

Imperial College of Science, Technology and Medicine

Centre for Environmental Policy

**Fuelling the flames -
The socio-economic and political forces driving wildfires**

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A thesis submitted for the degree of Doctor of Philosophy

06 March 2025

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Statement of originality

I hereby declare that this doctoral thesis is entirely my own work. All work done by others is fully acknowledged, cited, and referenced.

Previously published works, for which I hold the copyright, have been used throughout this thesis. The published papers which contain part of this material are:

Pirolì, E., La Mela Veca, D. S., Mistry, J., & Kountouris, Y. (2024). Understanding stakeholders' perspectives behind wildfires in Sicily: A Q-methodology approach. People and Nature. <https://doi.org/10.1002/PAN3.10729>

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Erika Pirolì

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Abstract

While numerous factors contribute to wildfires, stakeholders' interests and incentives surrounding fire use remain underexplored in the literature. This research aims to address this gap by examining the human-driven factors influencing wildfire management - not only those related to economic activities but also a broader range of human influences, from social to political. Focusing on fire-prone areas in Mediterranean Europe and the U.S., the thesis examines the complex interplay of socio-economic and political factors that may exacerbate the crisis in fire-prone regions.

A multidisciplinary approach is employed, integrating qualitative and quantitative methods to explore the roles and influences of various stakeholders in fire practices and management, with particular attention to policymakers' incentives. The selection of methods applied in the different chapters was driven by two key factors: introducing novel approaches to fire science by incorporating econometric and social science methodologies and leveraging the proven effectiveness of these methods in disciplines such as political economics. The findings highlight human-related factors across different jurisdictional levels and stakeholder groups, encompassing various market and political dimensions. When analysed together, these factors reveal a complex interplay of interests that sustain the wildfire status quo or contribute to its exacerbation.

Considering this matrix of interests, this thesis underscores the critical need for comprehensive fire management strategies that integrate ecological, political, and socio-economic considerations to mitigate wildfire risks effectively. This research also highlights the importance of decentralised governance, stakeholder and expert engagement, active citizenship, and the incorporation of local and Indigenous knowledge in fire management strategies. It advocates for policies prioritising collaboration, transparency, and promoting sustainable fire practices, moving away from one-size-fits-all approaches and addressing the unique dynamics of fire-prone ecosystems.

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about the world and myself. It gave me perspective through the frustration I felt while facing instability - moving every eight months on average - and navigating a highly competitive housing market, compounded by the cost-of-living crisis and intergenerational exploitation. That frustration fuelled my passion for research, turning it into my own little revolution. For all of it, I am truly grateful.

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“Praised be You, my Lord, through Brother Fire, through whom thou givest us light in the darkness: and it is bright and pleasant and very mighty and strong.”

(St. Francis of Assisi, Canticle of the Creatures; 1224)

“We have to get over the idea that any new technology is automatically going to make everything better. Technology is part of the solution, but it is not the whole answer. What’s required is a much deeper understanding of how the world works and how human beings relate to that.”

(Meadows D., The Limits to Growth; 1972)

“Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it’s the only thing that ever has.”

(Margaret Mead, 1901-1978)

“The way to cope with our coming fire age is, paradoxically, with more fire [...]”

(Pyne S.J., The Pyrocene; 2021)

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List of abbreviations

APZs – Asset Protection Zones

BEA – U.S. Bureau of Economic Analysis

CNVVF – National Fire Brigade (Corpo Nazionale dei Vigili del Fuoco)

DCP Sicily – Department of Civil Protection Sicily

DOS – *Direttore delle Operazioni di Spegnimento* (in English: Director of Fire Suppression Operations)

EOSDIS – Earth Observing System Data and Information System

FEMA – Federal Emergency Management Agency

FPA-FOD – Fire Program Analysis Fire-Occurrence Database

GDP – Gross Domestic Product

GMM – Generalised Method of Moments

GRAF – Group of Support to Forestry Action

HIZ – Home Ignition Zone

MODIS – Moderate Resolution Imaging Spectroradiometer

MSE – Mean Square Error

NB – Negative Binomial

NFMAS – National Fire Management Analysis System

NGO – Non-Governmental Organisation

NIFC – National Interagency Fire Center

NOAA NCEI – National Oceanic and Atmospheric Administration's National Center for Environmental Information

OLS – Ordinary Least Squares

PCA – Principal Component Analysis

Q – Q methodology

QGIS – Quantum Geographic Information System

RDD – Regression Discontinuity Design

RDE – Regional Department of Environment

RDRTD – Regional Department of Rural and Territorial Development

REDD+ – Reducing emissions from deforestation and forest degradation in developing countries

RFCS – Regional Forest Corps of Sicily

SAAF – Department of Agricultural, Food and Forestry Sciences

U.S. – United States of America

USDA-FS – U.S. Department of Agriculture Forest Service

WTP – Willingness to Pay

WUI – Wildland-Urban Interface

Chapter 1 - Introduction, theoretical framework, aims and objectives

1.1 Introduction

Fires, including forest fires and bushfires, are integral parts of many ecosystems, from the tropical to the boreal ones, providing the ecological services needed to survive and restore many plants and animals and control pests (Brandt, 2012). The term "fire regime" refers to the specific patterns of fire type, frequency, seasonality, intensity, and scale to which ecosystems have adapted and by which they are characterised (Pyne, 2001). In other words, most fires occur during a definite period of the year, and their regimes vary among ecosystems, topography, climate conditions, geographical regions, and landscape factors, such as vegetation composition or level of fuel aridity.

Most natural fires are ignited by lightning strikes (Balch et al., 2017), although other factors, such as weather conditions like drought or dry winds, underground coal fires, and volcanic activity, also play a role. Historical and environmental analyses emphasise the critical influence of climate on regional fire dynamics. Key drivers include wet periods that boost vegetation growth, as well as droughts and warming that prolong fire-prone conditions (Bowman et al., 2008). In arid regions, the combination of low precipitation, high winds, and low humidity during summer significantly increases the risk of uncontrolled fires (Dong et al., 2021). A recent example of this is the 2019–2020 Black Summer fires in Australia, which were amplified by extended drought and record-high temperatures, conditions that had already significantly degraded the resilience of the vegetation (Boer et al., 2020; Kramer et al., 2021). Climate oscillations, such as La Niña, increase fire activity in the southern United States (U.S.) and Patagonia, while El Niño exacerbates fires in tropical rainforests (Kitzberger et al., 2001; Van Der Werf et al., 2004).

Charcoal records show that fire activity tended to decrease during colder periods and increase during warmer ones, independent of human influence (Bowman et al., 2008). Fires have long influenced the development of forests, shrublands, and grasslands, helping to maintain biodiversity and support ecosystem resilience in different regions (Huggett, 2005). Pyro-diverse economies have thrived across millennia, adapting to varying climatic fluctuations (Bettinger, 2015; Denevan, 1992), with Indigenous peoples using fire to develop landscape-wide systems of resilient pyro-cultural food production. The burning practices involved informed decisions based on fuel availability, weather conditions, and landscape patterns. However, global fire levels decreased after ~1870, coinciding with agricultural intensification and widespread grazing (Marlon et al., 2008). Despite this, fire remains a vital tool in many societies today, serving a range of cultural and livelihood purposes, especially for Indigenous communities,

rural populations, and communities relying on family labour for their livelihoods. These include hunting, clearing land for rotational farming, improving livestock grazing areas, controlling pests and diseases and promoting specific plant growth, forestry, social signalling, and ritualistic practices (Brandt, 2012).

Nevertheless, in recent decades, fire regimes have changed, and the overall burned area has declined globally (Doerr & Santín, 2016; Fidelis et al., 2018). This shift is observed across diverse regions, from the Amazon to the Arctic and from tropical to boreal zones. Large and frequent uncontrolled fire events are deemed "catastrophic" because of their intensity and devastating impacts (Mallek et al., 2013; Tedim & Leone, 2020). Prominent examples include California's record-breaking 2020 fire season (Keeley & Syphard, 2021) and the surge in highly destructive, uncontrolled fires across Mediterranean European countries (Papavasileiou & Giannaros, 2024; Turco et al., 2014)

These events highlight an alarming trend with significant ecological, economic and social repercussions (Galizia et al., 2023), including severe threats to human livelihoods, the destruction of private dwellings, and damage to agricultural lands and products (Keeley & Syphard, 2021; Pausas & Keeley, 2019; Stephenson et al., 2013). It has also negatively impacted forest survival, harming both marketable and non-marketable goods and services provided by arboreal species (Bowman et al., 2008). Additionally, it has contributed to biodiversity loss, increased carbon dioxide and particulate matter emissions, adversely affected air, soil, and water quality, led to food and water insecurities, and exacerbated an escalating socio-environmental crisis (Paton et al., 2014).

Since the 1970s, anthropogenic climate change has been a major driver of increased fuel dryness and the expanding area of uncontrolled fires, known as wildfires (Abatzoglou & Williams, 2016; Fidelis et al., 2018). Intensified fire risks, driven by heatwaves, reduced precipitation, warmer temperatures, and drier summers, have significantly contributed to the rising frequency, intensity, and scale of wildfires globally (Duane et al., 2021; Westerling, 2016). Moreover, fire seasons have lengthened considerably since 1979 (Jolly et al., 2015).

Human activities across various sectors, from agriculture to forestry, combined with the expansion of human settlements into fire-prone wildland-urban interfaces (WUI), have increased the likelihood of fire ignitions and their spread into semi-urban areas, resulting in substantial socio-economic consequences (Pausas & Keeley, 2009a, 2019). In the U.S., nearly five out of six wildfires in recent decades have been caused by human activity, including unintentional incidents arising from various sources such as arson, debris burning, vehicle use,

power generation, and recreational activities like campfires and fireworks (Balch et al., 2017; NICC, 2021).

Prolonged fire suppression policies have also altered some areas' fire regimes. In regions where human settlements are dense and fire suppression is strong, fuel accumulation at the landscape scale has escalated the occurrence of extreme wildfire events (Schoennagel et al., 2017). The phenomenon of land abandonment, linked with migration and consequent untreated fuel stock accumulation, has further exacerbated ignition hazards (Pausas & Paula, 2012). For instance, agricultural land abandonment in the Mediterranean has led to forest expansion and fuel accumulation, resulting in more frequent and severe fires (Ursino & Romano, 2014).

While numerous factors drive fires, the complex web of stakeholder interests and incentives surrounding fire use remains uncovered in the literature. This critical dimension often escapes detection by satellite imagery, econometric analysis, or official government reports, which frequently classify a significant number of fire events as having undetermined causes (Camia et al., 2013; Short, 2022). My research aims to address this gap by directly examining these elusive and overlooked factors.

1.2 Background

Pyne (Pyne, 2001; Pyne & Cronon, 2019; Pyne, 1997, 2016) identifies two key narratives surrounding fire. The first is the Promethean view, inspired by Greek mythology, which sees fire as a symbol of human progress, representing both advancement and defiance through the figure of Prometheus. This titan challenged the gods by stealing fire and giving it to humanity. Fire has been celebrated in Western culture as a key milestone in human development, driving advancements in cooking, farming, transportation, and energy. However, the Industrial Revolution brought a shift, where urbanisation lessened the dependence on wood and further disconnected people from the natural world (Pyne, 2016). Today, as Pyne observes, many urban dwellers, especially in Western regions, have little direct interaction with fire, seeing it mainly as a threat and a destructive force, particularly during fire seasons. This association with disaster fosters predominantly negative attitudes toward fire and its use.

The second narrative is the companion view - or "Franciscan" (from St. Francis of Assisi) - which regards fire as a natural element (Pyne, 2022; Pyne & Cronon, 2019). In contrast to the Promethean perspective, which sees fire as power, this view recognises fire as an essential part of natural ecosystems, shaping landscapes and maintaining ecological balance. Fire scientists advocating for the widespread adoption of this perspective argue that humanity, particularly in Western cultures, must relearn how to coexist with fire by adopting a "decolonial"

approach that recognises fire as a shared resource, promotes integrated fire management practices, and supports the development of more sustainable approaches (Moritz et al., 2014).

While these practices can empower communities, their adoption may face significant challenges, particularly in implementing large-scale initiatives influenced by diverse individual actions, interests, and incentives within modern democratic societies (Ostrom, 2015). As with broader sustainability efforts related to environmental outcomes and shared resource management, scholars debate whether a shift in economic systems could better support the sustainable use of resources. Some advocate for a transition towards distributive and regenerative economic models, such as Doughnut Economics, which prioritises operating within planetary boundaries. This framework seeks to address the shortcomings of traditional growth-focused economics by integrating ecologically sustainable practices (Raworth, 2019).

Other scholars focus the debate uniquely on the roles of markets and states in achieving this change. Some advocate for states to play a central role in markets, promoting ambitious long-term policies and facilitating public-private partnerships (Mazzucato, 2018, 2021). Others argue that states and markets alone cannot effectively manage natural resources for long-term sustainability (Ostrom, 2015), advocating for community-based governance or cooperatives as a more effective solution. These perspectives emphasise the need for a societal reshape, moving away from the neoliberal focus on individual self-interest that characterises the *homo economicus*. They advocate for prioritising the community's well-being over personal gain and exploring new approaches to managing resources and caring for the environment.

1.2.1 Theoretical framework

People are essential in driving change, as decisions about land use, outdoor activities, and fire prevention largely rest in their hands and those of government policies. If every stakeholder cooperated and committed to fire prevention, social outcomes would improve (Ostrom, 2015), leading to a reduction in wildfire incidence and impact while providing social and economic advantages distributed across society. However, resistance to behavioural change in environmental practices is common unless triggered by significant external shocks or regulations (O'Garra & Fouquet, 2022).

Some public choice and game theory literature presents individual responses to climate threats as a multiplayer prisoner's dilemma (Álvarez et al., 2019; Becchetti & Salustri, 2019; Carrozzo Magli & Manfredi, 2022; DeCanio & Fremstad, 2013). In this framework, individuals generally choose between taking action - such as adopting sustainable land management practices - or prioritising their own interests. Although the first choice comes with costs, the benefits from

acting for the common good are substantial and align with Ostrom's perspective on governing the commons (Ostrom, 2015). However, the typical outcome often mirrors the Nash equilibrium, where self-interested strategies lead to collective inaction.

When cooperation does not originate from the local level, collective action can still be influenced by external factors, particularly through policy and regulatory frameworks. This highlights the critical role of institutions, governmental bodies, and the broader political agenda. A lack of robust top-down regulatory frameworks can impede progress, leaving communities without the essential guidelines needed to implement effective practices, ultimately serving as barriers to adopt change. Furthermore, competing political agendas can create a fragmented landscape, complicating efforts to foster cohesive and sustainable action.

This complexity is further underscored by research on electoral cycles, also known as political business cycles, which are pivotal when discussing political agendas in democratic systems. This research suggests that the motivations of incumbent politicians significantly influence environmental outcomes (Ashworth et al., 2002; Burgess et al., 2012; D'Amato et al., 2019; Fankhauser et al., 2015; Pailler, 2018). This literature indicates that policymakers' behaviours are often swayed by partisan motivations or the desire to please voters (Bolino, 1999). Consequently, partisanship and electoral cycles play a crucial role in shaping public policy, with governments typically aligning their actions with constituents' interests and re-election goals.

Evidence suggests that electoral incentives influence policymakers' decisions on environmental issues, including the implementation of environmental taxes (Ashworth et al., 2002), the granting of construction permits (D'Amato et al., 2019), and the management of deforestation rates (Burgess et al., 2012; Pailler, 2018). Notably, significant increases in burned areas due to wildfires often coincide with election periods (Kountouris, 2020; Skouras & Christodoulakis, 2014). In Galicia, a correlation has been identified between intense election years and increased forest fire frequency (Álvarez-Díaz et al., 2015). Similarly, in the U.S., governors seeking re-election tend to allocate federal disaster relief funds to counties that supported them in previous elections (Husted & Nickerson, 2022).

Traditional partisan theory suggests that left-leaning parties are more inclined to pursue climate policies due to their interventionist philosophies (Hibbs, 1977). However, counterarguments point out that such policies can negatively impact core constituents, particularly those in polluting industries (Garmann, 2014). Green parties, which are known for their strong pro-environmental positions (Carter, 2013), play a significant role in shaping electoral discourse on climate issues. Because of their alignment with leftist ideologies, established left-leaning

parties are generally more likely to adjust their policies in response to the success of green parties compared to right-wing parties (Fagerholm, 2016; Spoon et al., 2014). However, empirical evidence on the relationship between partisanship and environmental outcomes is mixed. While some studies suggest that left-leaning governments are more proactive on climate policies (Garmann, 2014), others find no significant correlation (Bayer & Urpelainen, 2016; Jensen & Spoon, 2011; Ward & Cao, 2012).

In conclusion, the socio-economic and political behaviours, interests, and incentives shaping fire regimes are insufficiently comprehensively analysed in the existing literature. Filling these gaps is vital for creating effective fire management strategies. My research seeks to explore these overlooked aspects and deepen our understanding of the complex factors that shape wildfire dynamics in fire-prone regions. The Mediterranean region and the U.S. exemplify how two Western countries have adopted a Promethean perspective on fire, viewing it primarily as a tool rather than as a resource. This historical focus on fire suppression has resulted in policies that prioritise immediate suppression and extinction responses over long-term ecological management (Pyne, 2016).

Both regions highlight the urgent need to reconceptualise fire management. Rather than merely seeing fire as a hazard to be eradicated, it is essential to understand its ecological role. Focusing on these regions allows me to explore local viewpoints in areas with differing perspectives, like Sicily, Italy, while also examining the effects of electoral cycles and bipartisanship on fire outcomes in the U.S. This combined approach will offer valuable insights into how socio-economic and political factors may shape fire use and its results.

1.3 Aims and Objectives

This thesis explores the human-driven factors behind fires, focusing on how socio-economic and political influences might escalate the challenges in fire-prone areas. Fire incident reports often miss the deeper motivations, incentives, and processes that lead to fires and their spread, making this research particularly important. To address this gap, my research concentrates on fire-prone areas, examining macro-level and localised factors that are not generally fully disclosed in fire reports.

My research employs qualitative and quantitative methodologies to answer the roles and interests of different stakeholders in a multidisciplinary context, investigating how these parties may influence sustainable wildland management. The research specifically seeks to reveal the underlying interests of different actors and applies key political economy theories to assess wildfire outcomes, with a particular focus on policymakers' incentives.

The central research questions for this thesis are: *What socio-economic and political factors drive wildfire occurrence and severity, and how do they interact? To what extent are stakeholders aware of the primary human causes of wildfires, and do hidden interests influence fire management decisions? Can political economic theory reveal whether political motivations shape wildfire extent, duration, and frequency?* These questions are addressed through the following research objectives:

- **Objective 1:** Identify the socio-economic and political factors that influence wildfire regimes, both directly and indirectly, and answer how these factors interact with one another.
- **Objective 2:** Investigate whether local stakeholders, based on their background and affiliation, can recognise the human dynamics - including interests - driving the ignition, distribution, and spread of fires.
- **Objective 3:** Determine whether macro-level political factors, through the application of econometric analysis, can influence fire characteristics, such as occurrence, duration, and extent of burned areas.

1.4 Methods

My overall research employs a mixed-methods approach, integrating both qualitative and quantitative methods to comprehensively address the research objectives, ensuring a well-rounded investigation of the research question and purpose while promoting complementarity and diversity in the findings (Newman & Ridenour, 2008). The research takes an interdisciplinary approach, drawing on human and natural geography, social science, econometrics, and broader political economics concepts. I use earth observation, electoral data, and more qualitative information to address specific aspects of the research questions, with the general aim of creating a cohesive and inter-disciplinary study.

This thesis employed a variety of research methods, summarised in Table 1.1. The selection of these methods was driven by two key factors: the desire to introduce novel approaches to the field by incorporating econometric methodologies traditionally used in political economics literature and the proven effectiveness of these methods when applied in different contexts (Ashworth et al., 2002; Burgess et al., 2012; D'Amato et al., 2019; Fankhauser et al., 2015; Husted & Nickerson, 2022; Pailler, 2018; Rogoff, 1987). By combining these different methodologies, the research seeks to provide new perspectives and thorough analysis, helping to deepen our understanding of the topic and strengthen the overall quality of the study.

Table 1.1- Main methods and research objectives of the thesis

Method	Objective 1	Objective 2	Objective 3
Scoping review	✓		
Participatory stakeholders' workshop	✓	✓	
Thematic analysis	✓	✓	
Q-methodology		✓	
OLS, Poisson, NB regression models			✓
RDD model			✓
Secondary data collection			✓

This study navigates several important ethical considerations, particularly regarding the involvement of human participants. All research components were reviewed and received ethics approval from the Head of the Centre for Environmental Policy and the Science, Engineering, and Technology Research Ethics Committee (SETREC) in April 2023 (application ID: 6497365). The review process did not identify any significant ethical concerns, yet it highlights the importance of maintaining vigilance throughout the research (Appendix B.1).

Data collection, conducted between May and July 2023, prioritised the anonymity and security of participant information in strict adherence to Imperial College policies. Participants, all adults acting in professional capacities or as stakeholder representatives, received comprehensive information sheets detailing the study's purpose, procedures, and potential risks. Informed consent was obtained, ensuring that participants were fully aware of their involvement and voluntary participation, including their right to withdraw from the study at any time.

To address positionality issues and potential biases in subjectivity, I implemented strategies to mitigate these influences during data collection and analysis. I employed methodologies that enabled me to extract data directly from the participants in my study rather than relying on preconceived notions or assumptions. This approach prioritises the voices and experiences of the participants, ensuring that their insights are central to the research findings. By actively engaging with their perspectives, I aimed to foster a more nuanced understanding of the complex issues at hand. Additionally, I recognised the importance of being mindful of cultural norms during interactions with participants, which further contributed to a respectful and ethical research environment.

1.6 Thesis structure

This chapter introduces the study, providing a theoretical background while outlining the objectives and research question of the thesis. Chapter 2 addresses Objective 1 by presenting a scoping review of the literature on the socio-economic and political incentives across different

sectors, both productive and non-productive, that may influence wildfire regimes. It identifies research gaps and examines what the literature reveals about the socio-economic and political dimensions related to wildfires. As a background analysis, Chapter 2 establishes the current state of knowledge on these influences and provides a foundation for the following chapters, which explore specific aspects of wildfire outcomes in greater depth.

Chapters 3 and 4 focus on Objectives 1 and 2, investigating whether local stakeholders can identify narratives regarding the origins, distribution, causes, and expansion of wildfires. Qualitative methodologies are applied to assess whether stakeholder incentives at the local level could be potential drivers of wildfire incidence. These chapters are based on a case study conducted in Monreale, located in the Palermo province of Sicily. Chapter 3 outlines the objectives, methodology, and stages of the stakeholder workshop organised and held in Monreale. Chapter 4 explores the use of the Q-methodology with stakeholders after the workshop, providing further insights into the narratives and perspectives that emerged and identifying incentives and barriers for adopting sustainable fire prevention and management practices.

Chapters 5 and 6 address Objectives 1 and 3. Chapter 5 examines the effect of electoral cycles on wildfire outcomes using secondary data and different regression models: Negative Binomial (NB), Poisson, and Ordinary Least Squares (OLS). Chapter 6 investigates partisanship and wildfire occurrence in the U.S., assessing whether the political affiliation of American governors affects wildfire incidents. This analysis utilises secondary data and a Regression Discontinuity Design (RDD) model to investigate the correlation and potential causal relationship between elections, partisanship, and wildfire characteristics in the Western U.S. The strong bipartisan nature of the U.S. and the region's wildfire-prone areas are key reasons why this context is central to my analysis. Finally, the thesis concludes with a conclusion chapter summarising key findings and providing policy, business, and research recommendations.

Chapter 2 - Unveiling the socio-economic and political forces and interests driving wildfires through a scoping review

2.1 Introduction

In addition to the biophysical determinants of fire (Alcasena et al., 2018; Fernandes et al., 2013), research has studied the influence of anthropogenic factors on wildfire ignition, spread, and intensity (Andela et al., 2017; Bowman et al., 2011). These anthropogenic factors typically refer to human activities and include both direct actions, such as deliberate arson or accidental fires, and indirect actions, such as land-use change, deforestation, and infrastructure development (Duane et al., 2021). Furthermore, a powerful indirect human driver of elevated fire risk is climate change, which exacerbates drought conditions and increases temperatures, is also critical in elevating wildfire risk (Abatzoglou & Williams, 2016; Bowman et al., 2020; Shuman et al., 2022).

The relationship between anthropogenic factors and wildfire occurrence varies in space across administrative geographies (county, city, region, etc), and with ecological conditions (Wang et al., 2023). Recognising contextual specificities, along with human activities and policy decisions, including land use actions, is crucial for understanding wildfire drivers (Carroll et al., 2007). Neglecting these factors can lead to ineffective fire management approaches, such as an excessive focus on suppression (Kreider et al., 2024). Despite their importance, aspects related to social, economic, governmental, and governance dimensions that may directly or indirectly influence fire occurrences are seldom examined comprehensively in research. These factors may interact in complex ways, influencing and shaping contemporary fire patterns. To gain a fuller understanding, it's essential to consider policy frameworks, economic incentives, behaviors, and the interests of different stakeholders.

Much of the existing work summarising and evaluating research on the human dimensions of fire regimes treats them in isolation rather than acknowledging their interconnectedness and cross-dependencies. For example, some prior reviews have concentrated on human behaviours during evacuations in urban and wildland-urban interface (WUI) areas (Haghani et al., 2024; Kuligowski, 2021; Kuligowski, 2016), such as the decision to evacuate, seek shelter, or defend properties (Strahan & Gilbert, 1995). Cowan and Kennedy's (Breslin et al., 2019) scoping review identified several key factors influencing the adoption of residential mitigation practices. These include social capital, risk perception, perceived effectiveness and responsibility, and access to education and information. The review underscores the significant influence of social connections on homeowners' behaviours, a factor also evident in urban areas.

Research on structural fires reveals those human behaviours, shaped by geographical proximity and social networks—such as peers and family—tend to exhibit similar patterns within specific communities (Breslin et al., 2019). Behaviours, like smoking and drinking, increase fire risk (Dewey, 1922; Duhigg, 2022), but repeated home safety visits can effectively change these households' behaviours (Breslin et al., 2019; Runefors & Nilson, 2021). However, a comprehensive review that maps the broader research landscape on the social, economic, administrative, and governance drivers of fires has not been conducted. This chapter bridges this gap, aiming to unify the fragmented understanding regarding the human drivers of fire characteristics.

