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RESEARCH REPORTS

Forest Fires in Cyprus

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ABSTRACT *According to a recent report by OECD (2023) the frequency and severity of forest fires and wildfires as well as the duration of the fire season, are increasing in many regions of the world. Wildfires, forest fires for the most part, in recent years have been severely affecting the Mediterranean region during the summer period from June to August, having severe and direct effect on the environment, local economies, livelihoods and societies. A good example of this Cyprus an island state in the north east of the region. The major issues that are responsible for this is climate change, the poor management of forests and the surrounding areas and socioeconomic factors that relate to the abandonment of the rural areas. All these factors lead to the increase of the available fuel.*

Keywords: Forest fires, forest management, climate change, socioeconomic changes, Cyprus

Introduction

According to a recent report by OECD (2023) the frequency and severity of forest fires and wildfires - the terms will be used interchangeably - as well as the duration of the fire season, are increasing in many regions of the world. Wildfires, forest fires for the most part, in recent years have been severely affecting the Mediterranean region during the summer period from June to August, having severe and direct effect on the environment, local economies, livelihoods and societies. The occurrence of extreme wildfires, that are particularly severe in terms of their size, duration, intensity and impacts, is also on the rise.

Cyprus is an island member of the European Union in the south-eastern Mediterranean and it is severely affected by wild fires. The aim of this paper is to review the pertinent, recent literature (which although not exhaustive, identifies the main contributing factors) mostly in the Mediterranean region and to identify the variables that affect the rise in the number and intensity of forest fires, wildfires and how these variables are affecting Cyprus. Therefore, the research questions are:

a. How is climate change manifested in Cyprus?
b. What are the social factors which affect forest fires?
c. How is agricultural land use affecting forest fires?
d. How is the management of forests affecting forest fires?

Duane et al. (2019) pointed out that understanding the interplay between climate, fuel and fire is necessary for developing strategies that minimize the negative impacts of fire on people and ecosystems. Their research suggests that climate–fire relationships in Mediterranean landscapes are dynamic: fires create

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short-lived conditions where fuels limit future fire activity in fire regimes usually limited by weather.

Based on a report by San-Miguel-Ayanz et al. (2023) last year was the second-worst wildfire season in the European Union since 2000, when the Copernicus' European Forest Fire Information System (EFFIS) records began. The burnt area in the European Union (EU) was the second highest ever, only behind the year 2017. The area mapped in EFFIS for the EU was 837,212 ha, which corresponds to an estimated burnt area of 881,275 ha, as EFFIS maps approximately 95% of the total burnt areas reported by the countries.

As it is pointed out in Torelli et al. (2023) a severe drought is currently affecting large parts of Europe. The severity and phases of its evolution differ across different regions but southern Europe already exhibits a significant impact and is slowly moving into a drought recovery phase. Droughts have affected Cyprus through the ages and there are records and sources going back nearly 2000 years to long periods of droughts that forced people to relocate to Asia Minor, the Greek islands and mainland Greece.

Peñuelas et al. (2023) provide a concise account of the challenges faced by forests in the northern rim of the Mediterranean region especially with reference "to more frequent and prolonged droughts", not adequate management of forests and fuel and the need to have green buffer zones between the forest and the surrounding communities. The authors point out that cultivations with fruit trees form an excellent buffer zone. Alas, the authors point out to "agricultural land abandonment in the northern Mediterranean Basin".

On a further note, prickly pears or cactus form an excellent buffer zone, because of the water present in the leaves and branches, and are used traditionally in Cyprus, Malta and Greece as natural barriers between properties, and of course, as fire buffer zones.

Koulelis et al. (2023) reviewed the impact of climate change on Greek forests, analysing factors such as climate trends, forest management, biodiversity, genetics, insects, and wildfires, using data from the Scopus and Mendeley databases and official reports. They found significant long term effects including tree growth. In addition, annual burned areas from forest fires data indicate a consistent long-term increasing trend, underscoring fire prevention prioritization and exploring fire risk, behaviour, and climate change.

