate the meteorological conditions in Albania.

## RESULTS

In Albania, from monitoring at 11 meteorological stations in the country in 2020, the average annual temperature is 2.8 degrees higher, and the rainfall is 300 mm less than the long-term average of 1961-1990. In Albania, in the May-September period, only 18-20% of the annual rainfall falls, which negatively affects the rainfall and extinguishing of fires.

This further increases the risks and the need for fire protection measures. Average snowfall depth in mountainous areas is 60-120 cm, with the highest snowfall reaching 2-3 m depth in Vermosh, Boga, Theth,

Valbona, Curraj and Lure. In the West Plains lowlands to the southwestern coast, snow is rare (CCKP, 2020; Rep. A, 2026).

In the period July - August 2019, the average maximum temperature values in the Orikum area were 29.3 °C and 31.7 °C, while in July - August 2020, they were 30.9 °C and 31.4 °C, favoring the intensity of fires in the area.

The average rainfall for August 2019 resulted in 8.7 mm of rain, in July 2019 there was a lack of rainfall. The average rainfall for the period of August 2020 was 27.9 mm, while there was no rainfall in July 2020, which has a negative effect on extinguishing fires. The average maximum temperature values in the area of Orikum, July-August 2021 were 32.1 °C and 33.3 °C. The rains in this period have been absent, favoring conditions suitable for fires.

Based on (National forest inventory, 2021), the forest fund covers 41% of the surface of the country's general territory, 15% pastures and 24% agricultural systems, these systems predisposed to fires, due to the promotion of human factors, terrain and meteorological conditions. 18.5% of the territory, mainly forests, have been declared “Protected Areas”, endangered by fires around.

In the tourist area in the south of the country (Vlore, Orikum, Himare, Sarande) in the period July-August, 2021, as a result of atmospheric pollution from fires, foreign tourists left and local residents moved, Figure 2. A factor in the increase of forest fires also affects the ownership status. At the national level, only 1.8% of the forest area and 4% of the pasture area are private property, 74% and 75% property of the Municipalities respectively, and 16.6-15% state property. Communities become disinterested in these conditions. Therefore, there is a need for cooperation between all actors and the implementation of instruments for the benefit of the community from the resources administered by the municipality.

### The impact of forest fires and the surrounding environment

Forest fire prevention is one of the most important tasks of today, as well as public awareness. When fires are intentional by people, it is important to increase the knowledge of the public, experts, administrative institutions of protected areas on the characteristics and composition of forest types, ecosystems, characteristics, and intensity of fires, as well as technical information on the properties of fires in forest. Also, to know their effects on different elements of the environment and the preparation of the infrastructure for the prevention and extinguishing of fires.

Forests in Albania, according to types, in 91% of their total area are dominated by deciduous and coniferous trees (pine and fir). Coniferous species and shrubs are predisposed to fires, rapid burning, intense spread, and



Figure 2. Forest fires (Tragjas, Vlore) fueled by north-south winds, 2021. Source authors.

difficulties in extinguishing, especially pine (*pinus nigra*). The height above sea level, slope, plant cover and mountainous terrain make the territory of Albania vulnerable to fires and the difficulty of extinguishing them. Specifically, the belt of pine and beech forests lie at an altitude of 1000-1600 m above sea level, where firefighting equipment cannot circulate. The summer pastures, which occupy 85% of the total surface, are located at an altitude of 1600-2700 m above sea level, the target land for fires by shepherds.

In the case of a fire, we say that a considerable number of animals cannot escape, their shelters and food sources are destroyed. This pushes the local fauna to migrate.

Due to the destroyed vegetation and degraded fauna, the balance of the microenvironment is disturbed and the local natural environment changes (Moser et al., 1990). Karaburun Peninsula, with protection status “Managed Nature Reserves” category IV, with an area of 20 thousand ha. Through intentional arson by shepherds in

103 fires during the month of July, Figure 3, was burned about 75-80% of the ground cover, 50 types of medicinal plants, of the rich biodiversity of the flora, which with the surrounding areas represents 42% of the types of tall plants. About 21% of rare plant species at the national level, burning or migrating fauna (wild boar, toad, wolf, wild goat, weasel, fox, rabbit, etc.) as well as 45-50 species of wild birds, Figure 4.