The chapter is structured as follows: the next section outlines the methodology used to conduct the scoping review. Section 3 presents the review's results, describing key characteristics of the literature, such as study location, publication year, and research methods, and provides an in-depth content analysis. The analysis is divided into three areas: first, it examines human presence and activities across various economic contexts and regions that contribute to wildfire characteristics. The second part explores fire management strategies, focusing on how cultural, traditional, and managerial decisions have influenced fire outcomes globally. The third area investigates the practical application of incentives to encourage stakeholders to adopt fire prevention or mitigation practices. Section 4 summarises and discusses the findings, and Section 5 offers conclusions and sets the stage for subsequent chapters.

2.2 Methodology

This study follows the five-stage scoping review methodology developed by Arksey and O'Malley (2007) to identify, map, and highlight potential gaps in research related to wildfire-related socio-economic and political factors. The five stages are: 1) formulating the research questions, 2) conducting a comprehensive literature review using online databases and Boolean search techniques, 3) identifying and selecting relevant studies, 4) charting and synthesising data, and 5) collating and interpreting the results.

While scoping reviews are similar to systematic ones (Pham et al., 2014), some fundamental differences remain. Unlike systematic reviews, the scoping one is usually descriptive, not requiring a critical review or a qualitative evaluation of the research collected. Both methods require a systematic appraisal of the bibliography, but while the former addresses broader topics and a variety of methodological approaches, the latter is usually narrower in scope and explores the evidence to address the specific research questions, synthesising what is known about a topic and what are the research gaps (Pham et al., 2014).

2.2.1 Scoping review steps

I assess the extent to which different factors have been considered in the research on wildfires and map the knowledge gaps in the field. Starting from the general aim to elicit the different socio-economic and political drivers influencing wildfire occurrence, I focus on the following research questions: 1) What socio-economic and political factors drive wildfire occurrence and severity, and how do they interact? 2) To what extent are stakeholders aware of the primary human causes of wildfires, and do hidden interests influence fire management decisions?

Figure 2.1 - Workflow detailing the different stages of the scoping review

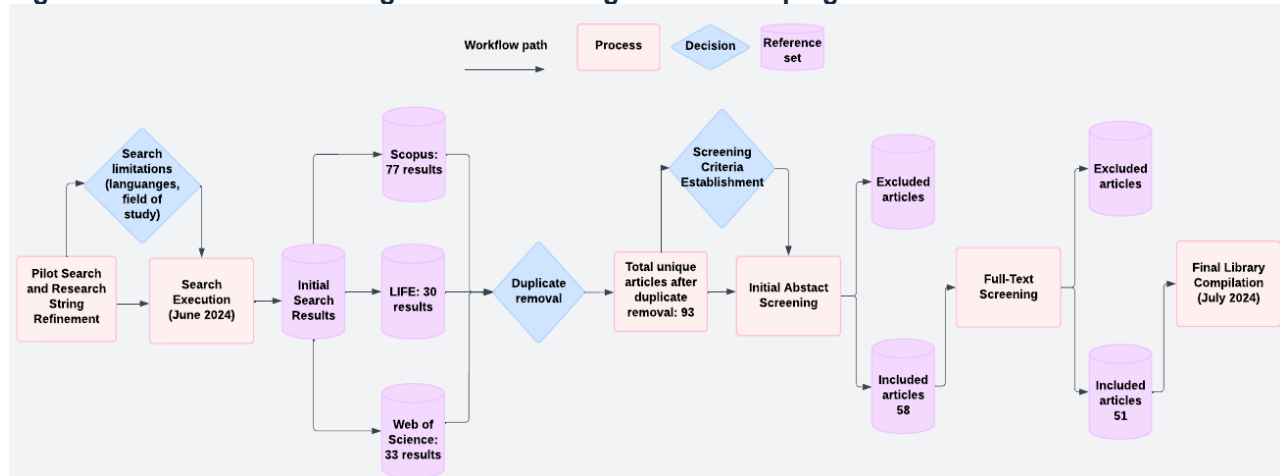


Figure 2.1 presents the workflow and the different stages of the review strategy. The active search was performed in June 2024, and the review was completed by July 2024. The following platforms and databases were explored to perform the scoping review: Scopus, Web of Science Core Collection, and LIFE database of subsistence-oriented and smallholder fire use and mitigation (Smith & Mistry, 2021). These three platforms were chosen to limit bias potentially arising from the use of a single platform and to have access to different journals. While Scopus and Web of Science are widely used for scoping and systematic literature reviews (Cowan & Kennedy, 2023; Piñeiro et al., 2020; Strahan & Gilbert, 1995), the LIFE database provides a global collection of over 500 case studies on contemporary subsistence-oriented and smallholder fire use and mitigation practices, enabling a deeper exploration of studies within the same research field (Smith & Mistry, 2021).

I first developed a research string using Boolean search operators derived from the main research questions and ran a pilot search using Scopus, adding synonyms and different spellings until I reached the saturation point, where additional terms would not change the total number of results discovered (Appendix A.1). The research was confined to the following fields: social sciences, environmental science, agricultural and biological sciences, economics, econometrics and finance, earth and planetary sciences, decision sciences, multidisciplinary,

and undefined fields. Subsequently, I refined the search terms after encountering results that were more focused on human health, firefighting tools, and greenhouse gas emissions rather than the specific focus of my study. Table 2.1 outlines the final research string encompassing three key themes: wildfires, stakeholder identification, and the identification of interests. The search was also limited to articles written in English, Italian, and Spanish. The search produced 77 results from Scopus, 33 from Web of Science, and 30 from the LIFE database, which were imported into Mendeley reference manager, where duplicates were removed, resulting in a total of 93 unique articles.

Table 2.1 - Search terms used in scoping literature review

Search Terms
("wildfire" OR "fire" OR "forest fire" OR "bush fire" OR "brushland fire" OR "grassland fire" OR "woodland fire" OR "land fire" OR "field fire" OR "bushfire" OR "wildland fire" OR "vegetation fire" OR "grass fire" OR "wildland-urban interface fire" OR "WUI fire" OR "wildland urban interface fire")
AND
("stakeholder" OR "stake-holder" OR "player" OR "actor" OR "socio-economic" OR "soci*" OR "economic" OR "agent" OR "interest part*" OR "part* of interest" OR "interest group" OR "relevant part*" OR "person of interest" OR "people of interest" OR "politic*")
AND
("incentive" OR "interest" OR "motiv*" OR "barrier" OR "obstacle" OR "factor" OR "challenge" OR "prevent*" OR "practice" OR "priorit*" OR "trade-off" OR "tradeoff" OR "trade off")

Before screening, inclusion, and exclusion criteria were established, as outlined in Table 2.2, I reviewed the 93 articles seeking out research explicitly dedicated to identifying or specifically examining policy frameworks, incentives, behaviours, and interests of various stakeholders associated with wildfire events. This includes research on how various stakeholders' actions, suppression measures, and prevention strategies influence wildfire occurrence and management. The screening also aimed to include original research - encompassing qualitative and quantitative analyses - and reviews of existing studies to ensure a comprehensive understanding of current knowledge and practices in wildfire prevention management across various ecosystems and communities.

Certain studies were excluded from the review to maintain focus. Studies focusing on leadership practices that concentrate solely on managing acute fire crises, emergency response actions, and suppression were not included, as these topics fall outside the scope of exploring how proactive wildfire prevention strategies can influence wildfire outcomes. For example, studies that focus solely on health and respiratory issues linked to wildfire smoke were excluded, as they don't directly relate to wildfire management practices. Similarly,

research limited to fires in urban settings was left out to maintain a focus on the use of fire in different ecosystems and communities.

Table 2.2 - Inclusion and exclusion criteria followed to select the literature

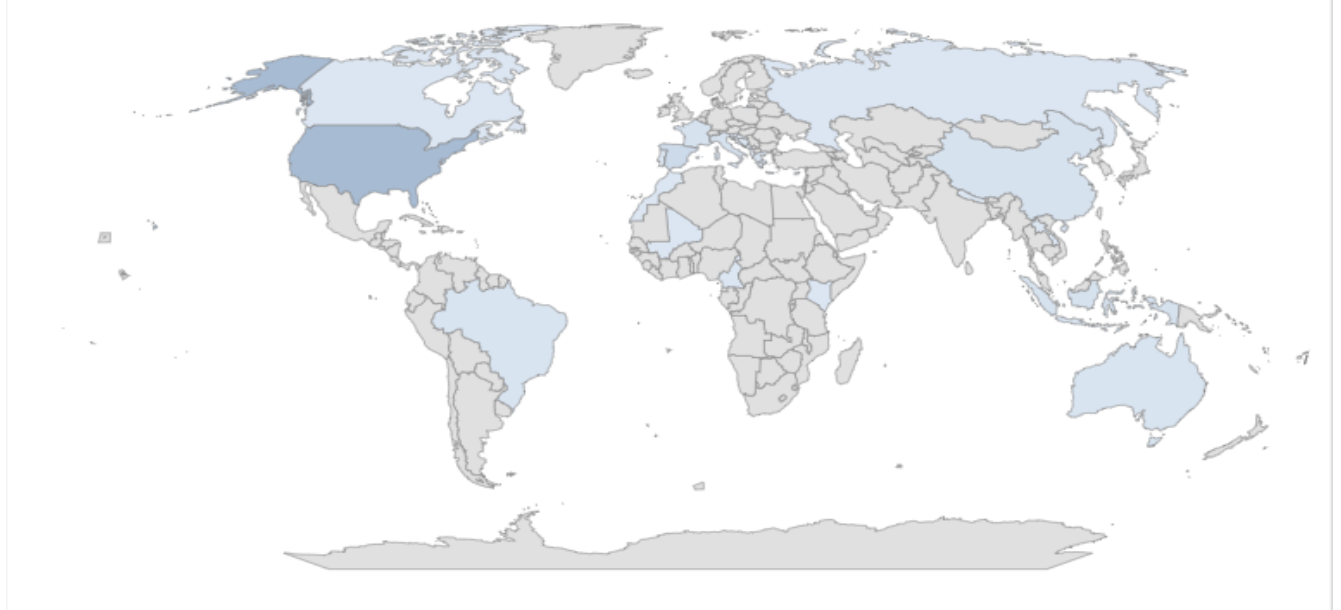
Inclusion Criteria
Studies specifically examining the incentives, interests, behaviours, and barriers associated with wildfire events.
Research explicitly focused on identifying best practices and strategies for wildfire prevention.
Policy analyses and studies that promote the adoption of wildfire prevention practices or measures to limit their extent.
Original research, including both qualitative and quantitative analyses, and/or reviews of existing research.
Exclusion Criteria
Management studies and/or collective leadership practices focused solely on fire crises, emergency response actions, and suppression.
Studies exclusively related to health and respiratory issues.
Studies focused exclusively on fires occurring in urban areas.

The initial screening process, based on reading abstracts, narrowed the selection to 60 articles that described various effects of incentives, behaviours, interests, and management strategies on wildfire occurrence worldwide. Subsequent full-text screening further refined the selection, resulting in a final total of 51 articles. The complete library of selected articles is available in the appendices.

2.3 Results

The final collection of scientific papers explores various anthropogenic drivers of wildfires across different regions globally. I start by cataloguing the geographical distribution of these studies as examined in the literature. Figure 2.2 provides a visual representation of the geographical focus of these studies. Most studies concentrate on localised fire phenomena, offering detailed case studies and analyses at the country or regional level. Some provide broader insights into wildfire dynamics across different regions. Only two of the identified studies address global-level phenomena.

There is a notable correlation between the volume of studies and regional wildfire activity, with a concentration of research in North America (23 studies), followed by Western Europe (18 studies), Southeast Asia (8 studies), Eastern Europe (6 studies), and Russia (1 study). The limited research in regions like Sub-Saharan Africa, Latin America, and parts of Asia can be partly explained by the review's intentional focus on the political and socio-economic factors that influence wildfire outcomes.

Figure 2.2 - Mapping of study locations

Note: Deeper blue shades indicate regions with a higher concentration of research.

While this focus provides valuable insights into how contemporary challenges impact fire management and incidence, it partially contributes to excluding studies that concentrate solely on traditional fire use by Indigenous peoples, its role in land management and ecological purposes, as well as the historical effects of colonisation on these practices. Additionally, the overrepresentation of studies from the Global North is potentially driven by factors such as remoteness and lack of funding in other regions, which risks emphasising factors specific to developed industrial or service economies, neglecting the distinct socio-economic and political dynamics in other parts of the world (Hughes et al., 2023; Torres & Alburez-Gutierrez, 2022).

Figure 2.3 illustrates the publication years of the studies. Research on the socio-economic aspects of the wildfire phenomena appears to have gained ground in the 1990s. The focus intensified after the early 2000s, reaching a peak around 2020. This surge may reflect the heightened global awareness and concern about climate change and its impacts, including the examination of socio-economic implications and anthropogenic roles. Significant large-scale and devastating wildfires near urban or suburban areas (Thomas & Butry, 2014), such as those in Australia, California, and the Amazon, may have drawn considerable attention to the broader impacts of wildfires beyond just environmental damage. Another reason for the increase in literature from the 2000s is the availability of remote sensing technologies, like Moderate Resolution Imaging Spectroradiometer (MODIS) data, from Terra and Aqua satellites, which significantly enhanced fire monitoring and analysis during this period. Additionally, it may be attributed to the proliferation of journals dedicated to environmental and sustainability issues.

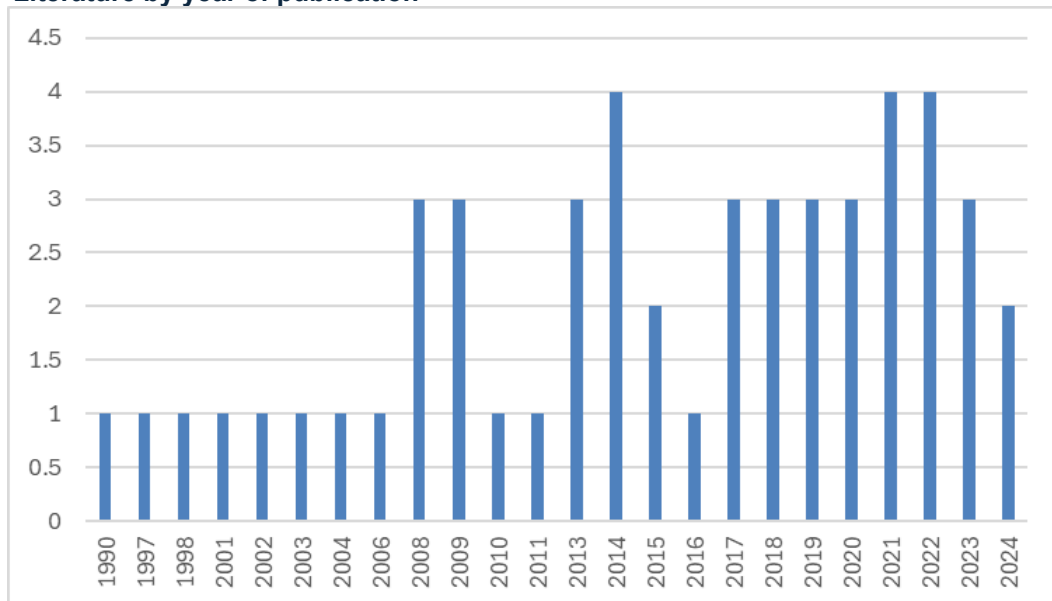
Figure 2.3- Literature by year of publication

Figure 2.4 illustrates the distribution of literature based on the use of secondary versus primary data sources. It shows that 70% of the studies rely on secondary data, including open-access socio-economic data and remote sensing information at the country, regional and global levels. This highlights the pivotal role of satellite data in wildfire research.

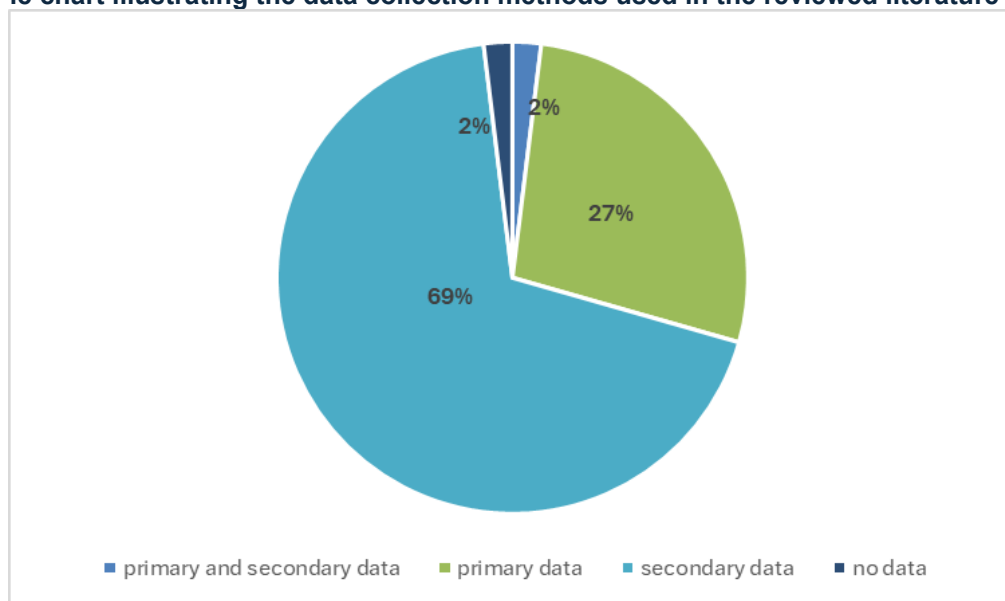
Figure 2.4- Pie chart illustrating the data collection methods used in the reviewed literature

Figure 2.5 further supports this observation by detailing the range of methodologies employed. Many studies focus on models such as willingness-to-pay assessments, evaluation frameworks, and agent-based models, as well as various statistical analyses, including regressions of socio-economic factors on risk exposure and fire use.

Figure 2.5- Bar chart illustrating the analytical methodologies used in the reviewed literature

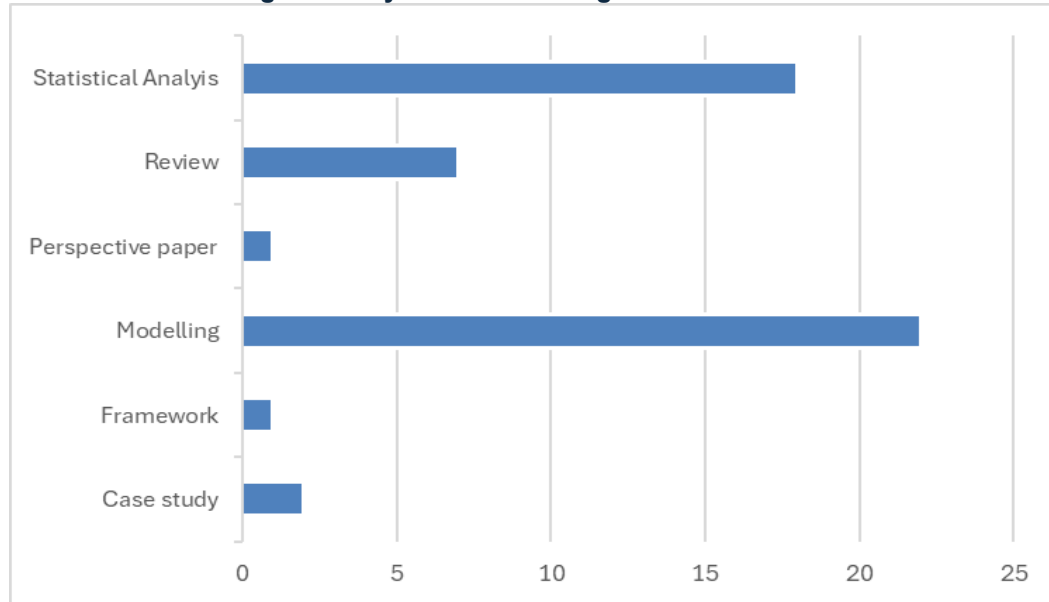
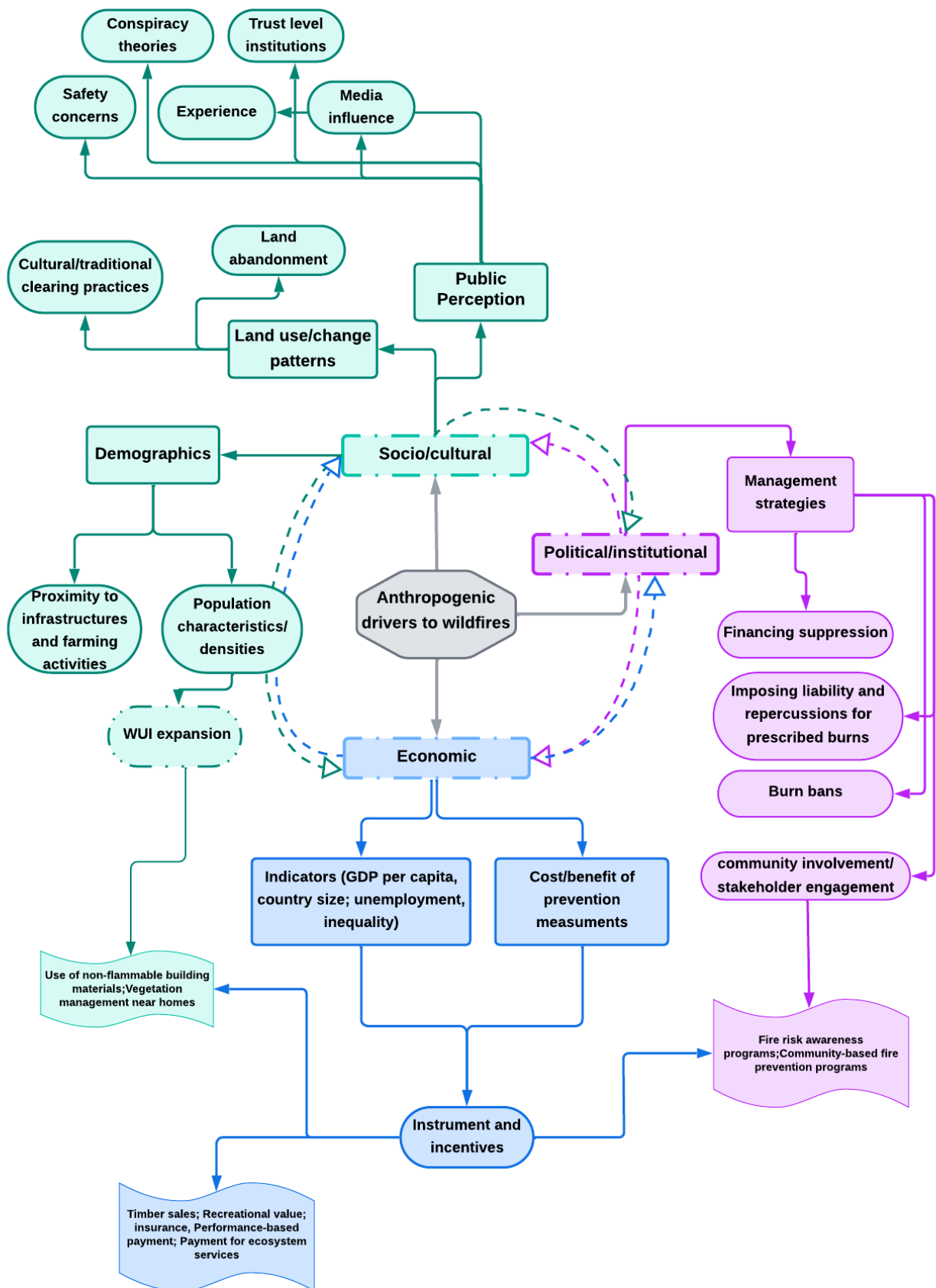


Figure 2.6 illustrates the interconnectedness of the diverse drivers identified in the literature. Grouped into three macro categories, socio-cultural, political/institutional, and economic drivers, they frequently recur across studies, even in those not specifically focused on them, highlighting the significant interrelation of socio-economic and political/institutional factors. In the following paragraphs, which summarize the literature, recurring concepts will become apparent as the interconnections among these drivers are explored in research.

Additionally, the literature consistently identifies various stakeholders connected to fires' characteristics through their behaviours, activities, incentives, interests, or management strategies. The following groups have been found to play a significant role in contributing to the current wildfire phenomenon worldwide: farmers, livestock owners, hunters, homeowners, forest managers and owners, timber companies, construction companies, firefighters, government agencies, and the media.

Figure 2.6 - Mind map of key drivers identified in the scoping review



2.3.1 Socio-economic factors

The reviewed papers underscore the influence of macro-level socio-economic factors on fire incidence, resulting from the complex interplay between human activities, land use patterns, and economic conditions. Common predictors of wildfire patterns, as examined in various agent-based models and geographical risk mapping studies, include proximity to roads, railways, residential areas, agricultural zones, livestock presence, GDP per capita, and country size (Chicas & Østergaard Nielsen, 2022; Kyrylaha & Chernenko, 2017; Sze et al., 2019). All these studies consistently indicate that various human activities associated with economic outcomes exert pressure on the environment, serving as stressors that increase the likelihood of wildfires. The presence of infrastructure like roads, railways, and power lines often contributes to accidental fire ignition. At the same time, increased agricultural and livestock activities, especially land clearing, are closely associated with a rise in fire incidence.

Research in China and Russia has shown a positive correlation between the number of fires and economic growth and lower education levels (Kirillina et al., 2020; Ren et al., 2018). This relationship is likely because lower education levels are often associated with economies dominated by the primary sector and are more prone to fire use. During China's rapid economic development, the incidence of fires was found to increase alongside economic growth (Ren et al. 2018). However, this relationship is not linear; in highly developed regions like Shanghai, Guangdong, and Beijing, fire incidents tend to decrease as economic development progresses, and the economy shifts toward higher levels of education and a service-oriented economy. Beyond GDP, socio-economic factors such as material deprivation, unemployment, and income inequality have been linked to an increase in wildfire-related crimes in Italy (Canepa, 2024).