Mitliadou et al (2021) carried out a survey in Cyprus to assess the perceptions of the Cypriot residents about climate change and forest degradation. The results confirm the findings of other published surveys. The majority of the respondents (66%) stated that they noticed moderate to very much degradation (not clear) of Cypriot coniferous forests. A potential degradation reason referred to tree die-back, while decreased soil moisture and difficulty in regeneration was also pointed out.

Raftoyannis et al (2014) carried out a multinational survey in six Mediterranean countries survey among foresters and forest scientists to study how climate change has increased the risk of fire in Mediterranean forests. The main results of the surveys are that although country differences were observed, adaptation measures related to firefighting efficiency and public awareness were valued as more important than fuel management.

Papakosta P. and Straub D. (2016) built probabilistic daily fire prediction

models, based on Poisson regression, to predict wildfire occurrences in Cyprus. Their results point out that the influence of weather conditions on fire danger in the studied area can be expressed through the FWI component of the Canadian Forest Fire Weather Index System. However, the prediction ability of FWI alone was limited. A model that additionally includes land cover types, population density and road density was found to provide significantly improved predictions.

Methods and Materials

The aim of this paper is to review the pertinent, recent literature mostly in the Mediterranean region and identify the variables that affect the rise in the number and intensity of forest fires, wildfires and how these variables are affecting Cyprus.

The results are based on an analysis of official statistics made available by the Cyprus Statistical Service (2023) and the Department of Forests of the Republic of Cyprus (2023).

Results and Discussion

Cyprus & Climatological Data

Situated at the north-eastern end of the Mediterranean Sea, Cyprus, with an area of 9.251 square km (3.573square miles), is the third largest island of the area after Sicily and Sardinia, extending 240 km (149 miles) from east to west and 100 km (62 miles) from north to south. It has an intense Mediterranean climate with the typical seasonal rhythm strongly marked in respect of temperature, rainfall and weather generally. Hot dry summers from mid-May to mid-September and rainy, rather changeable, winters from November to mid-March are separated by short autumn and spring seasons of rapid change in weather conditions. (Statistical Service of Cyprus, 2023).

The data presented in Figure 1: Observed Average Annual Mean Temperature for Cyprus 1901 -2021 and Figure 2: Annual Rainfall points out to two very clear trends (a) the average annual mean temperature of Cyprus has increased over the past few decades by about 2oC and (b) the average annual rainfall has decreased. The average rainfall per year is 503mm but in recent years there have been more years during which the total rainfall per year is below this threshold resulting to droughts.

Historically, in Cyprus, droughts occur every two-to-three successive years, due to the decline in rainfall and, moreover, in the last fifty years, drought incidences have increased both in magnitude and frequency (Sofroniou and Bishop, 2014). In addition, other studies have shown that the available underground water is not being replenished and sea water comes through filling the existing cavities resulting in the depletion of the island's aquifer (Myronidis et al., 2018).

This year there has been another contributing factor which had to do with extensive rain during May and June throughout the Mediterranean region that produced even more fuel to burn in July and August when very high temperatures were observed.

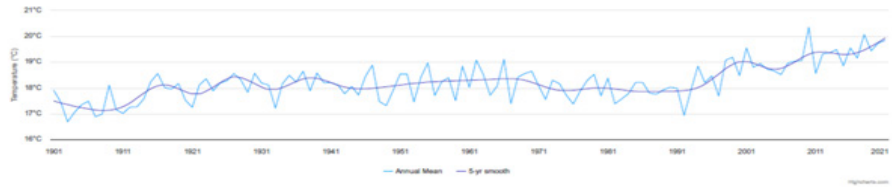

Figure 1: Observed Average Annual Mean-Temperature of Cyprus for 1901-2021.
Source: World Bank Group (ND)