In the year 2021 in Albania, from the burning of over 30 thousand hectares of forests, pastures, bushes and agricultural land, Figure 5, in addition to the destruction of nature, it is calculated that the ability to accumulate carbon from the atmosphere by trees is missing for about 100 thousand tons, causing impacts on air pollution and climate change (Lushaj et al., 2021).

#### Fire dynamics and burning intensity

The territory of Albania is organized with natural systems differentiated on the surface and types of



Figure 3. In the area of Karaburun, 103 fires and burned surfaces in 2007.

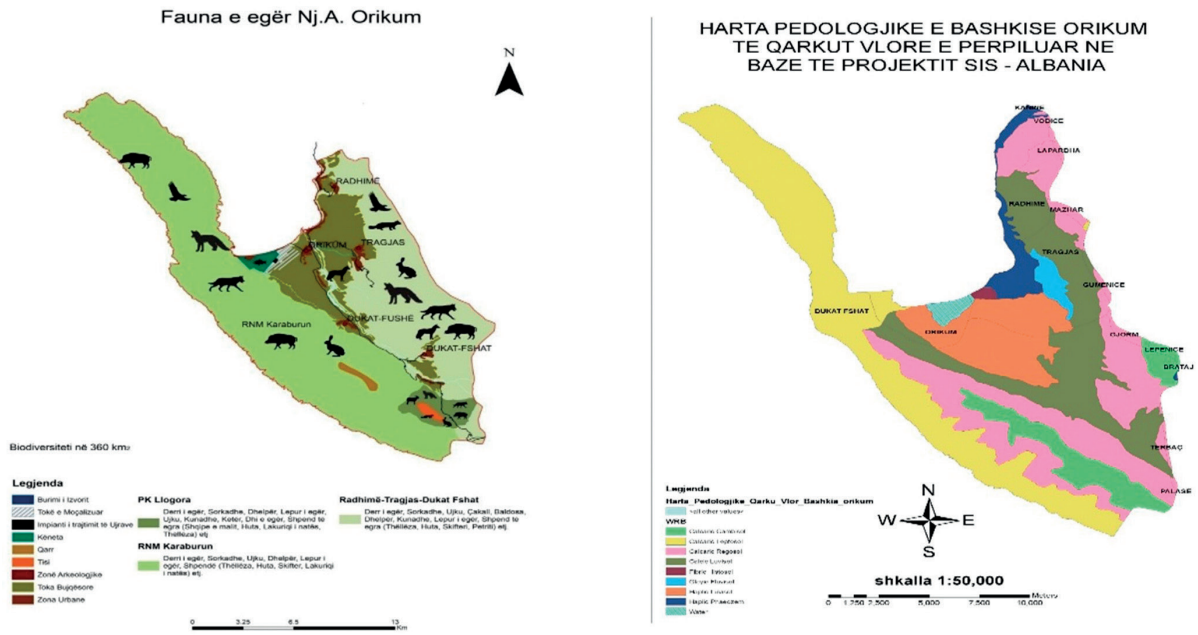


Figure 4. Pedological map and wild fauna of Orikum Municipality, Vlore District.

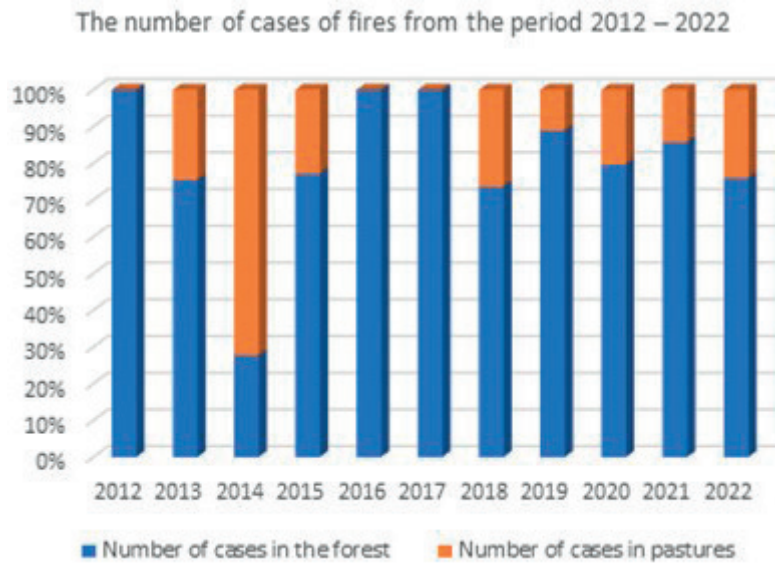


Figure 5. The number of cases of forest fires from the period 2012-2021 (INSTAT, 2022).

vegetation. The intensity and duration of forest fires also depends on the average volume per ha in the forests of Albania 109 m<sup>3</sup>/ha and bushes 20.68 m<sup>3</sup>/ha, but with volume extremes between areas and plots (National forest inventory, 2021). According to (INSTAS, 2021), 329 fires have been recorded, burning a total of 31,275 ha of forest and agricultural land, in addition to the fires spread throughout the country.