Demographic factors like population density and age are crucial in shaping wildfire patterns, but when considered in isolation, they exhibit complexity and inconsistency in predicting ignition probabilities (Arsanjani & Vázquez, 2020). Observations in different regions suggest that the relationship between population density and fire occurrence is non-generalisable. In the US, increased human access, particularly near roads and residential areas, has been linked to higher occurrences and more frequent reporting of wildfires, while larger wildfires tend to occur in more remote and non-forested areas (Cardille et al., 2001). Notably, the likelihood of a fire being reported is closely tied to the accessibility of the area, indicating that reporting rates are endogenous to how easily a location can be reached. Contrary, in Indonesia, during the 2015 extreme fire events, lower population densities correlated with higher fire occurrences, often in remote agricultural areas (Sze et al., 2019).

In southern Europe, the abandonment of farmland has significantly altered the landscape, creating vast, continuous fuel beds that amplify fire spread and intensity. This shift in land use has influenced fire regimes and necessitated adjustments in fire management strategies (Loepfe et al., 2010; Pausas et al., 2004; Pausas & Keeley, 2009). However, along the Mediterranean Basin, the socio-economic landscape is diverse. Regions like the Rif in Egypt still maintain rural populations engaged in livestock farming and fuel gathering, leading to more frequent but less intense fires (Chergui et al., 2018).

2.3.2 Fire management strategies

A substantial portion of the literature analyses how different management strategies and their effects on ecological, social, and economic aspects influence wildfire outcomes. Although fire has played a critical role throughout Earth's history and human evolution, serving as both a natural element and a vital tool for survival, in contemporary Western view, it is often perceived as a threat. When the U.S. Department of Agriculture Forest Service was established in 1905, its mission centred on conservation and ensuring a stable timber supply, leading to the implementation of a strict fire suppression policy, which deeply influenced and shaped the practices of generations of foresters (Donovan et al., 2008).

The "Smokey the Bear" campaign of the 1950s and 60s, while successful in raising public awareness about fire risks in rural and forested areas, also reinforced the belief that all fires should be extinguished at any cost. This, in turn, led to increased fuel accumulation and distorted public understanding of fire's vital ecological role (Daniel, 1990). Consequently, these misconceptions have hindered the acceptance of preventive measures, which are crucial for maintaining forest health and reducing wildfire risks (Thompson, 2014), and fire suppression efforts have long remained the dominant approach worldwide (Hessburg & Agee, 2003; Raftoyannis et al., 2014).

More recently, the policy of full fire suppression in the U.S. has become less common on public lands, particularly in wilderness areas with low housing density and limited road infrastructure (Daniels et al., 2024), following the increasing recognition of fire's ecological role (Doerr & Santín, 2016). Federal public land managers have been more inclined than state managers to adopt alternative approaches to full suppression, like confinement allowing fires to burn (Daniels et al., 2024), which helps to reduce fuel loads, support fire-adapted species, enhance the safety of fire responders, and lower firefighting costs (Donovan et al., 2008; Pausas & Keeley, 2019).

Evaluating the firefighting budget in the U.S., Donovan et al. (2008) examine how funding mechanisms affect fire managers' behaviour and contribute to the escalating costs of wildfire suppression. They find that fire managers respond to incentives, suggesting that modifying these incentives could influence their actions. They identify two persistent issues within the system: first, the use of emergency funds for wildfire suppression provides minimal incentive for cost control, and second, the benefits of fire -often non-market goods - are frequently undervalued in decisions about full suppression, leading to elevated suppression costs. Similarly, in Mediterranean Europe, despite increased firefighting budgets, fire suppression alone has not reduced the frequency of fire incidents (Moreira et al., 2020; Xanthopoulos et al., 2019). Effective suppression policies have instead led to more extreme fire behaviour due to fuel accumulation, underscoring the need for integrated fuel management strategies (Pyne, 2022; Reinhardt et al., 2008).

Research indicates that investing in proactive and preventative fire management programs can yield significant public savings (Bennetton et al., 1998; Heines et al., 2018). Techniques like cultural, prescribed burns and mechanical treatments aim to mitigate, rather than eliminate, fire severity, thereby reducing wildfire impacts and aiding in suppression efforts (Reinhardt et al., 2008), while protecting forests and the timber industry (Al Abri, 2022). Both prescribed burns and mechanical treatments are recognised as key strategies for managing fuel loads and forest health and mitigating wildfire risks. Prescribed burns involve controlled fire application to reduce combustible materials, while mechanical methods, such as thinning and debris removal, are generally more expensive and time-consuming (Al Abri, 2022).

Despite these benefits, the application of fuel management techniques is often restricted by high costs, bans, personnel shortages, and concerns about health and property damage, particularly in the WUI (Clark et al., 2022; Laris, 2002; Stockmann et al., 2010). Strategic approaches to mitigating wildfire risks near urban and wildland-urban areas often involve creating buffer zones, such as Asset Protection Zones (APZs) in southeastern Australia and "defensible space" or Home Ignition Zone (HIZ) treatments in the U.S. (Gill & Stephens, 2009). APZs, which are established just beyond urban areas, emphasise intensive fuel management to protect life, property, and assets from wildfires, facilitating safe firefighting operations and minimize fire spread. Their implementation requires collaboration among homeowners, farmers, and conservationists to manage vegetation responsibly, balancing fire risk reduction with land use and environmental conservation. In contrast, HIZ treatments focus on creating clear zones around individual buildings to prevent fires from reaching wildland areas.

Community acceptance of prescribed burning is significantly affected by diverse stakeholders' perspectives. Private companies often prefer mechanical harvesting, particularly in the WUI, whereas environmentalists typically favour prescribed burning across various land types (Costanza & Moody, 2011; McCaffrey et al., 2008). Public agencies, instead, may prioritise long-term wildfire risk reduction and conservation goals. Stakeholders' attitudes towards these methods might be also shaped by psychological factors, such as past experiences with prescribed fire and risk-taking orientation of fire escape and smoke management (Shrestha et al., 2021; Shrestha et al., 2021; Vogler et al., 2015).

Trust in institutions, public and political pressures, cultural norms, media coverage, and cognitive biases all affect how stakeholders perceive risks and make decisions, often incentivising risk-averse fire management strategies (Thompson, 2014). This hindrance of situational awareness can lead to suboptimal decisions, such as persisting with ineffective strategies due to prior resource investment, overestimating firefighters' ability to manage risks, or deploying more resources than can be effectively utilised. Additionally, exposure to conspiracy theories following real-world disasters can impact collective action, political engagement, and emotional responses, leading to intense emotions such as fear, anxiety, and anger (Gkinopoulos & Mari, 2023).

In some regions, opposition to fire prevention measures are also influenced by aesthetic considerations (Al Abri, 2022; Toledo et al., 2013), unemployment and low engagement with nature (Varela, Jacobsen, et al., 2014 Costanza & Moody, 2011; McCaffrey et al., 2008). Even when the public shows some support for prescribed burning, policymakers often hesitate to implement it, favouring less invasive methods like brush-cutters and controlled grazing (Costanza & Moody, 2011; McCrary & Justin, 2008; Varela, Jacobsen, et al., 2014). In Catalonia, instead, the Group of Support to Forestry Action (GRAF) promotes prevention and controlled burning, challenging traditional zero-tolerance policies to foster sustainable wildfire coexistence despite media sensationalism (Otero & Nielsen, 2017).

In Indigenous communities, traditional fire knowledge and extensive fire experience have fostered support for community-led wildfire mitigation programs. These communities value a mix of risk reduction and aesthetics, with traditional burners emphasising both, firefighters focusing on risk reduction, and bystanders prioritising aesthetics (Christianson et al., 2013). In Mali, effective fire management involves collaboration between the forest service and local communities to develop consensus-based strategies (Laris, 2002). Locals use small, patchy fires to manage the landscape, following a traditional "patch-mosaic" burning approach of burned and unburned areas, which enhances biodiversity and prevents larger, more

destructive fires. However, there is uncertainty among non-fire-setters on the reasons for burning and concerns over hunting or malicious intent behind local fire use. The same mosaic approach used towards the middle or end of the dry season by traditional cattle ranching in Brazil's Cerrado is applied to manage landscapes. Unlike lightning-induced fires, these fires tend to be more intense and spread over much larger areas (Pivello et al., 2021).

Integrating traditional ecological knowledge into contemporary policies is essential for effective fire management, yet it encounters substantial challenges due to the combined impacts of agricultural intensification, desertification, and climate change (Eloy et al., 2019). Legal obstacles, such as burn bans and varying liability standards, further complicate implementation (Laris, 2002). For instance, the Māori in New Zealand engage in unauthorised burning rooted in cultural practices and traditional knowledge (Lisa Langer & McGee, 2017). Texas has implemented burn bans that restrict these practices (Rideout et al., 2003). Despite its long history of use, prescribed burning in the southeastern U.S. encounters difficulties due to dense settlements and complex land use patterns. Some States have enacted laws to limit liability for trained professionals conducting burns, acknowledging their ecological benefits (Wondolleck & Yaffee, 2000). Nevertheless, fear of legal repercussions continues to hinder widespread adoption (Clark et al., 2022).

The literature also highlights the need for restoration planning to balance socio-ecological goals, such as restoring fire-adapted forest structures, reducing WUI risks, and addressing wildfire hazards (Ager et al., 2016; Paveglio et al., 2024). The economic feasibility of restoration projects, which may also aim to generate timber revenues, often involves trade-offs among these objectives. Consequently, there is growing support for adopting balanced management strategies that integrate local community perspectives to address both immediate and long-term needs. This approach ensures sustainable management that aligns with both ecological and socio-economic goals. For example, in the Mount Kenya Forest Reserve and National Park, biodiversity conservation and community interests were prioritised over wood production and other socio-economic benefits (Nyongesa & Vacik, 2019). Understanding the relational dynamics among stakeholders can enhance wildfire response strategies, underscoring the importance of trust-building and strong networks (Faas et al., 2017).

2.3.3 Economic instruments to influence fire management behaviours

Economic instruments play a crucial role in shaping behaviours toward proactive wildfire management and encouraging protective actions among homeowners, which can ultimately influence fire occurrence. By implementing targeted economic instruments to drive behavioural change, the aim is to achieve both ecological and economic optimal results, enhancing wildland

resilience, reducing fire damage, and lowering management costs. The literature has explored various methods for valuing non-market assets to create a more comprehensive cost-benefit analysis framework and has studied the effectiveness of different economic instruments in altering fire management behaviours.

- Assets threatened by wildfires, homeowner inaction, and willingness to pay for fire prevention strategies

As previously noted, fire managers might face challenges in accounting for the benefits and costs of wildfires when deciding their response, as many of the benefits associated with fire are non-marketable (Donovan et al., 2008). To improve wildfire management, it is important to identify, quantify and monetise their negative and positive effects on non-marketed resources and incorporate them into Cost Benefit Analysis (Venn & Calkin, 2009). While earlier economic valuation studies focused on assessing post-fire impacts, for example, on recreational demand (Hesseln et al., 2003), recent research has shifted to evaluating preventive measures against wildfires, including assessing the public's willingness to pay (WTP) for these measures across various stakeholder categories (Varela & Soliño, 2015).

Studies in Spain have found that the public's WTP for controlled grazing helps manage wildfire risk (Varela, Giergiczny, et al., 2014; Varela, Jacobsen, et al., 2014). Other research has shown that different stakeholders highly value fire risk reduction, even considering maintenance costs (González-Cabán et al., 2007; Kaval et al., 2007; Riera & Mogas, 2004; Walker et al., 2007). However, as previously discussed, support for fire prevention policies and activities in WUI can vary based on homeowners' risk perceptions (Talberth et al., 2006; Winter & Fried, 2001).

A case study in western Montana found that the low probability of home ignition, coupled with the high cost of preventive treatments, discourages many homeowners in the WUI from engaging in wildfire prevention measures (Stockmann et al., 2010). The availability of insurance, which typically covers the value of homes and their contents if destroyed by wildfire, further reduces the urgency for homeowners to act. HIZ treatments, as previously discussed, which focus on modifying home materials and the surrounding area, are generally the most cost-effective strategies, particularly for protecting homes in low-elevation communities in the western U.S. (Gill & Stephens, 2009). However, the costs of these treatments often exceed the marginal benefits of risk reduction, making them less appealing to homeowners (Nelson et al., 2004). Although parallel motivations, such as crime control, gardening, and pet needs, may prompt homeowners to clear hazardous fuels, these motivations are often counterbalanced by low perceived risk, overconfidence in fire suppression capabilities, and the benefits brought by

nearby vegetation, including shelter, shade, temperature and moisture control, noise reduction, privacy, aesthetics, and wildlife habitat (Stockmann et al., 2010).

- Incentives and behavioural change

A focused body of literature explores how different incentive programs can influence stakeholders' behaviours to promote change. Effective strategies include both direct measures, such as fire prevention efforts, and indirect approaches, like revitalising rural economies to maintain open landscapes and manage fuel loads (Wunder et al., 2021). Although these methods are complementary, their application often lacks coherence and faces challenges in many parts of the world due to ongoing rural depopulation.

Enhancing fire management policies and implementing incentive programs can align forest owners' or managers' actions with social objectives, thus improving forest resilience, reducing wildfire damage, and lowering suppression costs. Research has highlighted how private forest owners or managers make decisions about mitigating wildfire risk based on a range of economic incentives and their understanding of potential threats (Al Abri, 2022). These decisions are influenced by both the marketable benefits of the forest, like timber sales, and non-marketable benefits, such as recreational value or aesthetic enjoyment. These evaluations are also broadened to include considerations like the availability of resources and tools needed for mitigation, the risk associated with prescribed burns potentially escaping control, including the risk for neighbouring properties, and access to liability insurance that covers potential fire-related damages (Shrestha et al., 2021). Past experiences with wildfires and mitigation efforts, memory of fire-related property damage, as well as awareness about existing wildfire prevention programs also play significant roles (Shrestha et al., 2021; Varela et al., 2014). In addition, many forest owners avoid preventive measures due to free riding, relying on neighbours' efforts. Incentive-driven policies like cost-share programs and fuel stock regulations can encourage better fuel management and reduce free riding (Al Abri, 2022). However, misinformation about fire risks and behaviours can undermine these efforts.

Incentives have proven effective in influencing burning behaviours in developing countries, where, despite efforts to transition to more sustainable systems, such as rotational farming, hedgerow cropping, and alternative crops, their adoption is often constrained by economic and practical challenges (Roder, 1997). The Paris Agreement promotes performance-based payments to increase carbon stocks in forests, a mechanism expected to contribute to achieving the Sustainable Development Goals (Bastos Lima et al., 2017; FAO, 2019). In Nepal, such payment schemes successfully encouraged farmers to reduce the burning of rice straws (Pant, 2013). While initially beneficial, this shift has led to long-term ecological damage and

reduced productivity (Brown, 2006). Despite varying private costs, the social benefits of reduced burning remained consistent, with higher compliance observed in remote inland areas, where these payments helped diversify farmers' income sources and mitigate slash-and-burn practices.

In Jambi province, Indonesia, the government educates the public on preventing indiscriminate land burning and collaborates with communities by building water storage points and providing fire prevention training, ensuring swift response to fire incidents. Government strategies include socialisation, disaster management training, and infrastructure development tackling the more remote locations with routine patrols, community engagement, and resource enhancement (Sundari et al., 2022). Another study in Central Kalimantan explored how the REDD+ project could promote farmers' adoption of fire prevention activities in agricultural lands using monetary incentives (Yamamoto et al., 2020). The study found that engagement in fire prevention increased with the value of agricultural product yields, which are the primary income source for local communities. Additionally, social factors such as mutual assistance and cooperative actions, based on the social norm of reciprocity ("*gotong royong*"), were found to encourage fire prevention. Enhancing residents' intrinsic motivation, driven by peer effects or altruism, with well-designed monetary incentives can help institutionalise fire prevention, making it more effective, reducing carbon emissions, and lowering enforcement costs.

2.4 Discussion

This scoping review highlights various socio-economic and institutional factors that influence fire incidence and management. Key factors influencing fire occurrences include proximity to infrastructure, land use patterns, economic conditions, and demographic characteristics (Chicas & Østergaard Nielsen, 2022; Kyrylaha & Chernenko, 2017; Sze et al., 2019). Economic growth has emerged as a key factor influencing fire ignitions, though its effects are complex and context dependent. In some regions, GDP per capita positively correlates with fire occurrences, like in China and Russia, even if not monotonically increasing, reflecting different socio-economic and land-use dynamics (Ren et al., 2018). Conversely, literature estimating similar predictors in high-income regions like Australia, Western Europe, and the northeastern U.S. found that higher GDP is associated with fewer fire ignitions, likely because economic activities in these areas are less reliant on environmental resource extraction (Makunga et al., 2017). In addition, other socio-economic factors like farmland abandonment in Mediterranean regions have led to extensive fuel beds, complicating fire management (Pausas & Keeley, 2009). Socio-economic conditions, such as unemployment, education levels, and income inequality, can exacerbate wildfire risks, including increased fire-related crime (Canepa, 2024).

The literature highlights the importance of valuing non-market assets for a comprehensive cost-benefit analysis framework (Hesseln et al., 2004), assessing the public's willingness to pay for measures against wildfires (Varela & Soliño, 2015), and explores various economic instruments' effectiveness in altering fire management behaviours (Brown, 2006; Roder, 1997). In various global contexts, incentives have proven effective in modifying behaviours, particularly when aligned with social norms and economic goals, demonstrating the potential for integrated strategies to enhance fire management (Sundari et al., 2022; Yamamoto et al., 2020).

Donovan et al. (2008) found that fire managers, like others, respond to incentives, highlighting that emergency funds for suppression provide little motivation for cost control and adjusting these incentives could impact their actions. Similarly, private forest owners' decisions on mitigating fire risk are influenced by economic incentives, marketable and non-marketable benefits, awareness of existing prevention programs, and the availability of liability insurance might play significant roles in shaping these decisions (Shrestha et al., 2021).

Other incentives, such as performance-based payments in Nepal, have reduced rice straw burning, demonstrating the impact of economic incentives (Pant, 2013). Similarly, initiatives in Jambi Province, Indonesia, combining education, training, and infrastructure have enhanced community participation in wildfire prevention (Sundari et al., 2022). Generally, the literature suggests that determining optimal suppression budgets and developing effective forest and agricultural prevention strategies are more political than economic challenges (Donovan et al., 2008).

For instance, public acceptance of prescribed burns is frequently hindered by safety concerns and exaggerated risk perceptions (Vogler et al., 2015). Legal challenges, such as varying liability standards and burn bans, further complicate fire management, especially in densely populated areas (Clark et al., 2022). Stakeholder attitudes towards fire management vary widely, shaped by differing risk perceptions and economic incentives, past experiences, and cultural norms. Private companies often favour mechanical harvesting, particularly in the WUI, while environmentalists typically advocate for prescribed burning across various land types (Costanza & Moody, 2011; McCaffrey et al., 2008). Indigenous communities worldwide tend to support traditional burning for its cultural and ecological benefits (Christianson et al., 2013; Laris, 2002).

This review generally underscores the need for tailored, local solutions rather than a universal approach that might overlook site specific characteristics (Costanza & Moody, 2011; Paveglio

et al., 2024; Sundari et al., 2022). Increasing firefighting budgets alone is an insufficient strategy, as it often leads to fuel accumulation and more extreme fire behaviour (Pyne, 2001; Reinhardt et al., 2008). A one-size-fits-all approach risks being ineffective, as it may not account for the specific ecological, cultural, and socio-economic and political factors that influence fire behaviour and the effectiveness of mitigation strategies.

Similar conclusions have been drawn in flooding management, where research has shown that localised solutions are often more effective than broad, generalised approaches (de Moel et al., 2015; Merz et al., 2007). Flooding is highly context-dependent, influenced by local geography, weather patterns, urban infrastructure, and community preparedness. Consequently, strategies that work well in one region may be inadequate or even counterproductive in another. However, challenges such as high costs, personnel shortages, and public concerns, especially in the WUI, complicate the application context-specific efforts (Clark et al., 2022; Stockmann et al., 2010).

Effective fire management requires balancing immediate and long-term strategies, integrating traditional ecological knowledge with modern practices, and addressing public perceptions (Paveglio et al., 2024). Research highlights the critical role of coordinating diverse interests through stakeholder partnerships and public participation, aiming to achieve conservation objectives by aligning short-term and long-term goals while considering the socio-economic factors that influence fire management decisions (Costanza & Moody, 2011; Wondolleck & Yaffee, 2000). Community participation and strong collaboration between government and local stakeholders are essential for preventing forest and land fires and ensuring socio-economic benefits (Sundari et al., 2022).

2.5 Conclusion

This chapter outlines the socio-economic and political factors influencing wildfire occurrences, highlighting the importance of understanding regional specifics and cultural influences on fire regimes. Effective wildfire management necessitates integrated approaches that address both ecological and human factors, which are complex and interconnected, indicating the need for a comprehensive strategy to manage diverse behaviours, interests, and incentives. Although global databases provide crucial predictive factors, their broad nature limits the applicability of models at the local level. Research highlights the importance of site-specific dynamics, such as the competing concerns between residents, professionals, and local land use, in shaping successful fire adaptation strategies (Al Abri, 2022; Chicas & Østergaard Nielsen, 2022).

For example, prescribed burning presents a significant challenge: while it aims to prevent the unpredictable and potentially severe impacts of uncontrolled wildfires, it simultaneously exposes nearby communities to the risk of air pollution from the burn and the lower risk of the fire escape. Public education and information campaigns highlighting the benefits of fuel removal can significantly enhance the effectiveness of incentive programs and shift perceptions of controlled burning initiatives (Al Abri, 2022). Public support is essential for the sustainability of prescribed burning, ensuring it remains an environmentally, socially, and economically viable solution (Rideout et al., 2003).

However, wildfire risk mitigation cannot rely solely on educational efforts (Al Abri, 2022). Identifying key actors, fostering collaboration among currently unconnected sectors, and enhancing public participation is essential for balancing diverse conservation interests and addressing the socio-economic factors in fire management. Collaborative mechanisms that promote dialogue, experimentation, and learning among diverse stakeholders are being developed, but comprehensive theoretical frameworks for understanding differential fire adaptation remain limited (Paveglio et al., 2024).

In conclusion, policymakers should adopt flexible, multifaceted, and long-term strategies that address the socio-economic factors and spatial externalities associated with wildfires. These strategies must incorporate recognition of both incentives and disincentives to drive behavioural change among homeowners, farmers, forest managers, and other key stakeholders, including insurance carriers, fire managers, and local authorities. For instance, the role of insurance carriers, particularly in high-risk areas, has often been underestimated. Their potential reluctance to provide coverage due to extensive wildfire risks can undermine mitigation efforts. Revising the structure and role of insurance carriers to ensure they actively support and contribute to fire management, rather than merely limiting their involvement, could enhance both local and regional wildfire management outcomes. Ensuring that insurance carriers provide meaningful support can improve community resilience and foster better cooperation across all levels.

In the following chapters, I will delve into aspects that emerged from this literature review. Chapters 3 and 4 will focus on stakeholder participation. Using qualitative methods, these chapters will explore how policy frameworks, stakeholder incentives, and behaviours shape the current wildfire situation and influence management strategies in the Mediterranean context. Additionally, while the results highlight that the decision between prevention and suppression strategies is influenced by political considerations, the literature review does not fully address the role of political incentives, interests, and the broader political system as potential

contributing factors that might affect environmental outcomes. Chapters 5 and 6 will investigate the incentives and affiliations of policymakers, applying political economics theories and models to explore whether and how these factors shape fire outcomes.

Chapter 3 - Promoting stakeholder interaction and elicit fire management issues: a case study in Monreale, Sicily

3.1 Introduction

This chapter, along with the following Chapter 4, presents the methodology and findings of a case study conducted in Monreale, a municipality near Palermo in Sicily. This fieldwork played a pivotal part in addressing the thesis's objectives, particularly: 1) identify the socio-economic and political factors that influence wildfire regimes, both directly and indirectly, and explore how these factors interact with one another; 2) investigate whether local stakeholders, based on their background and affiliation, can recognise the human dynamics - including interests - driving the ignition, distribution, and spread of fires.

The municipality of Monreale is characterised by Mediterranean landscapes and climate and a complex socio-economic and institutional history. Like other Mediterranean regions, fire management policies in Monreale have prioritised active fire suppression at the expense of traditional practices rooted in pastoralism, ranching, and prescribed burns, which historically helped prevent large-scale wildfires (Castellnou et al., 2010). This suppression-focused approach (Olson et al., 2015) often overlooks the complex socio-ecological processes underlying fire use (Moreira et al., 2020). Additionally, shifts in historical fire regimes due to climate change, demographic shifts, and land-use changes (Doerr & Santín, 2016) have compounded the effects of strict fire exclusion. These combined factors have heightened the risk of severe wildfires, with significant economic and ecological consequences (Duane et al., 2021).

Monreale is also particularly significant given the wide range of opinions among experts and stakeholders regarding the causes of fires and effective management strategies. The literature highlights that stakeholders' interests can profoundly shape fire management policies and their effectiveness (Costanza & Moody, 2011). However, stakeholders often operate within institutional silos driven by conflicting priorities, ultimately undermining coordination (Marques et al., 2020). The lack of communication and consensus among stakeholders can hinder the effective implementation of fire management policies (Wunder et al., 2021), resulting in competing narratives and interests surrounding fire management practices (Swedeen, 2006). Understanding these diverse interests and priorities across various governance levels is essential for fostering cooperation among institutions and stakeholders (Kapetas et al., 2019) and enabling informed decision-making to learn, or re-learn, how to coexist with fire amid climate and environmental change (Finucane, 2009; San-Miguel-Ayanz, 2022).

Collaborative governance and participatory planning have proven effective in integrating diverse perspectives in conservation projects (Keough & Blahna, 2006) and enhancing community connections in fire management (Compton et al., 2007; Ostrom, 2015). Previous research highlights the effectiveness of collaborative or participatory planning approaches in conservation management (Keough & Blahna, 2006; Liu & Yang, 2020). In the realm of fire management, they have strengthened connections among communities and stakeholders, improving cross-sectoral management strategies (Brannan et al., 2006; Jackman & Miller, 2003; Keough & Blahna, 2006; Mistry et al., 2019; Strzelecka et al., 2021; Suiseeya, 2020).

A small but growing body of literature uses participatory approaches to study stakeholders' opinions and facilitate coordination in fire management. Tebbutt et al. (2021) and Copes-Gerbitz et al. (2021) apply participatory mapping to identify wildfire drivers in Tasmania and the Colombian Amazon, emphasising the importance of involving diverse stakeholders in decision-making while (Brenkert-Smith et al., 2017) use participatory systems analysis to assess obstacles to fire management in Australia. In South America, Bilbao et al. (2019) organised a participatory workshop to address tensions among stakeholders about fire management, resulting in an intercultural network to promote collaboration.