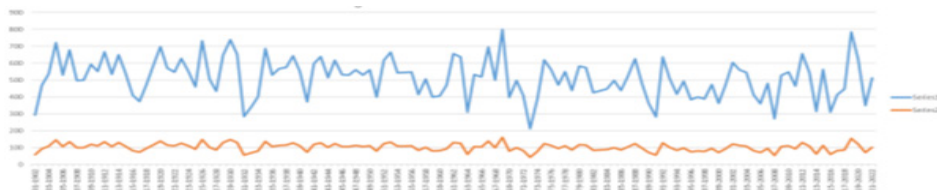

Figure 2: Annual Rainfall 1901 – 2021 (Series 1: Annual Rainfall, Series 2: % variance).
Source: Department of Meteorology (2023, August 16)

Social Data Demography

Since the establishment of the Republic of Cyprus in 1960 there has been a consistent effort on the part of successive governments to encourage the migration from the mountainous areas to the big urban areas in order to facilitate the transformation of the local economy from an agricultural economy to an industrial one. Based on the latest census of 2021 presented in Table 1: Census of Population 2011 and 2021 the total population in the government-controlled areas of Cyprus on the 1st October 2021 was 923.272 persons; an increase of 9,86% was recorded in the total population compared to the results of the 2011 Census of Population and Housing (840.407 persons).

While the overall population has grown by 9,86% over the last 10 years since the previous census, the urban areas have increased by 8,75% and the rural by 12,15%. The number of people living in villages of elevation of 500m and above has decreased by -3,92% to 28.049 people. In the Pitsilia region over 800m the percentage decline is even higher -6,52%.

Table 1
Census of Population 2011 and 2021

	2011	**2021**	**% Variance**
Total All of Cyprus	840.407	923.272	9,86
Urban	566.191	615.731	8,75
Rural	274.216	307.541	12,15
Rural Over 500m Pitsilia Region	29.194 10.231	28.049 9.564	-3,92 -6,52

Data from the 2021 Census compiled by the author
Source: Cyprus Statistical Service (2023, August 20)

Agricultural Production

As explained in the previous section, the decline in population of the mountainous areas leads to the abandonment of cultivated lands and therefore the forest areas increase and the fuel available for fires increases substantially and uncontrollably. To illustrate the point, the following excerpts from the Department of Agriculture Census of Agricultural and Livestock Production for 2020 are revealing. In the period between 2010 to 2020 a decrease was recorded in Fruit tress (29.6%), in vines (13.4%) and citrus fruits (9.0%). Fruit trees like apples, pears, nectarines, apricots etc and table and wine grapes are the main agricultural products of the Troodos region. Most of the people in the area engaged in agriculture, including the author, do so in parallel with other jobs they may have and usually the whole family is involved.

Fire Statistics

Based on the most recent data issued by the Forest Department in Cyprus for the area under the control of the Republic of Cyprus for the period 2000 – 2021 there were 1327 forest fires. Out of these there is data available about how the fire started for 1167 (88%) of them. For the other 160 (12%) there is no available data. Most fires (987 -85%) originated or can be attributed to human activity and only 180 (15%) to natural phenomena such as lighting . Out of those caused by human activity 337 (34%) were deliberate and 650 (66%) were due to negligence. Figure 3: Number of Forest Fires for the Period 2000 – 2021 and Figure 4 :Burnt Area for the Period 2000 – 2021 . Figure 5: Causes of Forest Fires 2000 – 2021 and Figure 6: Forest Fires Due to Negligence 2000 – 2021. provide and overall picture of the situation. In more recent years after 2006 the actual number of forest fires has decreased from the higher numbers in previous years. Along the same lines the area burned has decreased overall except for the years 2007 (4.483 Ha burned), 2013 (2.835 Ha burned), 2016 (3.205 Ha burned) and 2021 (6.612 Ha burned).