From the comparison of the data from (EFFIS 2020) it shows that the burnt area in Albania was significantly higher than in recent years and the intense seasonality in the summer months. Almost 329 fires were recorded, burning a total of 31 275 ha (35% of the forest), of which 90% of the surface in July and August. Have been detected 8 fires with a surface area of over 500 ha, the largest of which occurred in the province of Korça at the end of July

and covered over 5,000 ha. About one-third of all burned area occurred on forest lands (Table 1).

Dangers from fires in the territory of Albania are not absent from neighboring countries such as Greece, North Macedonia, Kosovo and Montenegro in the border areas, Figure 6. This dictates the need for a more sustainable cross-border cooperation in the function of joint measures in the prevention and extinguishing of fires. In the summer of 2021, in Albania, EU countries helped with 4 planes to extinguish fires in difficult areas, near protected areas and endangered residential centers.

Data from (EFFIS, 2021) show that in Albania, 84% of forest fires in 2021 were caused by anthropogenic factors. While the other cases, from electric power lines, from lightning strikes, such as at the height of the Cike mountain, 2300 m high, Figure 6. According to Global Forest Watch, Albania lost 1.68 ha of natural forest in 2021. The peak of fires in Albania usually starts at the end of June and lasts until October, but the number and the largest area are July-August. From (Global Forest Watch, 2021), Albania lost 17.9% of Broadleaf Forest and 19.6% of other natural land.

The year with the greatest loss of plant cover due to fires during this period was 2007 with 3.43 ha from fires, or 66% of all plant cover loss for that year.

In the same period (2001-2021), Shkodra District with the largest area of forests had the highest rate of plant cover loss due to fires with an average of 158 ha lost per year, Korca District with 154 ha, Dibra with 114 ha, Lezha 108 ha and Vlora with an average of 92 ha/year. Fires were responsible for 42% of the vegetation cover loss in Albania.

### The consequences of fire in the loss of biodiversity

According to Bronick, 2005, the heat generated by the fire kills the beneficial microorganisms in the surface layer of the soil and the regeneration of the vegetation is delayed. Soil erosion accelerates due to partially or destroyed vegetation; the top layer of soil fertility can disappear. While according to Kaiser, 1999, under the presence of ash created by fire, the soil can be washed by rains from the surface to the depth making the soil alkaline which leads to the disappearance of plants that cannot tolerate alkalinity.

Albanian nature has a rich biodiversity with 3250 tall plants, 252 species of medicinal plants, 350 species of trees and forest shrubs, 15% of the Albanian flora are of Balkan character, 24% of Mediterranean character, 18% species of European character, 50 species endemic and subendemic, rare and endangered species, diversity of fauna: 370 wild birds, over 70 mammals, etc. About 60% of the country's territory in dry areas and low hydric system, the regeneration of biomass and biodiversity of species after fires is developed at a low level. Fires also damage the seeds for new germination.

From the study carried out in the Orikum Administrative Unit with an area of 360 km<sup>2</sup>, with vegetation located in four phytosanitary zones up to 2300 m high, with a rich biodiversity of 1400 species of tall plants, which make up 42% of the country's flora, fires are frequent. The loss of the vegetative cover exposes the soil to strong erosion 2-3 times higher, and in forest soils with high slopes, after burning it is exposed to more than 80 tons/ha. In 2007, only one month after the burning of the Karaburun Peninsula, through calculation using the USLE method, the loss of soil from erosion was 12 tons/ha (Lushaj, Muharremaj).

Table 1. Distribution of burnt area (ha) in Albania by land cover types in 2021.