In Mediterranean Europe, participatory workshops and focus groups are used in forest management to tailor future scenarios to stakeholder needs (Palacios-Agundez et al., 2015). In Monchique, Portugal, a research project uses participatory mapping to highlight local knowledge and community agency in fire management, fostering a community-based disaster risk reduction approach (Partidário et al., 2022). There, active stakeholder participation led to a shared understanding of vulnerabilities and to the development of risk reduction strategies. However, despite increasing recognition of the importance of local knowledge, participatory action research in fire management remains underexplored in Mediterranean Europe.

Here, I apply a participatory research approach (Chambers, 2012), employing a workshop to provide a forum for local stakeholders with an active interest in fire management to exchange perspectives while fostering an understanding of their positions (West et al., 2008). I focus on the characterisation of the diverse and conflicting priorities, interests, and attitudes behind fire use and governing management in a traditional Mediterranean landscape with a history of land-use and fire regime changes and challenges. The workshop convened representatives from diverse sectors engaged or interested in different degrees in fire management policy, aiming to discern the factors influencing wildfire frequency and severity. Additionally, the workshop aimed to provide a foundation for understanding agreements on adopting fire management strategies and building collaborative networks at the local level (Piroli et al., 2025).

3.2 The national, regional and municipal context

Italy's Mediterranean climate, characterised by hot, dry summers, makes the country highly vulnerable to wildfires (San-Miguel-Ayanz, 2022). Despite efforts to expand forested areas, which now cover 11,054,458 hectares (36.7% of the country), wildfires have damaged approximately 1,100,000 hectares over the past 30 years (Gasparini et al., 2022). Forests play a crucial role in biodiversity, environmental stability, and economic contribution. However, the complex and evolving relationship between human activity and fire regimes remains a critical issue (Ford et al., 2021).

The economic divide between northern and southern Italy, which began in the late 19th century with industrial growth in the north and a lagging economy in the south, has had lasting consequences (Felice et al., 2019). Southern Italy's attempts at industrialisation, such as through the Southern Development Fund (in Italian: *Cassa per il Mezzogiorno*), led to socio-economic distortions and institutional fragility, hindering long-term growth (Cesaratto & Zezza, 2018; Charron & Lapuente, 2018). The South has also experienced population decline, an ageing demographic, and a brain drain, leading to a substantial loss of human capital as people migrate to the Centre-North (Svimez, 2017). By 2022, Sicily's population had declined to 4,814,016, marking a 0.4% decrease from 2021 due to natural decline and internal migration¹. While larger cities have generally maintained their populations, smaller towns have continued to shrink. Notably, about 47.3% of Sicilians reside in the provinces of Palermo and Catania.

In Sicily, much of the current forested areas stem from large-scale reforestation projects initially funded by the *Cassa per il Mezzogiorno*. These projects, initiated in 1950 under Law 646/10, aimed to support socio-economic development through infrastructural improvements, focusing primarily on public lands and soil protection (Cantiani et al., 2018). After the fund's dissolution, the Sicilian region continued reforestation efforts to protect soil and mitigate erosion on abandoned public properties. Today, forests cover nearly 20% of the island (Sadori et al., 2015), yet Sicily remains highly susceptible to wildfires due to its dry summers and Mediterranean climate.

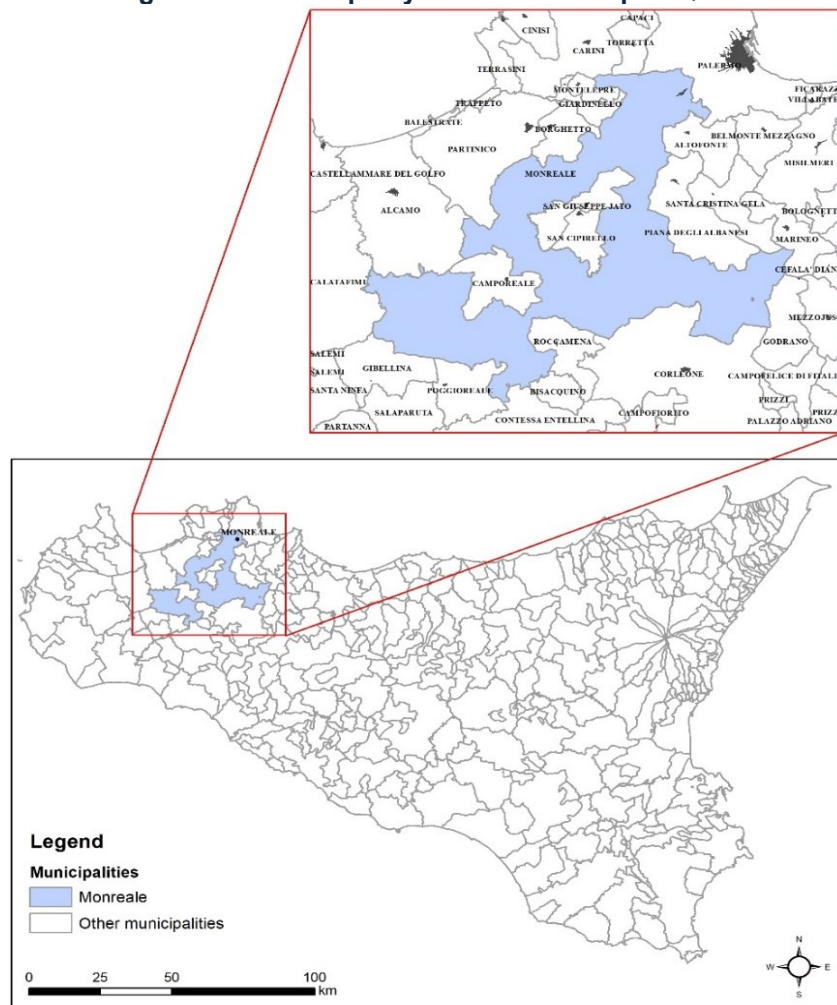
Historical wildfire data in Sicily from 1980 to 2022 reveals a significant increase in fire activity over the last 15 years, with particularly high peaks during years with extreme weather events occurring at increasingly shorter intervals (La Mela Veca et al., 2024). In 2021, an alarming 87% of wildfires in Italy occurred in just three southern regions: Sicily, Sardinia, and Calabria (Legambiente, 2022). Sicily experienced the highest number of fires, with extensive areas

¹ Data extracted on 12 February 2025 at 11:18 UTC (GMT) <https://www.regione.sicilia.it/sites/default/files/2024-07/popolazione.pdf>

devastated by flames. In 2023, fires in Sicily account for 70% of the total burned area in Italy (La Mela Veca et al., 2024). Its arid summers and vast forested and inhabited areas make it highly prone to wildfires. These fires not only devastate public and private infrastructure but also deteriorate air and water quality, harm biodiversity, degrade soil health, and scar the landscape.

Factors contributing to this include uncontrolled fires, exacerbated by the sirocco wind from northern Africa, which fuels fire spread. Although climate change plays a role in increasing fire risk (Turco et al., 2014), human activities remain a major contributor, accounting for 77% of vegetation fires in Italy in 2021 (Legambiente, 2022). The traditional use of fire for land management, such as burning fields and vegetation, remains prevalent in Sicily. However, migration-driven abandonment and degradation of agricultural lands have intensified wildfire risks (Gasparini et al., 2022) and eroded knowledge of cultural burning practices. Compounding these challenges, a summer prohibition on intentional ignitions often results in unattended fires spiralling out of control (Ascoli & Bovio, 2013).

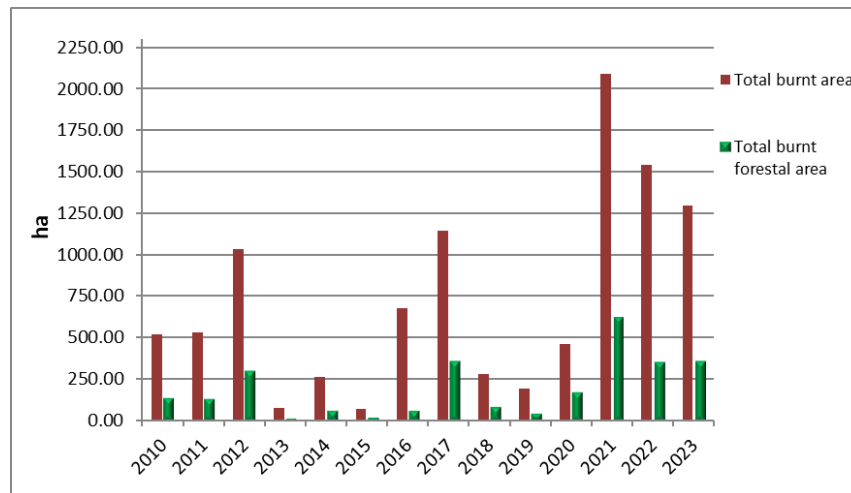
Figure 3.1 - Municipality of Monreale map in QGIS



Monreale, located near Palermo with approximately 40,000 residents, has also been heavily impacted by wildfires. The municipality, in Figure 3.1, encompasses several wildland-urban interface areas, agricultural lands, and forests spread across seven protected areas: Bosco della Ficuzza, Bosco delle Cappelliere, Rocca Busambra, Gorgo del Drago, Valle del Fiume Oreto, Monte Pizzuta, and Monarda.

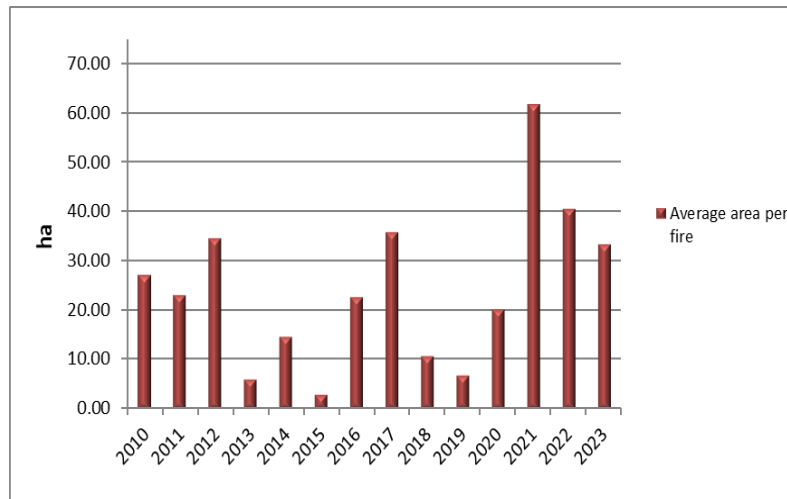
Between 2010 and 2023, a total of 337 fires were recorded in Monreale, affecting an area of 8,862 hectares (figures 3.2 and 3.3). Of this affected area, approximately 26% (2,297 hectares) was forest land. The average yearly fire-affected area during this period was 682 hectares, with an average fire-affected area of 26.30 hectares. Notably, particularly devastating fires occurred in 2021 and 2022, with peak affected areas of 61.51 hectares and 40.52 hectares, respectively².

Figure 3.2- Total burnt area and forested area in Monreale from 2010 to 2023



Data source: Forest Corps of Sicily

² This data has been sourced from the Regional Forestry Corps of Sicily in November 2023.

Figure 3.3 - Average burnt area and in Monreale from 2010 to 2023

Data source: Forest Corps of Sicily

3.2.1 Wildfire regulations and laws

In Italy, fire governance is primarily guided by Framework Law L. 353/2000, which establishes the foundation for wildfire prediction, prevention, and active firefighting. The law provides a clear definition of "forest fires," assigns responsibilities to both regional and national agencies, and offers planning tools at the regional level (Article 3) and within national parks (Article 8). Regions are responsible for planning, prevention, and active firefighting, using their own resources while coordinating with national entities, such as the National Civil Protection Department and the National Fire Brigade (CNVVF). However, several challenges persist within this framework. Firstly, the law's definition of forest fires has led to varying interpretations across regions, complicating the collection of standardised national data.

Since 2021, the *Carabinieri Forestali* has been responsible for mapping wildfire perimeters in regions with ordinary statutes, while regional forest corps handle this task in autonomous regions like Sicily. Despite updates to Law 353/2000 through Law 155/2021, which aimed to clarify these mapping responsibilities, issues with data storage and standardisation remain unresolved. The lack of a national database containing standardised information -such as ignition points, georeferenced fire perimeters, weather risk indices, and fire causes - limits the development of coordinated and effective fire management strategies. Furthermore, regions face difficulties in defining preventive measures within their wildfire management plans, often due to restrictive regulations and a conservation-focused perspective, which hinders more proactive approaches to wildfire prevention.

In Sicily, pioneering legislation, Regional Law 36/1974, tasked the Regional Forest Corps of Sicily (RFCS) with preventing, surveilling, detecting, and reporting fires. It mandated firefighting

interventions and the regional government's financial responsibility for fire-related expenses. Expanding this, Regional Law No. 16/1996 introduced planning concepts and personnel training provisions. Despite an extended hiring freeze, the Regional Forest Corps of Sicily (RFCS), established in 1972, oversees Sicilian forests and plays a key role in coordinating prevention, surveillance, and firefighting efforts.

While Legislative Decree No. 177 of 2016 dissolved the Forestry Corps nationally, Sicily, as a special status region, recognised the importance of maintaining the RFCS for natural heritage preservation. Thus, RFCS retains responsibilities for coordinating prevention, surveillance, apprehension efforts, and active firefighting functions. However, the RFCS struggles with personnel shortages and an ageing workforce, making it increasingly difficult to effectively manage wildfire prevention and response efforts (Legambiente, 2022), despite the establishment of the Department of Civil Protection in 1992.

Table 3.1 summarizes the key organisations involved in wildfire management in Sicily, along with their respective legislation and responsibilities. These include the Regional Forest Corps of Sicily (RFCS), the Department of Civil Protection (DPC Sicily), the National Fire Brigade (CNVVF), the Regional Department of Rural and Territorial Development (RDRTD), and the Regional Department of Environment (RDE).

Table 3.1 - Roles and responsibilities of the institutional bodies in Sicily

Organisation/department	Functions	Responsibilities
Regional Forest Corps of Sicily (RFCS)	Forest fire planning and natural heritage preservation.	Coordinates prevention, surveillance, and firefighting.
Department of Civil Protection (DCP Sicily)	Forecasting and preventive measures for diverse risks.	Safeguards assets and individuals during emergencies.
National Fire Brigade (CNVVF)	Technical safety interventions during emergencies.	Addresses fire incidents and diverse emergencies and focuses on wildfires in rural areas and the wildland-urban interface.
Regional Department of Rural and Territorial Development (RDRTD)	Governance of Sicily's territory and management of public forest areas.	Manages economic development, vegetation restoration, and forest fire prevention strategies.
Regional Department of Environment (RDE)	Oversight of Sicily's regional parks, nature reserves, and Natura 2000 network.	Protects regional parks, addresses pollution, monitors areas at environmental risk, and promotes strategic environmental assessments.

3.3 Methodology

Participatory workshops offer a valuable platform for engaging multiple stakeholders, facilitating the exchange of ideas, and gaining insights into their motivations and perspectives (West et al., 2008). In selecting participants for the study, it was crucial to include not only those directly involved in fire management but also individuals affected by wildfires, either through their roles or experiences (Pivello et al., 2021). This broader inclusion allows for a more holistic understanding of the context and the connections between participants and helps in identifying key interests, behaviours, and potential areas for change (Guerrero et al., 2013; Pierson et al., 2024).

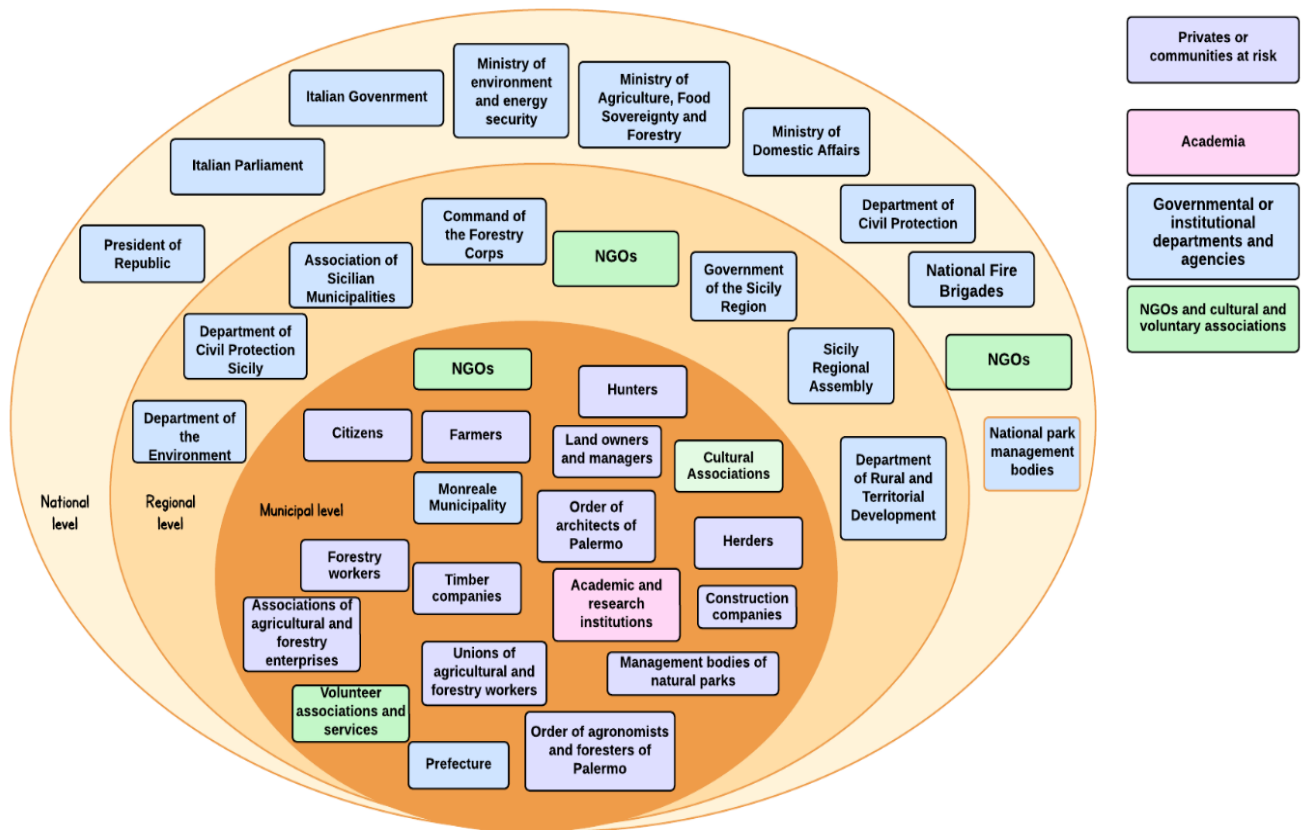
3.3.1 Stakeholder identification

To identify and categorise the stakeholders involved in fire management, I conducted a stakeholder analysis using the framework outlined by Reed et al. (2009). This approach enabled the systematic identification of individuals, groups, and organisations engaged in decision-making processes (Enserink et al., 2022) and allowed for an assessment of their influence in fire and land management activities. The Regional Plan for Forest Fire

Management 2023-2025, issued by the regional forestry authority, served as a key reference for this analysis.

This plan provides a comprehensive framework for fire management, outlining the roles and responsibilities of various bodies involved in fire management, ranging from national to municipal and local levels. Additionally, I incorporated information from key local organisations, including documents and projects managed by the Department of Agricultural, Food and Forestry Sciences (SAAF) at the University of Palermo, which oversees various forestry initiatives across different parks in Monreale. I also collaborated closely with the Office of the Mayor in Monreale, particularly during the stakeholder identification phase, to ensure the inclusion of relevant local actors.

Figure 3.4 - Onion diagram of the stakeholders grouped by jurisdictional level



Stakeholders were selected based on their expertise in relevant fields such as environmental policy, forestry, agriculture, or fire management, which made them essential sources of knowledge and insight. I categorised them into four broad groups: (i) government institutions, departments, and agencies; (ii) private organisations, individuals, and communities at risk; (iii) academic institutions; and (iv) NGOs and voluntary organisations. Figure 3.4 presents an onion

diagram illustrating the different stakeholder groups organised according to their jurisdictional levels.

3.3.2 Workshop structure

In June 2023, it was held a participatory workshop (West et al., 2008) to facilitate the exchange of ideas among various stakeholders and gain a deeper understanding of their motivations. Invitations were sent via email using a non-probability snowball sampling method (Reed et al., 2009), targeting networks and organisations identified during the stakeholder analysis.

The workshop was attended by 18 participants, representing a wide range of key stakeholder groups, including the Regional Forest Corps of Sicily (RFCS), the Department of Civil Protection (DPC Sicily), the National Fire Brigade (CNVVF), the Regional Department of Rural and Territorial Development (RDRTD), and the Regional Department of Environment (RDE), forestry experts, workers and trade unions, academia, NGOs, and cultural and voluntary organisations. The participant demographics reflected the male-dominated nature of fire-related professions, with 89% of attendees being male and 64% falling within the 40-64 age range. This imbalance is driven by the traditionally male-dominated nature of the field and a prolonged hiring freeze within the Regional Forest Corps of Sicily. It also reflects the broader gender disparity in unemployment across the region³.

Alongside another facilitator from the SAAF, I led the workshop in Italian, guiding discussions and encouraging participants to share their thoughts openly. The format was intentionally kept flexible to allow an in-depth exploration of the complex dynamics surrounding fire management in Sicily, providing all participants with an equal chance to speak and engage, even when opinions differed. The three participatory activities were carefully designed to ensure that each stakeholder could share their perspective, with each activity building on the previous one to foster interconnectedness. I selected the activities specifically for their complementarity in eliciting information from stakeholders, facilitating a progression from broad concepts to more specific insights developed through dialogue.

The activities enabled me to assess whether there was consensus - and in which specific arguments or themes - regarding the causes, effects, and roles of various stakeholders. Additionally, they helped identify who is most directly impacted by fires and who has the capacity to drive change and contribute to systemic transformation. These insights were crucial in aligning with the thesis's Objectives 1 and 2. All discussions were recorded and subsequently

³ Data extracted on 11 February 2025 at 10:02 UTC (GMT) from Istat:
<http://dati.istat.it/Index.aspx?QueryId=20744&lang=en>

transcribed for analysis. The data are available on Zenodo.org and can be accessed using the following DOI: 10.5281/zenodo.13684035. I employed an inductive coding process to analyse the transcripts, identifying themes, arguments, and viewpoints that naturally emerged from the data without imposing predefined categories.

- Rich pictures description

In the initial activity, participants were organised into two groups, each comprising a blend of civilian and institutional representatives, along with a facilitator who guided the discussions and recorded the proceedings. Their objective was to collaboratively create a “rich picture” that encapsulated their immediate thoughts, emotions and ideas about fires in the region (Bilbao et al., 2019). The groups had the freedom to determine the content and layout of their rich pictures, which could include drawings, symbols, and key terms (Berg & Pooley, 2013; Walker et al., 2014). This exercise acted as an icebreaker, promoting the sharing of perspectives and themes among participants. At the conclusion of the session, each group showcased their rich pictures to the others.

- Stakeholder matrix description

Building on the stakeholder analysis described in section 3.1, I aim to organise stakeholders into groups according to their interests and influence in fire-related activities (Varvasovszky & Brugha, 2000). To distinguish between decision-makers and decision-takers (Grimble & Wellard, 1997), I developed an interest-power matrix (Reed et al., 2009). During the plenary session of the workshop, participants were invited to assess each stakeholder group based on their levels of “interest” and “power” (Appendix B.2), utilising a scale of 1 to 10, with 1 indicating low and 10 indicating high, thereby creating a four-quadrant matrix.

Although “influence” and “power” are often used interchangeably in stakeholder mapping, I adhere to a definition of power found in the literature. Here, power is viewed as an attribute linked to control over essential assets, the unequal distribution of resources, or an actor's capacity to mobilise resources (Marques et al., 2019). To mitigate any potential confusion regarding these definitions during the plenary session, I arranged follow-up activities that included one-on-one sessions with each participant to develop the stakeholder matrix. In these sessions, respondents were encouraged to elaborate on the reasoning behind their evaluations.

Moreover, beyond identifying key stakeholders in fire management, understanding their diverse interests and levels of power can help refine engagement strategies. This insight fosters

potential collaborations for future local partnerships and supports a more comprehensive management approach (Eden & Ackermann, 1998).