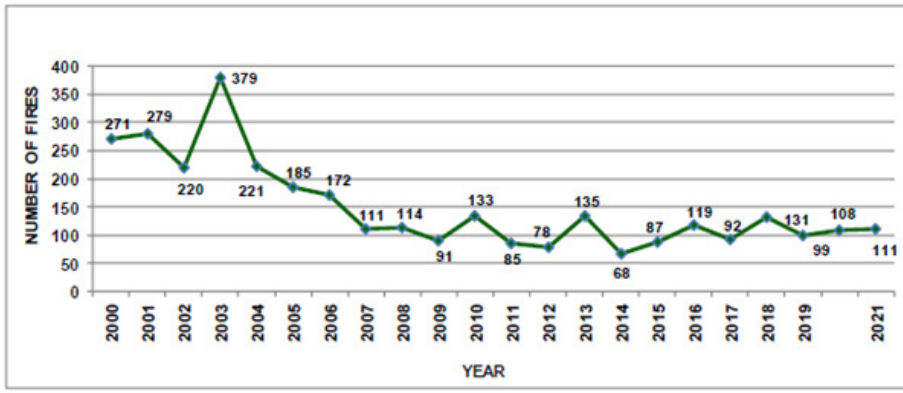

Figure 3: Number of Forest Fires for the Period 2000-2021.
Source: Forest Department (2023, August 20)

It seems that a major contributing factor 25% (337) of all forest fires are fires that are set deliberately, on purpose again this is not clear. Figure 5: Causes of Forest Fires 2000 – 2021. In Cyprus there are two groups of people that set forest fires; pyromaniacs that enjoy seeing forests being burned and shepherds who set fires at the external boundaries of forests so that there is regeneration of the area with new plants and therefore new grazelands for their livestock sheep and goats.

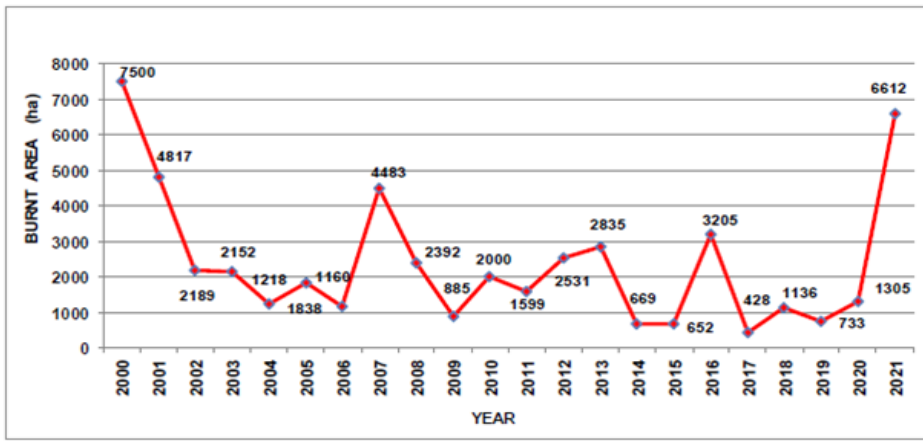

Figure 4: Burnt Area for the Period 2000-2021.
Source: Forest Department (2023, August 20)

Agricultural activities are also a major contributor (18% - 238) and have to do with two tasks. After the harvest and before the new planting, farmers have the bad habit of burning the top soil in an effort to get rid of existing parasites, pests and fungi. This method is effective but not as effective as other methods and has a high risk of fires and forest fires. The other activity that is also illegal, is the burning of discarded branches and other leftovers from pruning plants and trees in late winter and early spring.

Forest fires in Greece follow the same pattern with one additional factor that

is responsible for a number of the most extensive and destructive forest fires. In Greece there is no national land registry and, in many cases, arsonists set fires in forests around Athens and other major urban or touristic areas so that they can claim the land for development.

Experts in the field agree that the best way to control forest fires is to move very fast (within 5 -10 minutes) with a measured force to ensure that the fire does not expand beyond the control of the fire fighters. The overall command for the forest fire fighting is the Permanent Undersecretary of the Ministry of Agriculture, Rural Development and Environment and through him the Director of the Forest Department. As recorded in the local press there are still issues of coordination among the various departments involved in putting out forest fires.