No.	Distribution of burnt	Area (ha)	Area (%)
1	Broadleaf forest	5610	17.9
2	Coniferous forest	2018	6.5
3	Mixed forest	2372	7.6
4	Transitional	6883	22.0
5	Sclerophyllous vegetation	6275	20.1
6	Other Natural Land	6118	19.6
7	Agricultural	1972	6.3
8	Artificial Surfaces	9	0.0
9	Other Land Cover	18	0.1
	Total	31275	100



Figure 6. Burnt area scars in the Balkans in 2021. Largest fires are indicated in ha. AL=Albania.

From the observations and measurements in the burned areas in 2017, in addition to the loss of plant cover (Kučaj, 2022), five years later, morphological, biodiversity and species changes can be seen in the forests, in favor of deciduous trees (Hysolako and Lushaj, 2022).

#### DISCUSSIONS AND CONCLUSION

Intensive fire and land degradation can have a significant effect on climate because of the influence on the amount of carbon stored and released into the atmosphere (Michelesen et al., 2004). Lalet and al. (1999) estimate an average reduction in the soil organic carbon pool by 8-12-ton carbon/ha in the arid regions due to land degradation / ha (Sivakumar, 2007).

What about agricultural lands in Albania? Fires have become a tradition for clearing the land for cultivation and second planting. The damages are long-term and in some cases irreversible. The need for investments to return the land to its previous state also increases.

After burning, the biological activity of the soil, fertility and agricultural production decreases significantly, losing an average of 30-35 kg of nutrients N, P, K per year. In a soil monitored in Vlora in 2004, in the 0-7 cm layer before burning, with a content of 14.2 million microbial cells per gram/soil, and a test 40 days after burning, it resulted in 1.4 million cells and a significant reduction of the humus layer by 1.3 cm (Mani et al., 2004), Figure 7. In the absence of biomass, steep agricultural soils suffer the consequences of erosion, soil compaction is caused, porosity and aeration decrease, structural aggregates are dispersed by heat, organic matter, humus and soil moisture are reduced. The burning of agricultural lands is also encouraged by the lack of legislation.

#### Legislation for fire protection and the need for improvement

In the last 30 years, progress has been made in the drafting of legislation in Albania. Law no. 152/2015 “On fire protection and rescue service” in the country has a low implementation due to public awareness, insufficient management capacities, weak infrastructure for preventing and extinguishing fires, ownership conflicts, etc.

Even in Law no. 7895, dated 27.1.1995 “Penal Code of the Republic of Albania” amended for illegal fires, with serious consequences for the environment, for property and human health, constitute an environmental crime.

While in Article 206/b “Negligent destruction of forests by fire” under (i) damage to forests is punished with imprisonment.

Albania has also supported the Sendai Framework, 69/283, for disaster risk reduction worldwide for the period 2015-2030.

In Albania, there is no legislation for the protection of agricultural lands from fires. An initiative has recently been taken to draft legislation for the protection of agricultural lands from fires and the prohibition of the burning of plant residues and any other material that causes the spread of fires.

#### RECOMMENDATIONS

1. In the conditions of low awareness of communities in the prevention of fires, it is necessary to develop a nationwide campaign for public education and sensitization of communities and the drafting of engagement plans in the territory of each municipality of the country.

2. The main alternative of fire protection remains the planning and implementation of preventive measures. This dictates the need to study and create a database for each



Figure 7. The burning of agricultural land in Vlore and the loss of plant cover of the shores of the Ionian sea (Karaburun).

Municipality, based on the local study of the terrain, etc.

3. The municipalities of the country should integrate into their General Local Plan (drawn up for a period of 15 years) the strategy and projects for the prevention and protection from fires in their territory.

4. In the conditions of the mountainous terrain, where 62% of the surface of forests as ecosystems that are more affected by fires, are placed on land with a slope of 41-85%, with very limited circulation of vehicles. Albania needs to establish an air fleet for the rapid extinguishing of fires, the creation of a camera system in forests and massive pastures and protected areas, surveillance drones and other equipment.

5. In all plans, programs, legal aspects, in addition to the needs for the infrastructure for prevention and protection from fires, the risks arising from climate change and the requirements of the SENDAI framework should also be foreseen, for the reduction of the impacts caused by “Mass fires” and “Fires with large dimensions” in the concrete conditions of the terrain.

6. Albania needs to design a sustainable methodology for assessing fire damage not only in terms of economic losses, but in the broader sense of evaluating ecological benefits, environmental services, carbon dioxide emissions after burning and an approach with assessment of the costs of interventions for extinguishing fires and rehabilitation of burned environments.

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