- Problem tree description

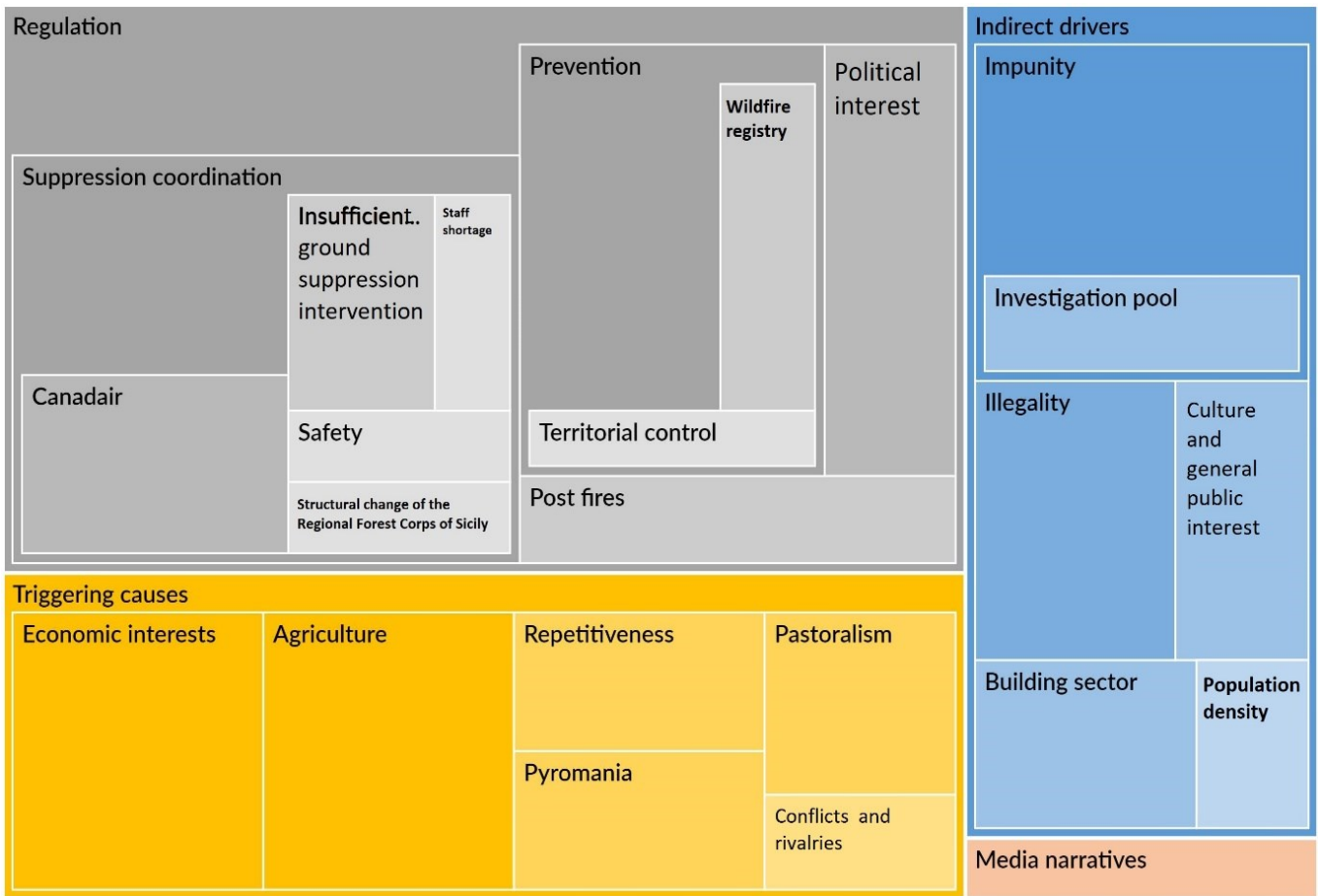
During the third activity, participants engaged in a plenary session to develop a problem tree. This analytical tool has been employed in various contexts, including poverty alleviation and agricultural development, to enhance understanding and address complex issues (Adesope & Ogueri, 2018; Ammani et al., 2010). Problem tree analysis helps simplify intricate problems by breaking them down into manageable parts, represented in a tree diagram that illustrates the causal relationships surrounding the issue, akin to a mind map (European Commission, 2004; Renger & Titcomb, 2002).

The primary objective of this exercise was to identify the factors contributing to the initiation and prevalence of wildfires in the region while also investigating the motivations and interests of the stakeholders involved. The heart of the activity lies in the discussions and dialogues that arise as participants organise and reorganise the various factors identified (Renger & Titcomb, 2002).

3.4 Results

Figure 3.5 displays a hierarchical chart outlining the themes discussed during the workshop, with the size of each area representing the amount of time spent on each theme. The primary topics of discussion included the coordination of firefighting efforts, the lack of a strong culture of prevention, and issues of institutional authority. Causes and indirect drivers were the second most frequently addressed topics, followed by some references to the role of media and their narratives.

Figure 3.5 - Hierarchical chart of themes explored during the workshop



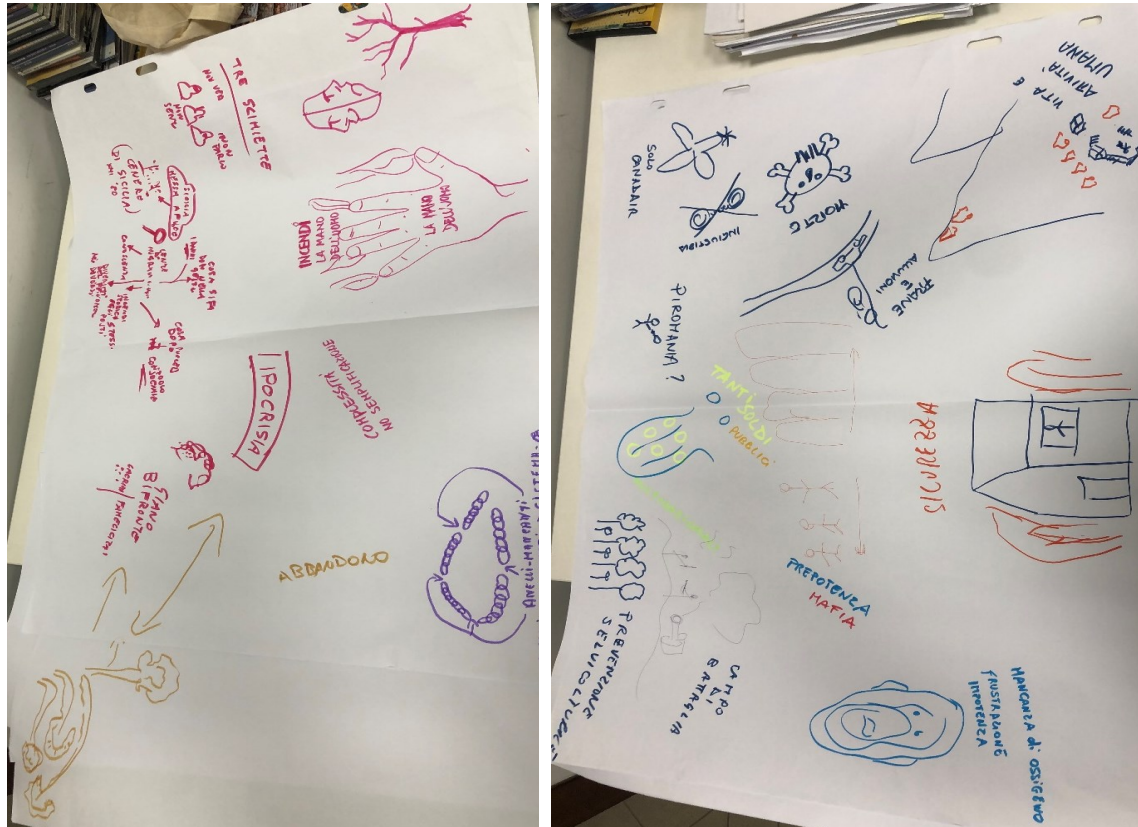
3.4.1 Rich pictures results

The rich pictures activity (Figure 3.6) highlighted the substantial emotional aspects of participants' experiences with fire. All groups expressed emotional engagement, using terms that underscored the psychological impacts of wildfires, such as "anger," "frustration," "preoccupation," "helplessness," "death," and "devastation." These sentiments were frequently noted in the groups' illustrations.

Participants also discussed operational aspects related to both prevention and firefighting. There was a clear recall of the historical evolution of institutions involved in fire management.

Some recalled that five decades ago, the military and local citizens took on firefighting duties, even for minor incidents. The formation of the DCP was identified as a key milestone in the process of “institutionalisation and politicisation of wildfires.” This change has resulted in reduced public involvement in direct firefighting efforts, in stark contrast to the more active role the community played in earlier times.

Figure 3.6 - Rich pictures from the two working groups



Additionally, there has been an increasing dependence on aerial extinguishing methods, particularly as larger wildfires have become more common, which has further diminished the public's sense of responsibility for participating in firefighting activities.

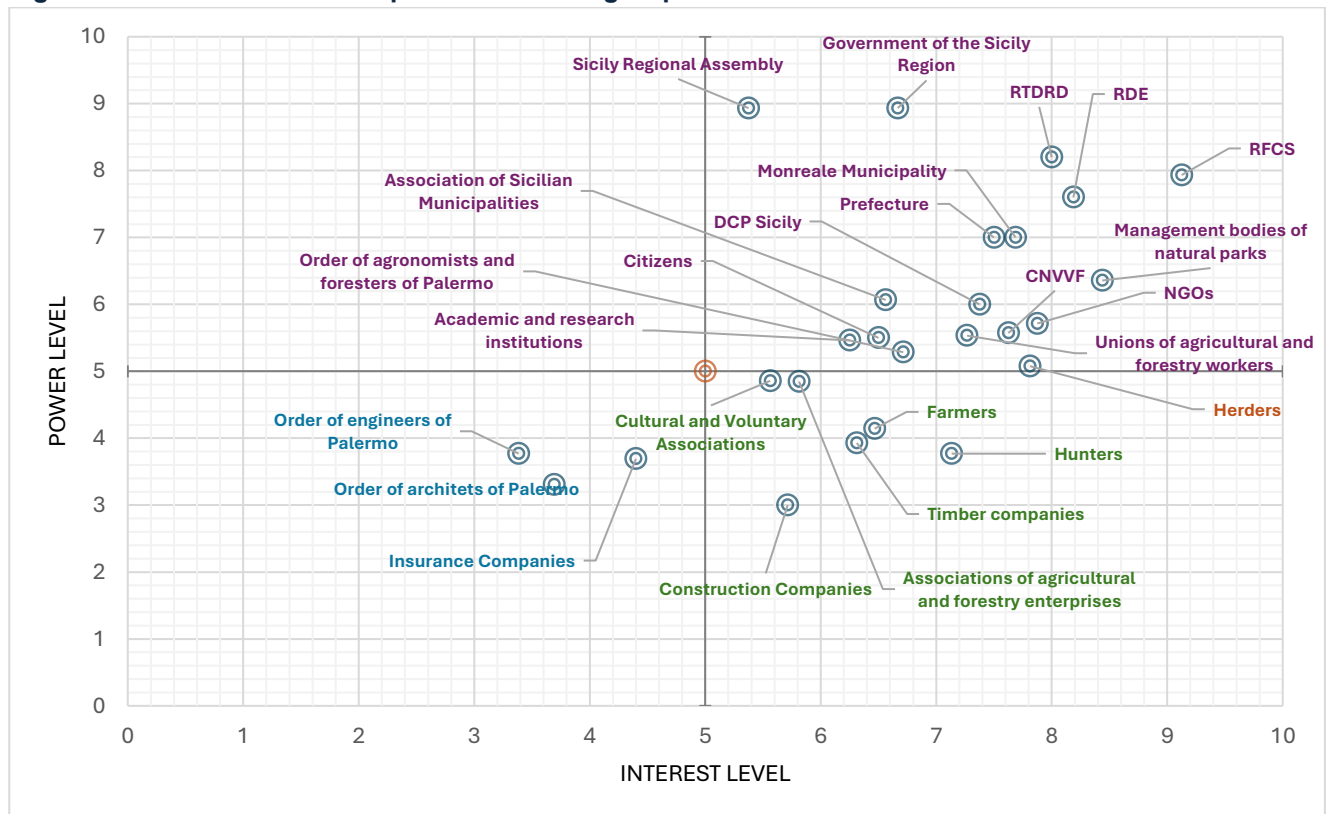
"Historically, reflecting on firefighting efforts - when they were unified under a single umbrella – there was a shift from social to political-administrative concerns. The establishment of civil protection services further emphasised economic over social aspects. In the past, firefighting was seen as an adventure, with everyone, from children to women, boarding fire trucks to extinguish relatively small fires. However, the transition to aerial firefighting activities transformed it into a paramilitary operation. Nowadays, firefighters rely on planes, and training occurs during active firefighting periods rather than in winter. This shift has turned firefighting into a spectacle, and there is a need to return to its roots."

- Participant 8, during the rich pictures session

3.4.2 Stakeholder matrix results

After the workshop, I held individual sessions to develop the stakeholder matrix. Figure 3.7 illustrates the positioning of each stakeholder group within the power-interest framework. Those situated in the top right quadrant are termed "leaders," representing stakeholders with both high interest and high power. They carry the primary responsibility for wildfire management within the current institutional framework. This category predominantly includes institutional organisations such as the Regional Forest Corps of Sicily (RFCS), the Department of Civil Protection (DCP Sicily), the National Fire Brigade (CNVVF), the Regional Department of Rural and Territorial Development (RDRTD), and the Regional Department of Environment (RDE). Additionally, this group encompasses NGOs, academic institutions, local citizens, and the municipality.

Figure 3.7 - Power-interest map of stakeholder groups



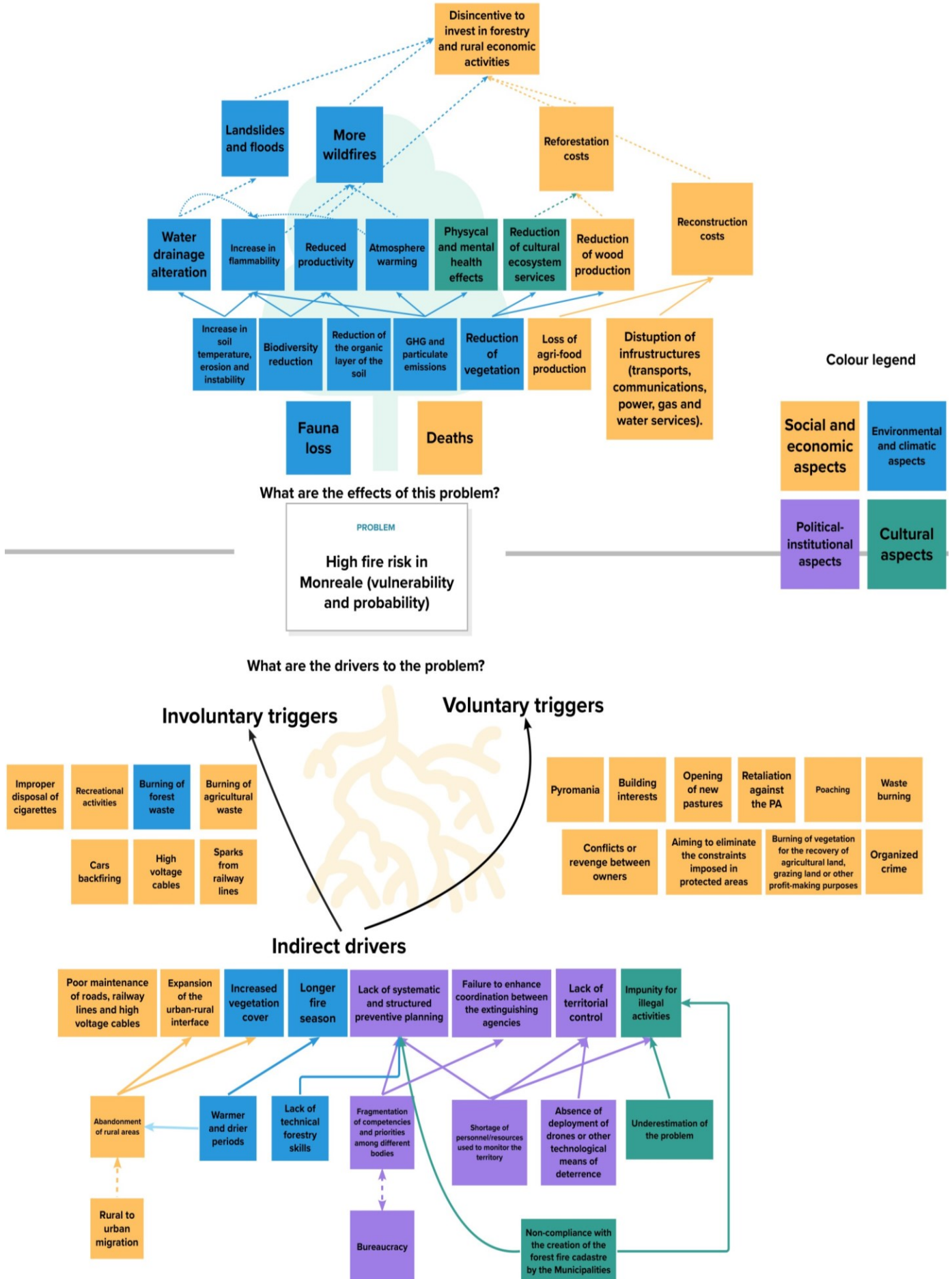
In the bottom right quadrant are the "players," characterised by high interest but low power. This group, which includes private companies and cultural associations, may lack formal authority but holds valuable insights and a certain degree of influence over the factors and dynamics that contribute to wildfire incidents. The bottom left quadrant contains the "crowds," which are stakeholders with both low interest and low power. Notably, no stakeholders were identified as fitting into the low interest-high power category.

This figure highlights the potential roles stakeholders can play in collaborative fire management across institutions and various groups. A network strategy that encourages future collaboration at the local level among stakeholders with significant interest and power could facilitate a more integrated approach to fire management (Eden & Ackermann, 1998). In this context, regional institutions must not only enhance coordination and collaboration within different departments and municipalities but also foster a network that includes academia, NGOs, citizens, forestry workers, and unions to create a comprehensive fire management framework.

3.4.3 Problem tree results

Figure 3.8 displays the problem tree developed during the third activity. This tree illustrates the participants' consensus on Monreale's vulnerability to wildfires and the increasing frequency of these events as primary concerns. Following this, they examined the direct causes and effects related to the central issue, using the tree structure to depict these complex interconnections visually.

Figure 3.8 - Problem tree developed during the workshop



- *Effects*

During the workshop, participants unanimously acknowledged the severe impacts of wildfires in the region. They recognised that these incidents cause significant human casualties and injuries, pose threats to local communities and disrupt infrastructure. Additionally, participants highlighted that wildfire emissions of greenhouse gases and particulate matter contribute to air pollution, with long-term consequences for air quality and human health. The discussion also underscored the detrimental effects on biodiversity and ecosystem health.

"Fires create a point of discontinuity in the territorial management. Consequently, the aftermath of fires includes floods and landslides, especially in the Monreale area, as the protective vegetation is compromised. Previously, the Oreto valley had no vegetation. After the flood of 1931, significant efforts were made to reforest the entire Oreto valley, including Monte Pellegrino."

- Participant 18 (during the problem tree session)

While there was a general agreement on the importance of restoring landscapes to their pre-wildfire conditions, participants also recognised that reforestation and ecosystem restoration come with considerable financial implications for local and national governments and communities. The productivity of soil declines significantly after a wildfire, which adversely affects agricultural and forestry operations. The decline in agricultural production and timber resources further impacts local economies and livelihoods. Consequently, there were concerns about the future viability of the forestry sector, with apprehensions that the ramifications of wildfires might discourage investments in economic activities linked to forestry and rural areas.

- *Causes*

Participants identified factors such as depopulation, abandonment of rural areas and agriculture, and changes in land cover as significant indirect drivers of wildfire incidents. While there was agreement regarding the lack of a preventive culture, inadequate pastoral and farming practices, a shortage of forestry-trained personnel for effective forest management, and the overall impunity of those responsible, there were differing opinions about the role of suppression coordination among the relevant authorities. Some participants contested the inclusion of firefighting coordination as a contributing factor to wildfire risk, while others provided examples of past fire incidents in Monreale where suppression efforts failed. Additionally, concerns were raised about whether the ageing workforce within the forestry corps could meet the increasing demands of forest fire management.

"(...) I would say that there weren't any problems related to coordination. We operate according to well-established procedures, have a unified operations room, and coordinate aircraft recalls collaboratively. In other words, we have a system that has worked very well, especially in recent years. (...) Since last year, firefighters have also trained DOS⁴ personnel, who are the directors of firefighting operations. Therefore, considering that the airplanes are under the fire brigade management, if in that area, at that moment, there is no forestry DOS, there is also a firefighter's DOS for forest fires."

- Participant 4 (during the problem tree session)

"(...) Regarding the fires in Monreale, I can share two dramatic cases. In 2021, a fire passed through the grove, entered Strasatto, consumed Carpineto, and reached Piana, practically travelling across Sicily. On that bad day, at least three teams from different bodies - AIB, firefighters, and civil protection - were present. Drawing from my firefighting experience, I know that when there's a sensitive spot, a line of fire, you must concentrate as many men as possible to stop it and then move to another spot. Instead, these potentially coordinated teams were scattered for various reasons. Only one team from the forestry corps remained, consisting of four people, highlighting the issue of decreasing personnel. The fire jumped the fender, passing through Strasatto, Piana degli Albanesi, and more. Now, let's discuss the terrible summer of 2022 in Valle Presti. On the night of August 15, 2022, things worked well; teams from the forestry corps, civil protection, and firefighters successfully controlled the situation. However, on August 18, a terrible day, around 12:30 pm, there was no longer a full team available. Some were sent to Contrada Barone. Despite efforts over three days, the fire reignited, leading to the devastation of Valle Presti—a tragic consequence of insufficient teams and resource allocation. That's what frustrates me."

- Participant 16 in response to Participant 4 (during the problem tree session)

Ultimately, participants concurred that firefighting forces have been facing challenges in addressing the large wildfires observed in recent decades, primarily driven by climate change, as well as by a lack of personnel and the fragmentation of priorities and responsibilities among various agencies.

"What is changing is the nature of the phenomenon. There are too many fires of aggressive nature, which tends to strain the existing structures. (...) Today, the scale of the phenomenon, not only here but in other regions as well, has become so extensive and intense that it is placing a significant burden on institutional systems. I believe this can be stated: you are forced to confront situations in certain contexts with complexities that put the systems - which include not only personnel but also resources and technical expertise -

⁴ DOS is the acronym for *Direttore delle Operazioni di Spegnimento*, which translates to Director of Fire Suppression Operations in English.

under stress. There should be more resources and additional structures in place. So, the phenomenon's widespread nature is creating challenges."

- Participant 5 (during the problem tree session)

The fragmentation of responsibilities across various bodies, stemming from bureaucratic challenges, has impeded efforts to enhance coordination among firefighting organisations as they adapt to changing climate conditions.

"Yes, where the flames are high. I'm sorry to say it, but in the end either there is an aerial support, or we won't be able to work."

- Participant 4 in response to Participant 5 (during the problem tree session)

Furthermore, some stakeholders highlighted that wildfires only attract public interest when they threaten urban areas and homes. Participants expressed that the media narratives surrounding wildfires do not reflect their actual experiences. They argued that media coverage often sensationalises wildfires, linking them to organised crime or mafia involvement to draw in viewers, despite lacking concrete evidence to back such claims. This focus on sensational stories obscures the genuine causes and management challenges related to wildfires, resulting in confusion and uncertainty among the public.

The true complexities of wildfires, often intertwined with various socio-economic factors, tend to be overlooked in these narratives. For instance, participants noted the use of fire to resolve disputes among landowners, as well as the actions of local farmers and herders who continue to clear land during the summer, often ignoring established national bans. This disregard for regulations points to a broader issue, highlighting the need to restore respect for rules and adopt a more comprehensive approach that goes beyond mere technical fire management. The NGO representative raised concerns about the frequent use of fire in protected areas, often with the intent of lifting agricultural or development restrictions in these regions.

Concerns about speculative development have revealed significant gaps in national legislation regarding the issuance of building permits in forested areas, which had previously been stringently regulated. The relaxation of strict non-buildability provisions has opened doors for potential abuse, as past incidents have shown where fires were deliberately set to manipulate land-use regulations for individual benefit. This situation underscores the need for a reassessment of current legal frameworks and their broader implications for environmental and social issues.

"We are in one of the realms of illegal construction. (...) We are not talking about hidden criminological phenomena it is not like drugs or murder. We are talking about illegal construction, what is illegal construction if not violating laws in broad daylight? Fires are becoming much more of a thing of this nature."

- Participant 5 (during the problem tree session)

The widespread presence of illegality and its impact on various aspects of society, particularly in rural areas and territorial control, can be understood in two ways: on the one hand, it reveals a marked institutional laxity toward environmental issues; on the other, it reflects a culture of self-serving individualism among the public.

"Illegality that is not necessarily linked to the existence of mafia, illegality that is in Sicilian culture, the culture of 'mine', of the private good and not of the public good, I don't take care of that of others, I take care of my own property, I do my interests. I don't care if I create problems for others."

- Participant 6 (during the problem tree session)

3.5 Discussion

The participatory workshop brought together representatives from diverse sectors involved in fire management policy with the aim of fostering a comprehensive understanding of the roles, behaviours, interests, and priorities of key stakeholders in Monreale's jurisdictional area. To my knowledge, this marked the first attempt to explore a participatory approach to identify major fire management issues within the territory. The discussions provided important insights into fire and land management in the municipality of Monreale, unveiling diverse perspectives on socio-economic and political dimensions. In this initial attempt, stakeholders engaged in a novel way, sharing information and perspectives. However, much more work is needed for them to fully recognise each other's value and role in the development of local participatory management strategies. The results of the workshop and the thematic analysis were used to further engage with stakeholders, assessing whether common ground could be found to advance more sustainable local policies (Piroli et al., 2024).

During the discussions, especially the rich picture exercise, I observed a clear emotional response to fire, particularly when discussing negligent and malicious triggers. Sentiments of anger and despair reported by participants are consistent with previous research on the negative impacts of wildfires on human well-being. While some cases of natural disasters can result in positive changes and post-traumatic growth (Hefferon et al., 2009) et al., 2009), other

studies indicate an increase in depression, feelings of hopelessness and anxiety, as well as post-traumatic stress disorder (Knez et al., 2018; To et al., 2021). Additionally, individuals may experience emotions such as loss of solace from the landscape and grief (Eisenman et al., 2015).

The workshop highlighted unanimous recognition of the negative effects of wildfires, including threats to human safety and health, biodiversity, and ecosystems, as well as economic disruptions and air pollution. Participants also noted soil erosion, altered water patterns, and increased risks of landslides and floods, further endangering settlements. All these findings align with the general literature related to wildfires (Doerr & Santín, 2016; Frankenberg et al., 2005; Robinne, 2021; Stephenson et al., 2013). Additionally, they expressed fear about the future of the forestry sector due to potential deterrents caused by wildfire consequences and the costs of restoring landscapes.

Overall, discussions among stakeholders revealed a notable diversity of opinions, especially between institutional bodies and civil society groups. The NGO representative expressed a deep mistrust of governing institutions, criticising their response to fire challenges and their structural inability to effectively address the escalating risks posed by climate change. Much of the conversation focused on socio-economic and demographic issues in Sicily, including the abandonment of agricultural lands due to migration (Gasparini et al., 2022) and property disputes (Ascoli et al., 2022). This focus on human activities reflects their substantial contribution to vegetation fires in Italy (Legambiente, 2022).

Concerns have emerged regarding the freeze on hiring within the Forest Corps in Sicily, an institution responsible for tasks ranging from combating wildfires to environmental conservation across the region. This freeze is detrimental to the sustainability of the Forest Corps. In contrast, other similar special status regions like Valle d'Aosta, Friuli Venezia Giulia, Trentino-Alto Adige/South Tyrol, and Sardinia have successfully conducted legitimate hiring competitions, leading to the employment of young individuals who contribute to their respective regions. The limited presence of specialised personnel and inadequate preventive control measures in Sicily highlights the challenges in mitigating catastrophic vegetation fires. The ageing, demotivated, and understaffed regional Forestry Corps is ill-equipped to effectively respond to this situation (Legambiente, 2022).