More recently there has been a lot of discussion about forest fires that result from failure of high voltage electrical transformers and powerlines 3% (35). Apparently, there are old transformers that need replacement and naked powerlines without protective coating that are very dangerous if the wires touch or are bridged by birds and tree branches or other materials that are good conductors of electricity.

During the summer season the Forest Department hires seasonal forest firefighters and rents from abroad additional flying helicopters and airplanes. Overall, there are enough firefighters and planes to support the local needs. The mountainous terrain in Cyprus, and to some extend Greece, make the more flexible helicopters more effective in forest fire fighting as opposed to airplanes that are preferred in Europe. This has caused an issue because the EU provides funding for airplanes but not for helicopters. Unfortunately, neither airplanes nor helicopters can fly at night. In general, aerial support can contain fires but there is always a need for ground forces to put out fires.

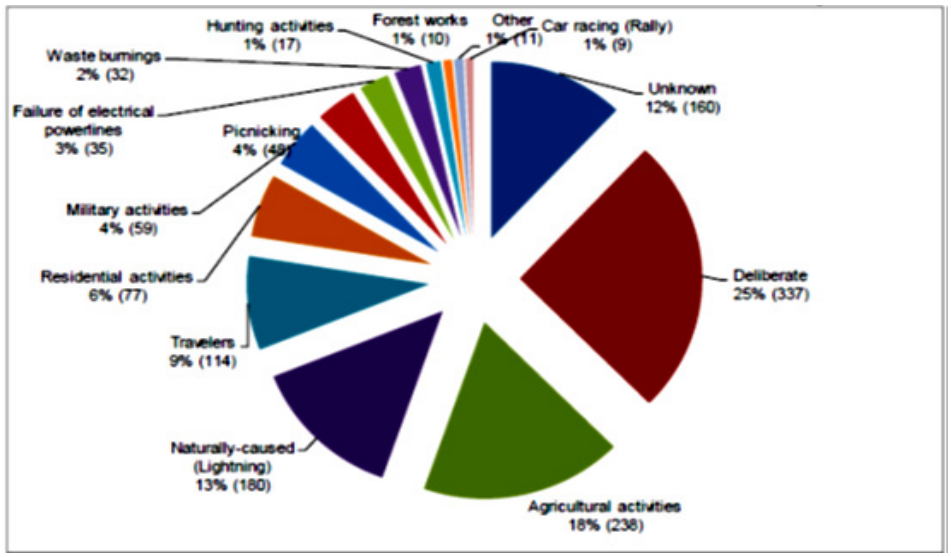

Figure 5: Causes of Forest Fires 2000 – 2021.
Source: Forest Department (2023, August 20)

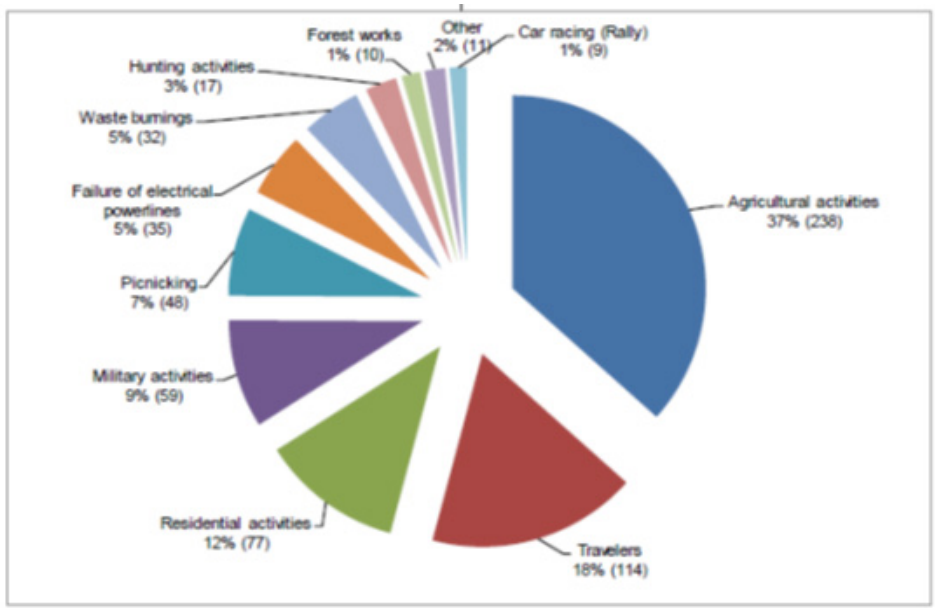

Figure 6: Forest Fires Due to Negligence 2000 – 2021.
Source: Forest Department (2023, August 20)

Another critical factor that can alter significantly the direction and strength of the forest fires is the strength and direction of the prevailing wind. In Cyprus and the rest of the Mediterranean area winds pick up during the day after midday. Usually the wind blows from west to east but on occasion there are winds from east or south east to west during the early hours of the day and in the winter from north to south. During huge fires these patterns change and the prevailing winds change direction depending on the strength of the fire and the effect it has on the climate.

Conclusion

The literature review reveals a consensus among researchers on the destructive nature of forest fires and what needs to be done to minimise their impact. These findings are reinforced by the results of the available official statistics. The main findings are:

a. climate change as expressed, mainly, through the rise of the average annual mean temperature from about 18 °C in the years before 1990 to nearly 20°C in 2021 and protracted periods of drought or low annual rainfall.
b. the change in social conditions and agricultural land use with the urbanization of people living around the forest areas has increased the land that is not managed in any meaningful way, it has increased the available fuel and decreased the available green buffer between villages and forests.
c. the conservative, outdated policies adopted by successive administrations with reference to forest management and conservation has resulted to the increase of fuel and the elimination of pathways to be used by firefighters to put out fires.

To begin with, the effort to minimise or reverse the effects of climate change should be a top priority for all governments, international organizations, businesses and people. There is a need to spend more money and resources on prevention and preparedness instead of fighting the forest fires and to carry a cost benefit analysis of the appropriate policy mix.

The Government is spending a lot of money and resources on fighting forest fires but not enough money and attention is paid on prevention and on those long-term policies that can prove game changers, From the review of the literature there are recurring policy measures that governments can take to lower the impact during the summer fires season. To begin with, it is important to manage forests in a sustainable manner. That includes building a network of roads to provide access to the firefighters, manage the available fuel with lowering the density of trees, removing excessive ground vegetation and loose branches, set up controlled fires in the perimeter of forests and rural communities to minimise the available fuel and the risk of a damaging fire. It might also include limiting access and potentially risky activities in or near the forests. "Building a green buffer" around communities may also help preserve properties and lives. A green buffer can be a cultivated area with fruit trees, olive trees or other long term plants such as grapevines and prickly pears or cactus.

The macroeconomic costs of wildfires result from a combination of the direct costs (e.g. lost and damaged assets, wildfire suppression costs, etc.) and the indirect costs (e.g. lost tax revenue, reduced property values, business interruptions, reduced productivity, recovery costs, etc.) (WFCA, 2022). There are few studies on the macroeconomic impacts of extreme wildfires, but there is growing evidence that their impact is high and likely to increase in the future. (OECD,2023)

Last but not least, there are several environmental issues that need to be addressed and could be the focus of further research efforts.

a. The impact of forest fires on the environment.
b. The time it takes to reforest, regenerate the burned area and how to go about it. It might take 30 -50 years for the forest to grow back to the level it was before the fire. The current practice is to allow the forest to grow back on its own. This practice needs to be assessed against other practices towards the same result.
c. Forest fires release vast quantities of CO2, ash and smog that negatively affect the environment and contribute to climate change. In addition, deforestation negatively impacts the absorption of CO2 and therefore it is critical to study what is the effect on the environment and quality of life.

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