Additionally, over the years, institutional bodies have been operating in isolated silos, limiting effective communication and transparency among them and contributing to the emergence of conflicting narratives and points of view on factors and management contributing to the *status*

quo. The limitations of the fragmented fire management system are becoming increasingly evident, and past research has stressed the importance of fostering greater integration and cooperation among the various stakeholders involved to overcome these challenges (Swedeen, 2006). By dismantling existing barriers and creating effective communication channels, these groups can collaborate more efficiently to address wildfire issues and tackle the underlying causes of recurring fire outbreaks (Ascoli & Bovio, 2013; Hasnaoui & Krott, 2019; Palaiologou et al., 2021). Developing a cooperative framework that promotes joint decision-making, and mutual understanding will ultimately lead to more cohesive and effective fire management practices, as demonstrated by Blatner et al. (2001) in the US.

Furthermore, participants generally perceive a lack of a compelling long-term prevention plan suitable for the current wildfire situation in the area. This perspective may, on one side, underscore an overemphasis on reactive fire management, leading to the neglect of preventive measures (Ellison et al., 2015; Xanthopoulos et al., 2019). On the other hand, it signals fluctuating confidence in the government, influenced by wildfire events (Sharp et al., 2013) or linked to historical events and corruption (Rust et al., 2020). This has repercussions at the local level, where smaller municipalities in the Sicilian inland struggle to allocate funds for road cleaning every year before the summer season starts.

Lastly, participants noted a decline in public engagement during the discussion, signalling a significant transformation in firefighting approaches over the past few decades. There has been a notable decrease in public involvement in active suppression efforts, particularly since the establishment of the DCP in 1992. This shift may have led to a detachment of the public from resource management responsibilities. While firefighting was once closely associated with community spirit, it has become less so with the adoption of aerial firefighting techniques and the professionalization of fire services. This trend reflects patterns seen in the US since the 1960s, where there has been a decline in social capital, according to Putnam (1995).

Active citizen engagement in public affairs facilitates more effective policy responses and service delivery, particularly in emergency situations like wildfires (Andrews & Brewer, 2010). Strengthening social capital can improve fire protection through increased funding and partnerships among local communities, voluntary associations, and the private sector (Purdue, 2001). Prioritising social capital development empowers policymakers to fortify community resilience, enhance wildfire prevention and response efforts, and prevent individual exploitation of shared resources, thus averting their depletion or degradation (Ostrom, 2015).

3.6 Conclusions

This chapter presents the outcomes of a participatory workshop that convened representatives from civil service, firefighting, forestry, civil society, land management, and academia. The workshop aimed to deepen the understanding of the roles, behaviours, interests, and priorities of stakeholders involved in fire-related activities in the Monreale area. The findings align with the first two objectives of the thesis: 1) identify the socio-economic and political factors that influence wildfire regimes, both directly and indirectly, and answer how these factors interact with one another; 2) investigate whether local stakeholders, based on their background and affiliation, can recognise the human dynamics - including interests - driving the ignition, distribution, and spread of fires. It also offers initial insights into critical questions: *What socio-economic and political factors drive wildfire occurrence and severity, and how do they interact? To what extent are stakeholders aware of the primary human causes of wildfires, and do hidden interests influence fire management decisions?*

The workshop provided essential insights into significant fire management issues, illustrating the complex interplay between environmental, social, and institutional dimensions. This initiative marked a pioneering effort to apply a participatory approach for identifying key fire management challenges in the region. Participants displayed strong emotional reactions, particularly during the rich picture exercise, expressing anger and despair over both negligent and deliberate causes of wildfires, revealing a profound connection to the landscape and feelings of grief associated with fire events.

Discussions predominantly focused on socio-economic and demographic dynamics in Sicily, including land abandonment due to migration and property disputes. These factors highlight the significant role human activities play in wildfires across the region and Italy. A range of opinions emerged during the workshop, especially between institutional representatives and civil society organisations. Distrust toward governmental institutions was expressed, with concerns about structural inadequacies in addressing the challenges posed by wildfire regimes in the context of climate change. Participants pointed to the critical shortage of specialised personnel and inadequate preventive measures in Sicily, exacerbated by an ageing and under-resourced RFCS.

Many participants noted that institutional bodies often operate in isolation, resulting in ineffective communication and conflicting narratives. This lack of coordination extends to the absence of effective long-term prevention strategies tailored to the current wildfire situation, suggesting a trend toward reactive fire management that overlooks preventive measures. Fluctuating confidence in government responses - shaped by past wildfire events and historical

corruption - has significant implications for local communities. Smaller municipalities in inland Sicily struggle to secure funding for essential infrastructure maintenance, a challenge compounded by a hiring freeze within the RFCS that undermines effective wildfire management.

Additionally, participants observed a decline in public engagement in firefighting strategies over recent decades, attributing this shift to a growing disconnect between the public and resource management responsibilities. This trend reflects a broader reduction in community involvement in firefighting efforts since the establishment of the DPC in 1992. The professionalisation of fire services and the adoption of aerial firefighting methods have further contributed to this decline, mirroring patterns seen in other regions.

Recurring themes, such as the impacts of climate change, evolving socio-economic conditions, and governance deficiencies, underscore the need for enhanced collaboration and proactive, long-term prevention strategies that extend beyond the local context, offering valuable lessons for broader fire management in the Mediterranean region (Castellnou et al., 2010; Costanza & Moody, 2011; Doerr & Santín, 2016; Duane et al., 2021; Moreira et al., 2020; Olson et al., 2015). Advocating for a comprehensive approach to wildfire management is critical; this approach should encompass prevention, active management, and stakeholder collaboration. Key elements include allocating resources for preventive measures, enhancing community involvement, and implementing legislative reforms to clarify governance.

In the following chapter, I further investigate the research questions and broader objectives 1 and 2 previously outlined. I explore whether stakeholders reach a consensus on specific factors and examine whether any lack of agreement can be attributed to their societal roles and underlying interests. Additionally, I assess whether it is possible to outline a starting point for developing a more integrated fire management approach.

Chapter 4 - Applying the Q-methodology approach to assess stakeholders' perspectives on wildfires and their management

4.1 Introduction

This chapter presents the research activities conducted during the fieldwork in Monreale, Sicily, following the participatory stakeholders' workshop described in the previous chapter. Expanding from the analysis and results from the workshop, in this chapter, I further investigate objectives 1 and 2 and present a methodology that offers a more nuanced investigation of stakeholder perspectives. I analyse the positions of various stakeholders, primarily aiming to rank their perceptions of the actual causes and interests related to wildfires in the region. Additionally, I consider whether these positions align with their societal and professional roles. The study, including its methodology and findings, was published in 2024 in *People and Nature*, one of the British Ecological Society journals.

As highlighted in the findings and discussion in Chapters 2 and 3, designing effective fire policies requires a comprehensive understanding of local fire use, its drivers, and its impacts. However, communication breakdowns and lack of consensus - where varied perceptions and conflicting views on wildfire causes prevail - hinder the implementation of a more comprehensive fire management strategy (Wunder et al., 2021). Limited stakeholder engagement in decision-making processes allows conflicts around fire management to persist (Bonsu et al., 2019). Bureaucratic inefficiencies further stifle dialogue and adaptation in fire management (Beggs & Dalley, 2023; Priyo et al., 2016), delaying preventive measures while political preferences for fire exclusion remain strong (Silva et al., 2010). Siloed institutional approaches can perpetuate competing narratives (Swedeen, 2006), whereas coordinated stakeholder knowledge and actions strengthen fire management approaches (Kapetas et al., 2019) and improve policy legitimacy (Mease et al., 2018).

Most fire related research focusing on stakeholders' perspectives, examine how forest owners' attitudes influence fire management strategies (Phelps et al., 2021), while European and US research reveals conflicting views of public, stakeholders and especially forest owners on fire-risk mitigation (Blennow et al., 2016; Champ et al., 2012; Hoeben et al., 2025; Karanikola et al., 2011; Eriksson, 2018).

However, the literature often lacks engagement with a diverse set of stakeholders, which is essential to understanding the socio-political and economic factors affecting fire management. The results of the stakeholders' workshop held in Monreale, as described in Chapter 3, reveal diverse perspectives among experts and stakeholders regarding the causes of wildfires and

effective management strategies. Building on these insights, I engaged further with stakeholders to systematically explore their views on wildfire drivers and fire management practices in Monreale, which are shaped by socio-economic and political interests. The Q-methodology analysis helps identify both common and divergent positions among stakeholders (Aguilar & Montiel, 2011) and categorises them based on the main solutions they advocate for to improve fire management.

Key differences emerged, with some stakeholders supporting modernised preventative management practices, others promoting increased private sector involvement, and some calling for stronger government oversight. However, areas of consensus also surfaced, suggesting potential pathways toward shared objectives in fire management. Ultimately, this analysis underscores the need for a multi-stakeholder approach that prioritises proactive strategies over reactive ones in Mediterranean regions, which remain heavily reliant on fire extension practices (Castellnou et al., 2010).

4.2 Methodology

The Q-methodology (Q) is a structured approach aimed at exploring and quantifying individuals' subjective views, organising their opinions and beliefs into distinct perspectives (Brown, 1993). The analysis primarily seeks to capture the diverse range of subjective viewpoints on a specific topic, identifying systematic patterns of consensus or disagreement within a group. Q is particularly useful for addressing complex issues with diverse stakeholders by promoting transparency and creating a supportive environment for participants to express their views openly (Cuppen, 2013; Steelman, 2016; Stenner et al., 2008).

An increasing number of studies leverage Q to systematically map viewpoints and narratives within conflicts and policy assessments, helping to identify consensus points, understanding public attitudes and behaviours, and revealing potential barriers to policy adoption (Sneegas et al., 2021; Zabala, 2014). Applications span diverse areas, such as renewable energy (Chang et al., 2019; Ellis et al., 2007), agriculture (Bumbudsanpharoke et al., 2009), and forest management (Steelman & Maguire, 1999). In the context of wildfire management, where socio-economic factors often play a critical role, Q methodology offers unique insights. For instance, it has been used to uncover differing perspectives on fire policy among experts and local resource users, as seen in studies on peatland fires in Indonesia (Carmenta et al., 2017; Phelps et al., 2021) and fire management in Australia (Ockwell, 2008), emphasising the importance of diverse values in fire governance.

The governance of wildfires involves multiple incentives, stakeholders, and management

approaches, and this complexity often leads to attributing blame across different groups, shaping policies based on perceptions of responsibility (Cammelli et al., 2019). Encouraging dialogue among stakeholders with competing interests can foster collaboration, as seen in studies on post-wildfire vegetation recovery and contrasting views on active fire management (Burns & Cheng, 2007; Edgeley et al., 2020). Such research underscores the value of surfacing hidden narratives to support effective governance and create pathways toward socially, ecologically and economically balanced solutions (Cuppen et al., 2016).

4.2.1 The Q-study steps

In a Q-study, researchers typically follow a structured six-step process (Stenner et al., 2008): (1) Defining the research question and gathering all relevant ideas and opinions on the issue within a specific context and timeframe - known as the *concourse*. (2) From this, a representative set of statements, called the *Q-Set*, is created. This set is refined and scrutinised, often using theoretical frameworks or expert judgment, following an inductive approach (Webler et al., 2009). (3) The next step is forming the '*P-Set*' by selecting participants who have relevant expertise and insight into the issue. (4) In the Q-sort phase, participants arrange the statements onto a grid shaped like a normal distribution, ranking them based on their viewpoints. (5) The data is then analysed, usually with principal component analysis (PCA), to uncover distinct groupings of perspectives. (6) Finally, the identified factors are interpreted to summarise shared viewpoints among the participants. In the following sections, I describe how I applied these steps to my fieldwork research.

4.2.2 The themes and concourse

The *concourse* was co-created with the workshop participants held in Monreale, as described in Chapter 3 (Billard, 1999). Themes emerged organically from the thematic analysis of the discussions. These themes were then further refined through individual interviews with three workshop participants, allowing for the clarification of key topics, the piloting of the Q-sort, as well as the inclusion of additional insights that could not be addressed in the workshop setting due to time constraints or the participatory nature of the process.

Although the individuals involved in these initial activities - workshops and interviews - differed from those who later completed the Q-sort, both groups were identified through an earlier stakeholder analysis of local actors (Reed et al., 2009) with roles in decision-making, policy, management, tourism, and research. Workshop and Q-sort participants included representatives from organisations, such as the Regional Forest Corps of Sicily (RFCS), the Department of Civil Protection (DCP Sicily), the National Fire Brigade (CNVVF), the Regional Department of Rural and Territorial Development (RDRTD), and the Regional Department of

Environment (RDE), as well as forestry professionals, labour unions, academia, NGOs, and cultural and volunteer groups.

Following McKeown & Thomas's (2013) inductive approach, I developed an initial Q-set of 60 statements based on participant input, deliberately avoiding any preexisting coding framework (Braun & Clarke, 2006). Through iterative Q-sorting and consultations to minimise redundancy, the Q-set was refined to 40 statements. Insights from the workshop and interviews revealed five main themes: (i) direct causes, (ii) indirect drivers, (iii) firefighting and suppression, (iv) prevention strategies, and (v) management culture and leadership. The study was conducted in Italian; Table 4.1 provides the English translations of the final statements (in Appendix C.1, the original Italian statements).

Table 4.1 - Themes and statements used in the Q-study

Theme	Num	Statement
Triggering Causes	S24	Wildfires are caused by power companies that do not properly maintain high voltage cables.
	S26	Fire is often used as a tool to retaliate and settle scores regarding land concessions.
	S28	Lands are set on fire for building purposes.
	S32	Most of the wildfires occur due to agricultural practices.
	S33	Most of the wildfires occur for the renewal of pastures.
	S34	The fires are ignited by forest workers as a means of protesting against working conditions.
	S35	Most fires occur due to arson.
	S37	Protected areas are set on fire in hopes of removing environmental restrictions.
	S39	Most of wildfires have unintentional origins, caused by people's imprudence.
	S40	Wildfires in the Monreale area occur at the hands of organized crime.
Indirect drivers	S8	Land abandonment has contributed to the spread of the fires.
	S9	Current residue burning ban effectively discourages the use of fire in agriculture.
	S13	Sanctions against those responsible for the fires should be increased.
	S16	The management of Firefighting airplanes should not be transferred to the state.
	S17	Government prioritises spending on suppression over funding forward-looking prevention.
	S21	Those responsible for the fires are not punished for lack of surveillance and control of the territory.
	S29	Extending the periods of land concessions would make farmers and breeders loyal to the land and would improve the situation of fires.
	S36	Privatising the forestry sector would improve the situation of wildfires.
Prevention strategies	S1	The Sicilian Forestry Corps ensures the performance of public security services and territorial control in Monreale.
	S2	Prevention activities, such as silvicultural management and land cleaning, are modern and up to date.
	S3	Forestry prevention activities should also be carried out during the winter months and not just at the beginning of the fire season to be effective.
	S4	The use of technology in land surveillance and control would reduce the number of fires.
	S5	The creation of a specialized investigative apparatus within the <i>Carabinieri</i> and / or Forestry Corps to identify the causes and those responsible would improve the situation of wildfires.
	S6	Prescribed fires should not be adopted as a means of prevention.

	S7	Investing in prevention rather than firefighting would improve the situation of wildfires.
	S10	The planning, organisation, and resources available to forest workers are sufficient to carry out prevention activities.
	S12	A synergistic collaboration between the different stakeholders can favour the development of an integrated fire management policy.
	S19	A complete and accurate register of burned areas can prevent fires.
	S25	Road managers are diligent in cleaning the edges of the roads.
	S31	There is no way to prevent forest fires.
	S38	The forestry works are carried out according to the specific technical skills of the sector.
Firefighting and suppression	S11	The current organisational structure and the level of coordination in extinguishing procedures is sufficient to control the expansion of fires.
	S14	Ground operations during fire suppression are often sufficient to contain them.
	S15	Fire suppression relies too much on the use of firefighting aircraft.
	S27	Wildfires are difficult to extinguish in the field because the areas are often difficult to access.
Culture and institutional leadership	S18	The obligation of the Municipalities to conduct an annual census of the areas affected by the fire is not fulfilled and is controlled for political interests.
	S20	I trust that politics is in the service of the interests and the protection of the common good.
	S22	The individuals responsible for the fires are not punished because of the negligence of the institutions.
	S23	Illegality and the individuality at the expense of the common good are widely tolerated by society.
	S30	Citizens are concerned only when fires reach residential areas.

- Triggering causes theme

Workshop participants and local experts identified two primary causes of wildfires in the region: negligence and arson. Negligence encompasses inadequate preventative measures and poor infrastructure maintenance, such as the failure to clear vegetation around road networks. Intentional ignitions, on the other hand, are often motivated by disputes and unsanctioned land practices. For instance, local farmers and herders may disregard seasonal fire restrictions, while some pastoralists in the island's interior use fire unlawfully to expand grazing areas. Specific areas in Calabria and Sicily repeatedly suffer from arson incidents (Legambiente, 2022), with motivations spanning from retaliatory actions against authorities to using fire to improve hunting access.

In urban and tourist areas, intentional fires are sometimes set to clear land for illegal construction, embodying the concept of "ecomafia" introduced by the NGO Legambiente, which highlights territorial control through environmental degradation. Unchecked urban expansion in Sicily, as seen elsewhere, is often unplanned, disregarding zoning and environmental protections, leading to long-standing informal construction practices and environmental harm (Fiorini et al., 2019). A recent study identifies illegal constructions in wildfire-affected protected forest areas in Sardinia, finding that fires are more likely to spread in more remote areas, highlighting the challenges local authorities face in monitoring and

responding to fires in less accessible regions (Corrado et al., 2024).

- Indirect drivers theme

Indirect drivers include shifts in regional, national, and global economies and policies, such as the rural-to-urban migration trends during Italy's post-World War II industrial boom, which left some marginal lands more vulnerable to fires (Ciliberti & Frascarelli, 2015). Political decisions further shape human-ecological systems and wildfire patterns (Leverkus et al., 2020). Politicians often prioritise fire suppression policies over sustainable forest management, driven by the appeal of short-term results. In Southern Italy, longstanding political patronage and Mafia influence have intensified the economic divide between the North and South, issues that require thorough reform and the dismantling of entrenched networks (Quaresima & Fiorillo, 2020).

Some indirect drivers in the Q-set, while potentially viewed as solutions, are also linked to unintended consequences and mismanagement. In fire management, causes and effects can blur; for instance, shorter land concessions and seasonal restrictions may inadvertently incentivise illegal fire use. Additionally, controversies around firefighting aircraft management raise ethical questions about private sector involvement, with conspiracy theories suggesting that private interests may favour suppression approaches over proactive fire prevention.

- Prevention strategies theme

Stakeholders highlighted the importance of a two-fold approach to wildfire management: addressing ignition sources and enhancing forest and fuel management. However, the RFCS, primarily responsible for monitoring both ignition sources and forest fuel, faces obstacles due to an ageing workforce and limited personnel, restricting their ability to manage forests effectively and creating a capacity gap when compared to similar regions with autonomous forest governance. Delays in pinpointing fire causes and identifying those responsible complicate management efforts, underscoring the need for a dedicated law enforcement task force. Fragmented responsibilities across administrative bodies further impair effective forest management.

Forest planning across the country remains limited, with only 18% of forested land managed under corporate-level management plans (RaFITALIA, 2017). Sicily's 391 municipalities include 147 that have not fulfilled their obligation to survey and report fire-affected areas, a process essential for timely mapping⁵. This mapping could play a vital role in prevention by

⁵From Dept. Decree "D.A. 357/3/2023"

limiting access and identifying high-risk areas repeatedly affected by wildfires.

- Firefighting and suppression theme

Fire suppression frequently dominates political discussions, as it serves as a visible indication of governmental action. However, this reactive strategy can compromise long-term fire management objectives, allowing fuel loads to accumulate. When combined with local topography and a changing climate, this can lead to more severe fires (Doerr & Santín, 2016). In Italy, as in many Western countries, this approach has become entrenched, resulting in significant changes to natural fire regimes (Williams, 2013). Stakeholders voiced concerns regarding the existing organisational framework and the coordination among various bodies involved in firefighting efforts. Additionally, the topography and local weather conditions in mountainous regions can further complicate these firefighting challenges.

- Culture and institutional leadership

Workshop discussions highlighted the intricate relationship between the drivers of wildfires and their management, underscoring a more critical issue: the urgent need to reinforce compliance with rules and regulations while adopting a holistic approach that transcends basic fire management techniques. Stakeholders noted that the prevalence of illegality significantly impacts various societal dimensions, especially in rural areas and in terms of territorial governance. This situation reveals two key aspects: it reflects a culture of self-interest and individualism among the public, and it also highlights the leniency of institutions towards environmental issues.

Participants stressed the necessity for institutions to reclaim their authority by addressing illegal activities that threaten both the environment and social order. This requires a reaffirmation of the importance of rules and the principle of legality to effectively tackle these challenges and mobilise available resources. While promoting active citizenship is vital for maintaining land and fostering cleaner communities, garnering community participation and raising awareness presents a complex challenge. Thus, effective coordination is crucial to ensure that local communities are engaged in wildfire prevention initiatives.

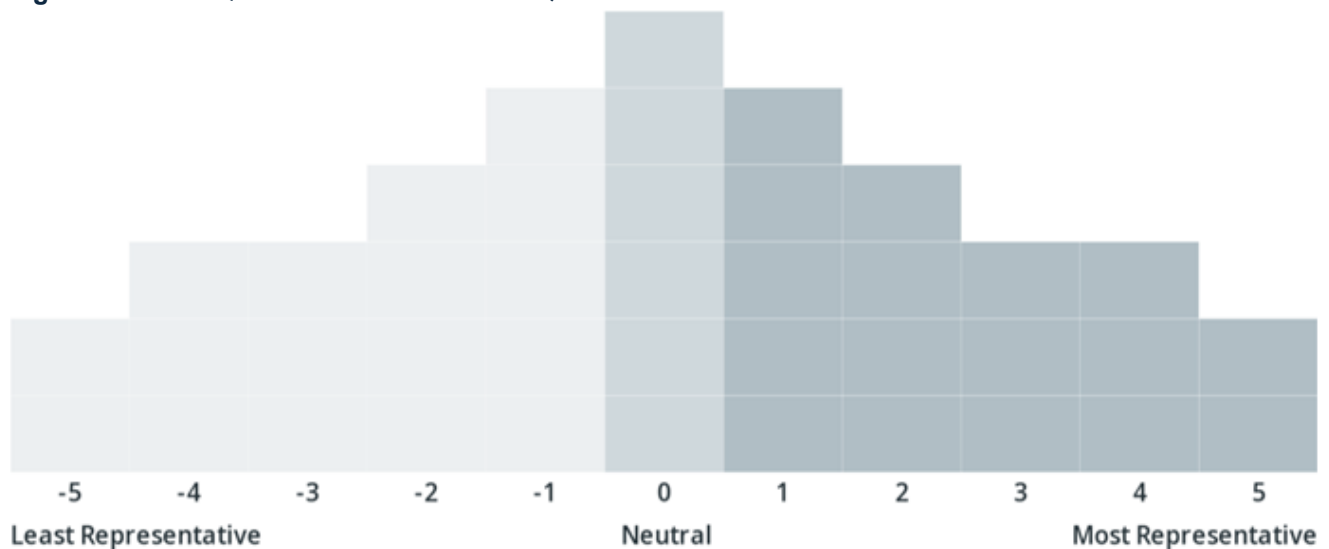
4.2.3 Selection of participants and Q-sorting

To ensure participant diversity (Webler et al., 2009), I conducted a stakeholder analysis to leverage the network of the Department of Agricultural, Food and Forest Sciences at the University of Palermo (SAAF) and employed snowball sampling through email invitations (Reed et al., 2009). The 16-member P-set included representatives from academia, NGOs, public bodies, tourism, agronomists, forest experts, and trade unions. It is important to emphasise that a substantial number of participants is not a prerequisite for conducting high-

quality research in Q-studies (Brown, 1993); as long as there are enough participants to establish a factor comparable to another, a meaningful Q analysis can be achieved.

Data collection was facilitated using *QMethodSoftware* (Lutfallah & Buchanan, 2019). Participants engaged in Q-sorting by following these instructions: *“Please sort these 40 statements based on how well they align with your views regarding wildfire events in Monreale. Use a forced-choice quasi-normal distribution on a grid ranging from -5 to +5, where -5 indicates ‘least representative of my view’ and +5 indicates ‘most representative of my view.’ A selection of 0 signifies ‘neutrality or uncertainty.’”* This method effectively identifies the statements that resonate most with participants' perspectives by encouraging them to distinguish between statements and be selective about their highest ratings. A quasi-bell-shaped grid is depicted in Figure 4.1.

Figure 4.1 - The Q-sort distribution of the *QMethodSoftware*



To reduce potential order and fatigue effects (Atmanspacher & Römer, 2012), participants initially pre-sorted the statements, categorising them with a 3-point scale: agree, disagree, or feel neutral/unsure about each statement. After completing this sorting process, a follow-up interview was conducted with each participant to gain deeper insights into their rankings, gaining more nuanced insights of their viewpoints (Watts & Stenner, 2005).

4.3 Data analysis

I employed principal component factor analysis (PCA) to streamline the multidimensional data and uncover common themes among the Q-sorts. Data are available on Zenodo.org and can be accessed with this DOI: 10.5281/zenodo.13684035. The factor loadings (table 4.2), which capture the participants' association with every one of the identified points of view, allow for the resulting factors to be interpreted as representing unique perspectives (Zabala & Pascual,

2016). It is important to highlight that there is no consensus on a single method for determining the number of factors in the literature (Sneegas et al., 2021). I used a combination of criteria to establish a three-factor solution, including the eigenvalue, scree test, and the avoidance of cross-loading (Brannstrom et al., 2022; Holmes et al., 2022).

Table 4.2 - Participants and their factor loadings

Participant	Affiliation	Factor1 loading	Factor 2 loading	Factor 3 loading
P1	Trade union for forestry labourers	0.43	*0.70	0.24
P2	Eco-cultural organisation	*0.80	0.02	0.26
P3	Regional government department	*0.77	0.27	-0.12
P4	Academia	*0.84	0.09	-0.10
P5	Regional Forestry Corps	0.21	*0.36	0.15
P6	Regional Park management	0.33	0.21	*0.73
P7	Order of agronomists and forestry experts	0.18	*0.60	-0.16
P8	Eco-cultural organisation	*0.83	0.24	-0.05
P9	Grass-roots organisation	*0.73	0.14	0.20
P10	NGO	*0.68	0.25	0.28
P11	Eco-cultural organisation	*0.82	0.00	-0.11
P12	NGO	*0.64	0.40	0.16
P13	Local grass-roots organisation	0.11	0.14	*0.64
P14	Regional government department	-0.05	*0.82	0.09

P15	Regional Department of Civil Protection	*0.53	0.31	0.04
P16	Province Fire brigade Command	0.11	*0.73	-0.40

*Note: Factor loadings, shown by *, capture the participants' association to every one of the identified points of view.*

I compared solutions ranging from two to four factors, applying Varimax orthogonal rotation. Both the three-factor and four-factor solutions were statistically valid, with p-values below 0.05 and loadings from at least two participants. However, the four-factor solution introduced a confounding participant with loadings on multiple factors, falling below the 'elbow' in the scree plot and yielding eigenvalues less than 1. Following the principle of one factor per 6-7 participants (Watts & Stenner, 2005) and ensuring no cross-loading, I ultimately decided to extract three factors. All analyses were performed using the *qmethod* package in R (Zabala, 2014).

4.4 Results

The analysis yielded three factors that together explained approximately 60% of the variance (see Table 4.3). These factors represent distinct clusters of agents with unique perspectives, each assigned a concise title and elaborated upon in the sections below.

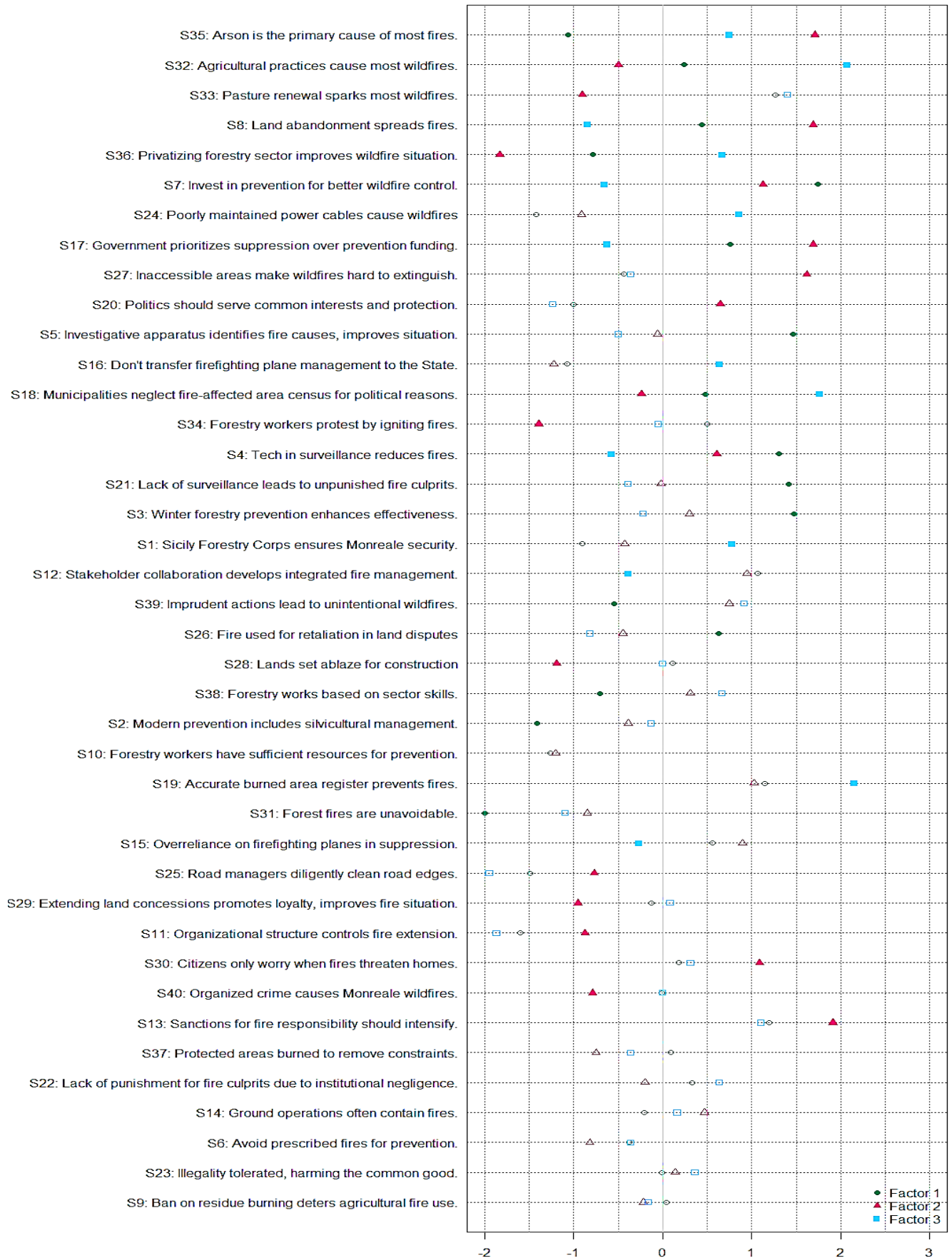
Table 4.3 - General characteristics of the three factors

Factors	N load	Eigenvalues	Explained Variance
1	9	5.39	33.72
2	5	2.72	17.01
3	2	1.46	9.15

The three factors displayed varying levels of consensus across 10 of the 40 statements, illustrated in Figure 4.2, which highlights their positions on the value scale. Consensus was achieved on 25% of the statements related to the theme of indirect drivers, 40% for culture and institutional leadership, 50% for firefighting and suppression, and 35% for prevention strategies. Notably, no consensus was reached regarding the theme of the triggering causes.

The three factors demonstrate the greatest divergence in opinions concerning the enhancement of prevention practices, the impact of privatisation on effective fire management, and the role of institutions. Factor 1 was labelled "Prevention Advocates," Factor 2 as "Pro-Government," and Factor 3 as "Privatisation Supporters," reflecting the dominant themes emerging in their responses.

Figure 4.2 - Three-factors Z-score plot of the 40 statements



4.4.1 Prevention advocates - factor 1

Factor 1 explains approximately 34% of the total variance and includes nine Q-sorts that significantly loaded onto this factor. This group comprises stakeholders from NGOs, regional government officials, local environmental and cultural no-profits, civil protection, grassroots organisations, and academia, all united in their focus on wildfire prevention. They advocate for a comprehensive reform of fire management practices at both local and regional levels.

Participants in this factor argue that the government disproportionately allocates resources toward fire suppression rather than proactively on prevention (S17). They propose reallocating funds to support prevention strategies (S7) and recommend modernising silvicultural practices (S2, S31), extending these management practices into the winter months (S3), and investing in the training and skills of forest workers (S38). Additionally, they emphasise the importance of incorporating technology for land use monitoring (S4) and assert that inadequate control and surveillance are significant contributors to wildfire occurrences. To address this, they advocate for the establishment of a specialised investigative unit within the *Carabinieri* or the RFCS (S5).

The prevention advocates also point to various socio-economic factors as root causes of wildfires, such as land abandonment (S8), and they highlight issues related to land concessions (S26), agricultural practices (S32), and pasture renewal (S33) as primary drivers of fire incidents.

4.4.2 Pro- government - factor 2

Factor 2 accounts for 17% of the total variance and comprises five distinct Q-sorts associated with regional government departments, trade union representatives of forest workers, as well as agronomy and forestry experts. In contrast to Factor 1, which conveys a sense of mistrust toward the political system, Factor 2 expresses strong support for government and institutional bodies, arguing that politicians and institutions act in the public's interest (S20). They refute the idea that political motivations are to blame for the lack of an annual census of fire-affected areas conducted by municipalities (S18).

This group strongly advocates for keeping fire management within the public sector and opposes any form of privatisation, emphasising that public safety should never be sacrificed for private profit. They challenge the belief that privatising the forestry sector would enhance wildfire management (S36) and are more assertive than the prevention advocates in their call for government involvement in managing firefighting aircraft (S16). While they support enhanced prevention practices (S17), their overall stance is somewhat more moderate. They recognise the difficulties faced when extinguishing wildfires due to challenging access conditions (S27) but dispute claims that lands are intentionally ignited for construction purposes

(S28) or that expanding land concessions would mitigate fire issues (S29).

4.4.3 Privatisation supporters - factor 3

Factor 3 accounts for approximately 9% of the total variance and is represented by two distinct Q-sorts associated with local grassroots organisations focused on tourism and regional park management. This factor expresses skepticism about the effectiveness of collaborative efforts among stakeholders in developing an integrated fire management policy (S12). Instead, proponents of this factor advocate for the privatisation of the forestry sector, believing it could enhance wildfire management outcomes (S36). They show no objections to private ownership of firefighting aircraft (S37) and do not perceive a significant risk in relying on these resources for fire suppression (S15).

In contrast to Factors 1 and 2, Factor 3 holds a more favourable view of the Forestry Corps of Sicily, believing it effectively ensures public safety and territorial control (S1). Furthermore, they argue that the government does not disproportionately prioritise funding for suppression efforts over prevention, suggesting a more balanced approach to resource allocation (S17).

4.3.4 Area of consensus among the factors

The respondents reached some key points of consensus, highlighting the necessity for stricter penalties against those responsible for wildfires (S13) and mild support for incorporating prescribed burns into fire management strategies (S6). However, there was unanimous agreement on the inadequacies of planning, organisation, and resources available to forest workers for prevention efforts (S10), as well as the lack of diligence among road managers in maintaining road edges (S25) and the overall feasibility of preventing forest fires in the region (S31).

Neutral positions were expressed regarding the effectiveness of the current ban on burning residues during the summer months as a means to deter agricultural fire use (S9) and society's tolerance of illegality and individualism at the expense of the common good (S23). While there was a unanimous acknowledgment of the current organisational structure's insufficiency and poor coordination in firefighting efforts to control fire spread (S11), opinions were more divided on whether ground operations alone are adequate to contain wildfires (S14) and the lack of consequences for those accountable for institutional negligence (S22).

4.5 Discussion

The Q-study conducted in Monreale contributes valuable insights by highlighting the diverse perspectives on factors influencing wildfires. Three distinct factors emerged: prevention advocates, pro-government supporters, and privatisation proponents. Despite the clarity of

these categories, the role of participant affiliation in shaping their views remains unclear, challenging any oversimplified conclusions.

The absence of consensus regarding ignition causes underscores the invisibility of these factors fueled by the lack of transparency and complexities inherent in a siloed approach. Similar to the sentiments expressed by Greek residents in Ilia (Karanikola et al., 2011), participants raised concerns about the authorities' management of streets and paths, linking this neglect to fuel accumulation and increased fire risk. Factor 1 particularly identifies land abandonment as a significant contributor to wildfire pressure, reinforcing findings from previous studies that emphasise the impact of socio-economic changes, landscape alterations, and unintended fires (Ascoli et al., 2022; Martínez et al., 2009; Williams, 2013).

However, the study also suggests potential solutions and avenues for progress toward shared objectives. Stakeholders exhibit a slight preference for incorporating prescribed burning as a preventive measure, particularly in Sicily's fragmented forests, especially those in abandoned rural areas (Ascoli & Bovio, 2013). Yet, practical implementation faces numerous challenges, including sociocultural resistance and regulatory constraints (Ascoli & Bovio, 2013; Fernandes et al., 2013; Miller et al., 2013).

Within the prevention theme, only Factor 1 advocates for modernizing silvicultural practices, improving the skills of forest workers, and fostering collaborative efforts, aligning with trends observed in other Mediterranean countries (Alcasena et al., 2018; Troumbis et al., 2022). An overemphasis on reactive fire management, particularly suppression, has led to the neglect of preventive measures, contributing to increasingly frequent catastrophic wildfires (Ellison et al., 2015; Ferrara et al., 2018; Xanthopoulos et al., 2019). This trend is illustrated by the rising average size of wildfires in the U.S., despite escalating annual wildfire expenditures (Rossi & Kuusela, 2019). Similar patterns are evident in Europe, though limited data on fire management budgets complicate a comprehensive assessment of costs (Mattioli et al., 2022).

All factors agree on the ineffectiveness of suppression strategies in Sicily, which are hindered by challenges such as limited personnel and inadequate preventive measures. The RFCS grapples with an ageing workforce, insufficient coordination, and top-down approaches that overlook local landscape characteristics (Legambiente, 2022). Despite existing coordination frameworks, these approaches fail to fully acknowledge local fire culture, further compounded by historical migration trends and summer ignition bans. Additional challenges arise from the mountainous terrain and adverse weather conditions, while protected areas often lack vital firefighting resources, impeding suppression efforts. Integrating agricultural incentives into

forest management programs is essential; however, forest management in the region lacks context-aware interventions and often operates independently across various institutions⁶.

Factor 3 does not oppose private ownership of firefighting aircraft and expresses less concern about over-reliance on them. The European Commission's plans to acquire new planes by 2027 could establish long-term contracts with private providers as a new standard for Italy. Companies like Babcock have significantly contributed to managing Italy's aerial firefighting services since 2011. While countries may seek to bolster their defences, long-term contracts between government agencies and private operators offer stability and cost predictability (OECD, 2018).

Both Factor 1 and Factor 3, within the culture and institutional leadership theme, display a distrust of the political system, reflecting fluctuating confidence levels following wildfire events (Sharp et al., 2013), other natural disasters (Rittelmeyer, 2020), or historical corruption issues (Micha et al., 2015; Rust et al., 2020). While Factor 3 endorses privatisation for wildfire management, Factor 2 advocates for public sector accountability and opposes privatisation, underscoring the importance of public resources and retaining public forest workers for their expertise, which aligns with previous research on public forest workers in Italy (Fagarazzi et al., 2021).

4.6 Conclusions

In this chapter, I present the application of Q-methodology to build on the insights from the previous chapter and workshop, delving deeper into stakeholders' perspectives on the causes and drivers of wildfires in the fire-prone region of Monreale, Sicily. This analysis is linked to Objectives 1 and 2:

- Identify the socio-economic and political factors that influence wildfire regimes, both directly and indirectly, and answer how these factors interact with one another.
- Investigate whether local stakeholders, based on their background and affiliation, can recognise the human dynamics - including interests - driving the ignition, distribution, and spread of fires.

Like Chapter 3, this chapter seeks to address my research questions: *What socio-economic and political factors drive wildfire occurrence and severity, and how do they interact? To what*

⁶ <https://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:decreto.legislativo:2018-04-03;34> (Retrieved on 05 June 2024)

extent are stakeholders aware of the primary human causes of wildfires, and do hidden interests influence fire management decisions?

The findings illuminate the socio-economic and political factors at play, revealing a spectrum of diverse viewpoints (Lewicki et al., 2003). The challenge of balancing political interests, public safety, and resource allocation is compounded by the varied visions held by different stakeholders. While conflict is an inherent aspect of policymaking, acknowledging these diverse perspectives can enrich discussions and contribute to the development of widely accepted fire policies.

Stakeholders identified numerous actors and drivers associated with wildfires, pointing to incomplete disclosure of causes and the perpetuation of myths. However, the results also offer valuable insights for enhancing fire policies by focusing on areas of consensus. Rather than merely increasing funding for firefighting efforts, the study suggests adopting sustainable solutions, such as prescribed burning, imposing higher fines for violations, and strengthening the forest sector. Innovations could include hiring specialized personnel, providing training, and updating silvicultural practices. Additionally, leveraging technology for territorial control and establishing investigative units to identify those responsible for fire-related infractions could help enforce bans on residue burning. Other recommended measures involve implementing Payment for Ecosystem Services to incentivise sustainable practices, promoting cultural and natural heritage through education and community engagement, and integrating practices like the burial of agricultural residues and strategic grazing in firebreak lines (Jack et al., 2022).

Despite the decentralisation of responsibilities to regional institutions, government influence remains prevalent, hindering the shift from a government-centric model to a governance-based approach in landscape management. This issue extends to fire management, where stakeholders, motivated by individual interests and ideological backgrounds, maintain diverse perspectives (Peterson St-Laurent et al., 2019; Pinillos et al., 2023). These differing viewpoints significantly impact government involvement and the allocation of resources for fire management.

Subsequent Chapters 5 and 6 delve deeper into the role of government by examining the incentives and affiliations of policymakers, as linked to Objective 3. Using theories and models from political science and economics, these chapters explore how political factors shape wildfire outcomes, focusing on another region that, despite its size, remains highly prone to extreme wildfire events.

Chapter 5 - Investigating political incentives on fire characteristics: do electoral cycles matter?

5.1 Introduction

Government institutions play a crucial role in managing public environmental goods and services, such as clean air, water, and forested lands, which require coordinated oversight and policy frameworks to ensure their preservation (Mansbridge, 2014). Effective management of these resources often relies on a combination of regulatory policies, funding, and enforcement, which are best achieved through a strong, top-down approach (Eicken et al., 2021). Without clear, robust government-led frameworks, local communities and industries often lack the essential guidelines needed to adopt integrated fire management practices, leading to fragmented efforts and limited progress in environmental protection (Steelman, 2016).

Political agendas play a crucial role in shaping environmental efforts; however, policy priorities often diverge along partisan lines, making cohesive and sustainable action difficult (Kulin & Johansson Sevä, 2019). Conflicting political interests can result in inconsistent policies, regulatory rollbacks, and diminished enforcement of existing environmental protections. For instance, in areas where industries exert strong lobbying influence over natural resource management, governmental bodies may encounter pressure to ease regulations, ultimately undermining long-term environmental objectives (Pacca et al., 2021). This fragmentation can hinder progress and compromise the effectiveness of addressing environmental challenges, which ultimately influences voter well-being, both economically and in quality of life. However, the long-term effects of environmental issues often clash with short-term political cycles, a challenge known as the "Tragedy of the Horizons," which can bias electoral priorities (Boly et al., 2023).

Research on political business cycles (PBCs) shows that incumbents, motivated by the desire for re-election, can manipulate economic conditions through fiscal and monetary policies to enhance their chances of remaining in office (Nordhaus, 1975). In well-established democracies, where voters are more informed, politicians may focus on visible spending rather than long-term investments like environmental protection, especially during election periods (Alesina et al., 1997, 1997; Alesina & Tabellini, 1990; Fankhauser et al., 2015). Consequently, less visible public goods, such as environmental programs, often receive less funding and are overshadowed by more appealing short-term projects (D'Amato et al., 2019; Rogoff, 1987). Existing evidence suggests that electoral incentives can affect policymakers' adoption of environmental policy, including the introduction of environmental taxes (Ashworth et al., 2002, 2006), issuing of construction permits in rural areas (D'Amato et al., 2019), and deforestation

rates (Burgess et al., 2012; Paillet, 2018). In the U.S., evidence shows how re-electable governors would award larger shares of a federal disaster relief program to those counties at risk that favoured the incumbents in previous elections (Husted & Nickerson, 2022).

Regarding fires, empirical evidence shows that burned areas significantly increase around elections (Kountouris, 2020; Skouras & Christodoulakis, 2014). In Galicia, Álvarez-Díaz et al. (2015) find a positive correlation between years of elections and number of forest fires. The effect of electoral cycles on fire occurrence could be explained by voters' imperfect information (Rogoff, 1990) on how political processes surrounding election periods might affect fire settings. Governments may alter their fire prevention and response efforts around election periods to shape public perception of their effectiveness, potentially enhancing their chances of re-election. In this context, electoral cycles regarding fires would be less detectable by rational voters, even in more long-lived and structured democracies like the U.S. However, politicians' role and their incentives in the determination of fire regimes have been largely ignored in that research branch advocating for the adoption of effective fire management strategies.

This chapter aligns with the research questions by examining whether wildfire characteristics in the U.S. fluctuate with the timing of gubernatorial elections in a pattern consistent with electoral cycles. Additionally, it explores whether this relationship differs depending on whether incumbent governors are seeking re-election, as they may adjust their fire prevention and response efforts around election periods to shape public perception of their competence and enhance their chances of re-election (Rogoff, 1990). Certain regions of the U.S., much like Italy and other Mediterranean climate zones, share similar environmental conditions, with ecosystems shaped by the presence of fire. However, unlike Italy, the U.S. offers a particularly relevant context for political-environmental analysis due to its distinct political and institutional structure.

Each year, wildfires affect vast areas of the U.S., with some regions experiencing more frequent and severe incidents than others, leading to significant ecological, economic, and social consequences (Crist, 2023). Climate change has exacerbated extreme heat, drought, and wildfire risks, leading to more intense and unpredictable fire behaviour that often overwhelms response efforts, resulting in substantial economic losses, environmental damage, community displacement, and fatalities (Crist, 2023; Stephens & Ruth, 2005).

Focusing on the influence of gubernatorial elections in States heavily impacted by fires, this chapter aligns with the broader goals of my thesis and specifically supports Objective 3:

determine whether macro-level political factors, through the application of econometric analysis, can influence fire characteristics, such as occurrence, duration, and extent of burned areas. To assess the impact of electoral cycles on fire occurrence, I employ a Poisson fixed effects and a Negative Binomial model.

5.2 Institutional background

5.2.1 Overview of gubernatorial elections and term limits

In the U.S., the governor serves as head of government within each State, which operates as a semi-sovereign entity with specific powers granted by the Constitution, such as regulating intra-state commerce, holding elections, and ratifying amendments. Each State has its own Constitution and government, divided into three branches: executive, legislative, and judicial (Ferguson, 2006). Governor elections in the U.S. typically occur every four years, although there are exceptions. In New Hampshire and Vermont, governors serve two-year terms and are up for re-election biennially. The timing of these elections varies by State; however, most States hold governor elections to coincide with either midterm or presidential election years.

Term limits for governors also differ across States. In most States, governors may serve up to two consecutive four-year terms before they must step down. Some States, such as Virginia, limit governors to a single term, whereas others, like Connecticut, New York, and Utah, have no term limits, allowing governors to serve an unlimited number of terms if they continue to be re-elected. In New Hampshire and Vermont, governors serve two-year terms with no restrictions on consecutive service, enabling them to run for re-election indefinitely.

5.2.2 Wildfire management in the United States

As the U.S. population expanded and the value of forest resources increased, fire was increasingly viewed as a danger rather than a beneficial tool. The U.S. Department of the Interior initially oversaw fire suppression on public lands, with support from the army, before this responsibility shifted to the U.S. Department of Agriculture Forest Service (USDA-FS) in 1905 (Donovan & Brown, 2005). During this time, a debate emerged regarding fire management strategies, with some advocating for controlled fires to manage risks and enhance habitats, while the USDA-FS historically prioritised fire suppression to protect timber resources.

Economic considerations initially guided suppression efforts, balancing costs against the value of protected resources. However, fire suppression disrupted forest ecosystems by preventing natural fire cycles, leading to fuel buildup and increased wildfire risks, especially as development encroached on forested areas (Schultz et al., 2012). By the 1970s, policies

allowed some fires to burn naturally in wilderness areas, leading to the creation of the National Fire Management Analysis System (NFMAS) for cost-effective fire planning (Stephens & Ruth, 2005). Controlled burns gradually gained cautious acceptance, though public concerns and regulatory constraints continued to limit their widespread implementation (Fried et al., 2004). In contrast, thinning and mechanical fuel removal encountered greater public approval, bolstered by legislative measures such as the Healthy Forests Restoration Act (Office of the Federal Register, 2003) under the Bush administration and the Collaborative Forest Landscape Restoration Program (U.S. Congress, 2009), both of which aimed to reduce forest fuels and enhance community protection (Crist, 2023; Schultz et al., 2012).

Between 1984 and 2020, the area burned by wildfires in the U.S. increased fivefold, while funding for fire management by the Department of the Interior and the USDA-FS more than doubled between 2011 and 2020 (The Pew Charitable Trusts, 2022). Additionally, projections for housing growth in California suggest that wildfire suppression costs could increase by nearly \$24 million annually (Bayham & Yoder, 2020). To further enhance wildfire preparedness and response, the 2021 Infrastructure Investment and Jobs Act allocated \$3.3 billion for wildfire risk reduction (U.S. Department of the Interior, 2022). This funding focuses on protecting vulnerable communities and preparing landscapes for climate change through methods like mechanical thinning and prescribed fire while also improving firefighting capabilities, early detection equipment, and firefighter compensation.

In the U.S., the government entity that owns the land where a fire ignites is primarily responsible for firefighting efforts (Stephens & Ruth, 2005). However, as wildfires often cross jurisdictional boundaries, cooperative agreements among Federal, State, and local governments are essential for coordinated suppression, typically organised through the National Interagency Fire Center (NIFC). These agreements define financial responsibilities, with the land-owning entity generally covering the costs. Governments face two main challenges in wildfire management: budgeting for unpredictable costs and investing in long-term mitigation strategies. The Federal government provides grants to support State, local, and Tribal authorities in managing larger fires, with reimbursement structures varying by State, such as up to 75% recovery for disaster costs from the Federal Emergency Management Agency (FEMA) (Bayham & Yoder, 2020). In other words, when fires start on non-Federal lands, States generally cover the costs from their own budgets. However, for large or exceptionally destructive fires, they can request assistance from FEMA to help with expenses. State governments serve as intermediaries, coordinating funding and implementing tailored programs, often relying on diverse revenue sources, including general funds and disaster

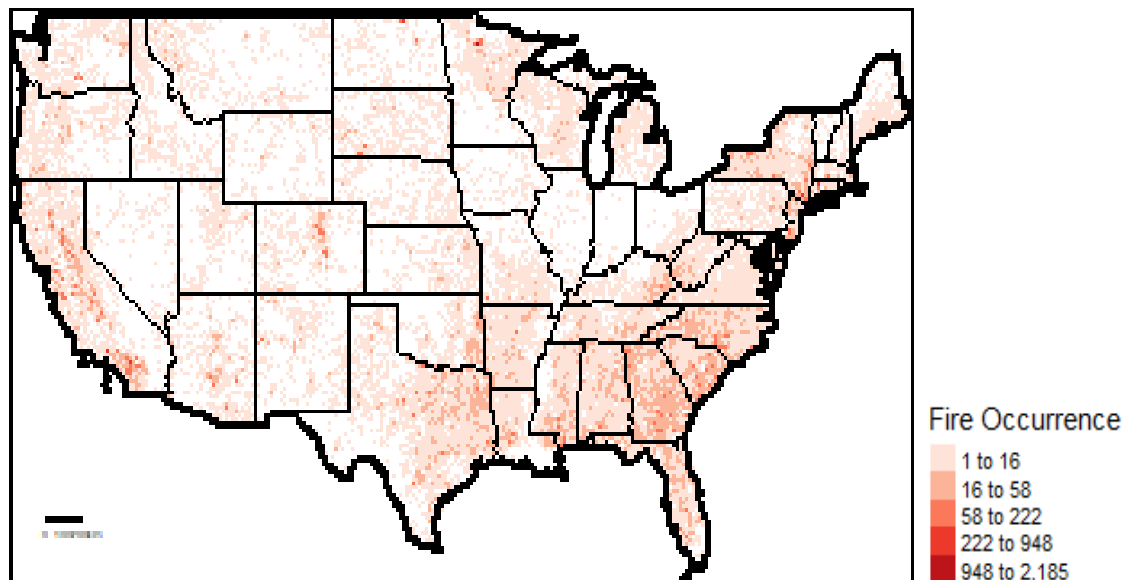
accounts. Many States heavily rely on post-fire funding mechanisms, which complicates long-term financial planning and can result in significant upfront costs due to delays in reimbursements.

5.3 Methodology and data

5.3.1 Data

I use data from the Fire Program Analysis Fire-Occurrence Database (FPA-FOD) (Short, 2022). The FPA-FOD facilitates geospatial analysis of fire activity and includes 2.17 million geolocated fire records from 1992 to 2018 in the U.S. Figure 5.1 shows the ignitions (2.6 km² grid resolution) reported by the FPA-FOD in the continental U.S. from 1997 to 2018 (Liu & Yang, 2020; Pourmohamad et al., 2023; Syphard et al., 2017). Each record reports fire size, as well as the dates and times ignitions were discovered and extinguished. Importantly, the dataset includes information on ignition causes, enabling an analysis that distinguishes between human-ignited fires and natural sources⁷. Fire records are relatively more comprehensive for the Western States, with the exception of Hawaii, which has limited data. In contrast, data for States such as Connecticut, Delaware, Vermont, and Rhode Island are often incomplete or missing.

Figure 5.1- Active human-ignited fires in the U.S. from 1997 to 2018, collected in the FPA-FOD



Information on candidates and election timings for the 2003–2018 period is derived from Ballotpedia (Adams, 2020; Jacob, 2023; Kafle et al., 2024). Meteorological data, including average annual temperature and precipitation anomaly rates, are compared to the 20th-century average (1901–2000). These data are sourced from the National Oceanic and Atmospheric

⁷ These include fire arsons, debris burning, smoking, firearms and explosives use, fireworks, equipment or vehicle use, power generation or transmission, and railroad operations and maintenance.

Administration's National Center for Environmental Information (NOAA NCEI) database (Liu et al., 2024; Margolis et al., 2025; Oakley et al., 2017) (NCDC, 2022). Socio-economic information at the State level, including real Gross Domestic Product (GDP), adjusting inflation on the 2017 US dollar value, population estimates, and annual unemployment rate are drawn from the U.S. Bureau of Economic Analysis website (BEA) (Barrage & Lint, 2023; Tavor, 2024) (BEA, 2022). The final compiled panel dataset is available on Zenodo.org and can be accessed using the following DOI: 10.5281/zenodo.13684035.

Before selecting control variables, I perform multicollinearity checks to ensure the robustness of the model, and Table 5.1 presents some summary statistics of the dependent variables used in the analysis, giving a sense of the distribution and scale of fire incidents, burnt area, and duration within this dataset. The presence of zero values in the minimum statistics suggests that some records captured periods with no incidents or no burned area. From 2003 to 2018, each State experienced an average of 1,663.8 fire incidents per year. The lowest recorded number of fire incidents in any observation is 0, while the highest is 19,451. The average total area burned across all observations is 150,374 acres (approximately 61,000 hectares), ranging from 0 (indicating cases with no burned area) to a maximum of 6,591,869 acres (approximately 2,670,000 hectares) within a single State over a year. The largest average burned area for a single State in one year is 32,879 acres (approximately 13,000 hectares). The average duration of a fire incident is 1.5 days, with the longest recorded duration being about 45 days from the time of discovery.

Table 5.1- Descriptive statistics: means, maximum and minimum levels for the independent variables of the FDA-FOD dataset

Statistic	Mean	Minimum	Maximum
Fire incidents	1663.8	0	19451.0
Total burnt area	150,374	0	6,591,869
Average burnt area	310.93	0	32879.40
Duration	1.5082	0	44.8176

5.3.2 Empirical model

To assess the impact of electoral cycles on fire occurrence, I estimate both Poisson fixed effects and Negative Binomial (NB) models. While both models are commonly used to analyse count data, they differ in their underlying assumptions, particularly regarding the relationship between the mean and variance of the data and how they account for overdispersion—when the variance exceeds the mean.

In the Poisson model, the key assumption is that the mean and variance are equal, which makes it unsuitable for data exhibiting overdispersion, where the variance is greater than the mean. On the other hand, the NB model accounts for overdispersion by introducing an additional dispersion parameter, allowing for greater variability in the data than the Poisson model can accommodate. This makes the NB model particularly well-suited for situations where the data exhibits more variation than what the Poisson distribution would predict. Overdispersion can arise from several factors: unobserved heterogeneity, where hidden subgroups or risk factors increase variability; clustering, where events occur in bursts (e.g., fire seasons); and excessive zeros, where the count data has more zero observations than expected under the Poisson model. Consequently, the NB model offers a more robust approach when overdispersion is present in the data. The Poisson model can be expressed in the following formula:

$$(R1) \quad FI_{st} = \alpha_1 EY_{st} + \alpha_2 EY_{st+1} + \alpha_3 EY_{st-1} + \beta E_{st} + \gamma M_{st} + \delta_s + \mu_t + \varepsilon_{st}$$

where the outcome FI_{st} is the count of ignitions, duration of fire, total burnt area and average burnt area in State s in year t . EY_{st} is a dummy variable equal to 1 if t is a gubernatorial election year in s , and α_1 captures the change on fire occurrence during election years against non-election years. To capture potential lead and lag effects of gubernatorial elections on fire, I include indicator variables of one year before and one year after the election, respectively EY_{t-1s} and EY_{t+1s} while the remaining two years serve as the reference variables (Pomponio & Abergel, 2013). Matrix M_{st} controls for annual temperature and rainfall anomaly levels, compared to the 1901-2000 average. Finally, matrix E_{st} includes average annual real GDP and population density. To select the control variables, I conducted multicollinearity tests to ensure robustness of the model. I also repeated the analysis by incorporating additional controls: average temperature and precipitation levels for M_{st} , and the real GDP and population density for E_{st} . While these changes slightly affected the magnitude of the results, they did not substantially alter the overall findings, the model's influence, or the statistical significance, as reported in the results section. Terms δ_s and μ_t are State and year fixed effects, controlling for State- and year-specific variation respectively.

To account for overdispersion, I transition from a Poisson model to a NB model, introducing an additional parameter to capture the overdispersion. The NB model can be specified as follows:

$$(R2) \quad FI_{st} = NB(\lambda_{st}, \theta)$$

Where λ_{st} is equal to the previous $R1$ equation and is the θ dispersion parameter, which accounts for overdispersion.

To assess the influence of incumbent's re-election incentives on fire incidence I estimate:

$$(R3) \quad FI_{st} = \alpha_1 EY_{st} + \alpha_2 EY_{st+1} + \alpha_3 EY_{st-1} + \varphi IR_{st} + \beta E_{st} + \gamma M_{st} + \delta_s + \mu_t + \varepsilon_{st}$$

Where, LG_{st} is the interaction term between election years and incumbent governors of State s being a lame-duck. Parameter φ is a moderating factor of EY_{st} , capturing the difference in the influence of elections on fire outcomes between lame-duck and re-electable incumbents. For the NB model, following the previous example, I add the parameter θ to capture the overdispersion.

Additionally, I conduct an Ordinary Least Squares (OLS) regression to estimate the relationship between the same set of independent variables and three dependent variables (Y_{st}): the average burnt area, total burnt area, and the duration of fire events per State per year.

$$(R4) \quad Y_{st} = \alpha + \beta_1 EY_{st} + \beta_2 EY_{st+1} + \beta_3 EY_{st-1} + \lambda E_{st} + \gamma M_{st} + \delta_s + \mu_t + \varepsilon_{st}$$

Lastly, I conduct a series of robustness checks to assess the stability of the results. First, I refine the analysis by examining ignitions on Federal- and State-owned lands to assess whether land ownership influences the findings. I then focus on the Western States, where wildfire prevalence is particularly high, to determine if the patterns hold in this fire-prone region. Finally, I leverage fire cause data from the FPA-FOD database to analyse human-ignited fires separately, investigating whether a cyclical pattern emerges.

Additionally, I introduce a dynamic panel model to account for the potential influence of past ignitions on future fire occurrence. Given that recent fire activity may affect future ignitions, I include lagged dependent variables in both the Poisson and NB models to capture these dynamics:

$$(R5) \quad FI_{st} = \alpha_1 EY_{st} + \alpha_2 EY_{t+1} + \alpha_3 EY_{t-1s} + \sigma FI_{t-1s} + \varphi IR_{st} + \beta E_{st} + \gamma M_{st} + \delta_s + \mu_t + \varepsilon_{st}$$

Where FI_{t-1s} is the count of fire incidents that took place in State s at time $t - 1$ and σ captures the effect of past ignitions on the contemporary ones. I estimate $R4$ applying the Generalised Method of Moments (GMM) approach proposed by Arellano and Bond (1991) to address the endogeneity introduced by including the lagged variable (Arellano & Bover, 1995; Fritsch et al., 2020).

5.4 Results

5.4.1 Electoral cycles and fires

Table 5.2 presents the estimates from equations *R1* and *R2*, which examine the relationship between gubernatorial election cycles and fire counts. Two models are used - the Poisson and NB models - both incorporating State and year-fixed effects, as well as controls for economic and weather data. To normalise the data, the average and total burnt area are divided by the population size for the corresponding year to account for population differences, and the number of events is divided by 100. The key variable, gubernatorial election year, is binary, set to 1 during election years. Its coefficients in both models are not statistically significant, as indicated by the standard errors, which are relatively large in comparison to the coefficient values. The year before the election and year after the election capture lead and lag effects around election cycles. Each variable is coded as 1 for the respective year before or after an election year. Both have positive coefficients in both models, suggesting a potential increase in fire events just before and after election years, yet these estimates lack statistical significance as well. The AIC suggest that the NB model may better capture the data's overdispersion.

Table 5.2- Election years and lag and lead effect on fire events

Dependent variable: Fire events		
	Poisson	NB
Gubernatorial election year	-0.060 (0.057)	0.003 (0.076)
Year after the election	0.055 (0.033)	0.056 (0.045)
Year before the election	0.051 (0.042)	0.036 (0.061)
Annual real GDP	Yes	Yes
Annual population density	Yes	Yes
Annual precipitation anomalies	Yes	Yes
Annual temperature anomalies	Yes	Yes
State and year fixed effect	Yes	Yes
Observations	752	752
AIC	204094	11520

*Note: Two models are presented: the Poisson model and the Negative Binomial (NB) model. The NB model is used when data exhibit overdispersion, where variance exceeds the mean, while the Poisson model assumes equal mean and variance. The dependent variable is the count of fire incidents. "Gubernatorial election year" is binary, equal to 1 for the election years. "Year after the election" and "Year before the election" are binary equal to 1 for the year after and before the election, respectively. All models include State and year-fixed effects, annual population density and control variables for annual average precipitation and temperature anomalies. Standard errors are clustered by State in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

The results presented in Table 5.3 are from a series of OLS regression models examining factors that influence fire duration, total burnt area, and average burnt area (in acres). The

findings indicate that election years, as well as the years preceding and following elections, do not have a statistically significant effect on changes in total burnt area, average burnt area, or fire duration. The models vary in their explanatory power, with the first two models accounting for approximately 33-37% of the variation, as indicated by the Adjusted R^2 values. The third model explains only around 19% of the variation, suggesting a weaker fit. In summary, tables 5.2 and 5.3 offer insights into potential trends in fire events, duration, and burnt area around election cycles, but the absence of statistically significant findings suggests that any observed patterns should be interpreted with caution. The results do not provide strong evidence of a consistent relationship between election cycles and fire characteristics.

Table 5.3 - Election years and lag and lead effect on total and average burnt area, and fire duration

Dependent variable: Total burnt area, fire duration, average burnt area

	Total Burnt Area	Duration Average	Average Burnt Area
Gubernatorial election year	-0.035 (0.056)	0.438 (0.333)	0.0001 (0.0002)
Year after the election	-0.019 (0.067)	-0.129 (0.393)	-0.0001 (0.0003)
Year before the election	0.008 (0.067)	0.610 (0.397)	0.0002 (0.0003)
Annual real GDP	yes	yes	yes
Annual population density	yes	yes	yes
Annual precipitation anomalies	yes	yes	yes
Annual temperature anomalies	yes	yes	yes
State and year fixed effect	yes	yes	yes
Observations	752	752	752
Adjusted R^2	0.332	0.371	0.185

*Note: The dependent variables are total burnt area, fire duration, and average burnt area by State by year. "Gubernatorial election year" is binary, equal to 1 for the election years. "Year after the election" and "Year before the election" are binary, equal to 1 for the year after and before the election, respectively. All models include State and year-fixed effects, annual population density and control variables for annual average precipitation and temperature anomalies. Standard errors are clustered by State in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

5.4.2 Re-election incentives

Table 5.4 presents the estimates from equation $R3$, which includes the interaction term LG_{st} to explore how gubernatorial election cycles and re-election incentives may affect fire events. In the Poisson model, the coefficient for the election year is -0.062, hinting at a potential reduction in fire events during election years, whereas in the NB model, this coefficient is 0.049, implying a slight increase. However, neither coefficient reaches statistical significance, indicating that election years likely do not have a strong or consistent influence on fire counts. The coefficients for the year immediately before and after the elections are both positive in each model, suggesting a potential rise in fire events immediately surrounding election years. Still, these effects lack statistical significance, which makes these observations less robust and suggests

limited evidence for a reliable pre- or post-election effect on fire occurrences. The variable lame-duck governor is coded as 1 when a governor cannot seek re-election due to term limits. Here, the coefficient is slightly negative in both models (-0.058 in the Poisson and -0.034 in the NB), which could suggest a modest decrease in fire events under lame-duck governors. Nevertheless, this effect is also not statistically significant. Finally, the AIC is considerably lower in the NB model compared to the Poisson model, suggesting that the NB model may better capture the data's overdispersion and is, therefore, the preferred model for this analysis.

Table 5.4 - Election years and re-election incentives

Dependent variable: Fire events

	Poisson	NB
Gubernatorial election year	-0.062 (0.056)	0.049 (0.073)
Year after the election	0.051 (0.004)	0.073 (0.087)
Year before the election	0.047 (0.043)	0.060 (0.088)
Lame-duck governor	-0.058 (0.053)	-0.034 (0.057)
Annual real GDP	yes	yes
Annual population density	yes	yes
Annual precipitation anomalies	yes	yes
Annual temperature anomalies	yes	yes
State and year fixed effect	yes	yes
Observations	752	752
AIC	203501	11522

*Note: Two models are presented: the Poisson model and the Negative Binomial (NB) model. The NB model is used when data exhibit overdispersion, where variance exceeds the mean, while the Poisson model assumes equal mean and variance. The dependent variable is the count of fire incidents. "Gubernatorial election year" is binary, equal to 1 for the election years. "Year after the election" and "Year before the election" are binary, equal to 1 for the year after and before the election, respectively. "Lame-duck governor" is also binary and one when the governor faces the term limit. All models include State and year-fixed effects, annual population density and control variables for annual average precipitation and temperature anomalies. Standard errors are clustered by State level in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

The results in Table 5.5 come from a series of OLS regression models assessing the factors influencing total burnt area, average burnt area, and fire duration. None of the variables representing election timing show significant effects on any of these outcomes, indicating that the timing of elections may not substantially influence total burnt area, fire duration, or average burnt area. Similarly, whether the governor is in a final term with no re-election eligibility does not show a statistically significant impact on changes in these outcomes. The models vary in explanatory power, with the first two explaining approximately 33-37% of the variance, as indicated by Adjusted R^2 values, while the third model accounts for only around 18%, suggesting a weaker fit. Tables 5.4 and 5.5 provide a lack of statistically significant results

across all key variables, implying that no strong relationship was identified between election timing, governor term limits, and fire characteristics.

Table 5.5- Election years and re-election incentives effects on total and average burnt area, and fire duration

Dependent variable: Total burnt area, fire duration, average burnt area

	Total Burnt Area	Duration Average	Average Burnt Area
Gubernatorial election year	-0.035 (0.056)	0.438 (0.333)	-0.0001 (0.0002)
Year after the election	-0.019 (0.067)	-0.128 (0.393)	-0.0001 (0.0003)
Year before the election	0.008 (0.067)	0.610 (0.398)	0.0002 (0.0003)
Lame-duck governor	0.006 (0.044)	0.009 (0.259)	-0.0001 (0.0002)
Annual real GDP	yes	yes	yes
Annual population density	yes	yes	yes
Annual precipitation anomalies	yes	yes	yes
Annual temperature anomalies	yes	yes	yes
State and year fixed effect	yes	yes	yes
Observations	752	752	752
Adjusted R ²	0.331	0.370	0.184

*Note: The dependent variables are total burnt area, fire duration, average burnt area by State by year. "Gubernatorial election year" is binary, equal to 1 for the election years. "Year after the election" and "Year before the election" are binary, equal to 1 for the year after and before the election respectively. "Lame-duck governor" is also binary and one when governor face the term limit. All models include State and year fixed effects, annual population density and control variables for annual average precipitation and temperature anomalies. Standard errors clustered by State in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

5.5 Robustness checks

5.5.1 Electoral cycles and fires in the Western U.S.

Table 5.6 presents the estimates from equations *R1* and *R2*, examining the relationship between gubernatorial election timing and fire counts in the Western U.S. - a region significantly impacted by wildfires. Both the Poisson and NB models are presented, with each model including State and year fixed effects as well as controls for economic factors (e.g., real GDP, population density) and meteorological variables.

In both models, the coefficient for gubernatorial election years is positive (0.030 in the Poisson and 0.066 in the NB model), but neither coefficient is statistically significant, indicating no clear association between election years themselves and fire events. However, the coefficient for the year following an election is positive and statistically significant in both models (0.150 in the Poisson and 0.164 in the NB), suggesting a potential increase in fire incidents in the year after an election, with the NB model providing particularly robust support for this finding.

Similarly, the coefficient for the year preceding an election is also positive in both models (0.119 in the Poisson and 0.139 in the NB) and achieves statistical significance in the NB model. This result indicates a possible, though tentative, increase in fire events in the year leading up to an election. Lastly, the AIC values for each model suggest that the NB model may provide a better fit for the data, as evidenced by its notably lower AIC compared to the Poisson model.

Table 5.6 - Election years and lag and lead effect on fire events In the Western States

Dependent variable: Fire events		
	Poisson	NB
Gubernatorial election year	0.030 (0.095)	0.066 (0.074)
Year after the election	0.150* (0.069)	0.164** (0.060)
Year before the election	0.119 (0.068)	0.139* (0.066)
Annual real GDP	yes	yes
Annual population density	yes	yes
Annual precipitation anomalies	yes	yes
Annual temperature anomalies	yes	yes
State and year fixed effect	yes	yes
Observations	176	176
AIC	32764	2704

*Note: Two models are presented: the Poisson model and the Negative Binomial (NB) model. The NB model is used when data exhibit overdispersion, where variance exceeds the mean, while the Poisson model assumes equal mean and variance. The dependent variable is the count of fire incidents. "Gubernatorial election year" is binary, equal to 1 for the election years. "Year after the election" and "Year before the election" are binary, equal to 1 for the year after and before the election respectively. All models include State and year fixed effects, annual population density and control variables for annual average precipitation and temperature anomalies. Standard errors clustered at the State level in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

The results from the OLS models instead are consistent with those observed for the broader continental U.S. Table 5.7 shows that neither election years nor the years before and after elections have a statistically significant impact on changes in total burnt area, average burnt area, or fire duration. The explanatory power of the models varies, with the first two models accounting for approximately 35-65% of the variation, as indicated by the Adjusted R^2 values. In contrast, the third model explains only about 15% of the variation, suggesting a weaker fit.

Table 5.7 - Election years and lag and lead effect on total and average burnt area, and fire duration in the Western States

Dependent variable: Total burnt area, fire duration, average burnt area			
	Total Burnt Area	Duration Average	Average Burnt Area
Gubernatorial election year	-0.098 (0.241)	0.114 (0.679)	0.0005 (0.001)
Year after the election	-0.353 (0.678)	0.257 (1.913)	0.0001 (0.003)
Year before the election	-0.395	1.319	0.001

	(0.714)	(2.013)	(0.003)
Annual real GDP	yes	Yes	yes
Annual population density	yes	Yes	yes
Annual precipitation anomalies	yes	Yes	yes
Annual temperature anomalies	yes	Yes	yes
State and year fixed effect	yes	Yes	yes
Observations	176	176	176
Adjusted R ²	0.349	0.649	0.150

*Note: The dependent variables are total burnt area, fire duration, and average burnt area by State by year. "Gubernatorial election year" is binary, equal to 1 for the election years. "Year after the election" and "Year before the election" are binary, equal to 1 for the year after and before the election, respectively. "Lame-duck governor" is also binary and one when the governor faces the term limit. All models include State and year-fixed effects, annual population density and control variables for annual average precipitation and temperature anomalies. Standard errors are clustered by State in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

5.5.2 Land rights and electoral cycles

The analysis in Table 5.8 considers jurisdictional differences, focusing on fires from 2003 to 2018 on State-owned lands versus the ones under Federal jurisdiction (e.g., lands managed by the Bureau of Land Management, U.S. Fish and Wildlife Service, National Park Service, and USDA-FS). The analysis compares the land ownership and management to analyse whether there is a difference in the outcomes, introducing the dummy variable equal to one if a fire occurred or started in a state-owned land. It is expected that gubernatorial election cycles may have a stronger effect on fire occurrences in State-owned lands under governors' jurisdiction.

Table 5.8 investigates how fire incidence on State-owned lands relates to gubernatorial election cycles, including potential lead effects (the year before an election) and lag effects (the year following an election). Both models used - Poisson and NB - incorporate State and year-fixed effects, with additional controls for economic and environmental factors like real GDP, population density, precipitation, and temperature anomalies. The results for State-owned lands show a statistically significant relationship between election years and fire incidence, suggesting that election timing consistently impacts fire incidence on lands directly managed by States. In the lead-up to elections and during the electoral year, the models show positive and statistically significant coefficients. These coefficients range from 20% to 25% higher in the Poisson model and from 4% to 46% higher in the NB model. In the year following an election, both models report negative and statistically significant coefficients.

This result shows that accounting for land jurisdictions and potential management, some evidence of cycles in the frequency of ignitions emerge on lands managed under the governor's jurisdiction. These results might confirm that there is a cyclical pattern following electoral years in fire occurrences.

Table 5.8 - Election years effect on fire events in State-owned lands

Dependent variable: Fire events		
	Poisson	NB
Gubernatorial election year	0.253** (0.079)	0.468* (0.217)
Year after the election	-0.320*** (0.018)	-0.184*** (0.030)
Year before the election	0.205*** (0.001)	0.040*** (0.003)
Annual real GDP	yes	yes
Annual population density	yes	yes
Annual precipitation anomalies	yes	yes
Annual temperature anomalies	yes	yes
State and year fixed effect	yes	yes
Observations	64	64
AIC	1028	645

*Note: Two models are presented: the Poisson model and the Negative Binomial (NB) model. The NB model is used when data exhibit overdispersion, where variance exceeds the mean, while the Poisson model assumes equal mean and variance. The dependent variable is the count of fire incidents. "Gubernatorial election year" is binary, equal to 1 for the election years. "Year after the election" and "Year before the election" are binary, equal to 1 for the year after and before the election, respectively. All models include State and year-fixed effects, annual population density and control variables for annual average precipitation and temperature anomalies. Standard errors clustered at the State level in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

Table 5.9 examines the relationship between gubernatorial election timing and three fire impact measures on State-owned: total burnt area (acres), fire duration (average days), and average burnt area (acres) per fire event. The models account for State and year-fixed effects and include controls for economic and environmental factors such as GDP, population density, and weather anomalies.

The coefficients for the gubernatorial election year and the year after are negative for both total and average burnt area, but these coefficients are not statistically significant. Similarly, for fire duration, the coefficients are negative and not statistically significant. However, in the year before the election, a negative and statistically significant effect (at the 10% level) is observed for the average fire duration on State lands. This suggests that fires may burn for shorter periods in the year after the election, though this effect does not translate to a reduction in the area burnt. The Adjusted R^2 values range from 0.394 to 0.72 across the models, indicating that the models explain a moderate proportion of the variance in fire impact measures.

Table 5.9 - Election years effect on total and average burnt area, and fire duration in State-owned lands

Dependent variable: Total burnt area, fire duration, average burnt area

	Total Burnt Area	Duration Average	Average Burnt Area
Gubernatorial election year	-0.000 (0.000)	-2.061 (4.039)	-0.000 (0.000)
Year after the election	0.000 (0.678)	-10.802** (1.913)	0.000 (0.003)

Year before the election	-0.000 (0.000)	-4.378 (3.197)	-0.000 (0.000)
Annual real GDP	yes	yes	Yes
Annual population density	yes	yes	Yes
Annual precipitation anomalies	yes	yes	Yes
Annual temperature anomalies	yes	yes	Yes
State and year fixed effect	yes	yes	Yes
Observations	64	64	64
Adjusted R ²	0.394	0.720	0.599

*Note: The dependent variables are total burnt area, fire duration, and average burnt area by State by year. "Gubernatorial election year" is binary, equal to 1 for the election years. "Year after the election" and "Year before the election" are binary, equal to 1 for the year after and before the election, respectively. All models include State and year-fixed effects, annual population density and control variables for annual average precipitation and temperature anomalies. Standard errors are clustered by State in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

5.5.3 Anthropogenic fires

I repeated the analysis with a specific focus on fires caused by human actions, as the FPA-FOD dataset distinguishes fire events based on their cause - whether triggered by natural factors or human activities, including both accidental and intentional fires. Table 5.10 examines the relationship between gubernatorial election years and the timing of human-driven fire events, applying both Poisson and NB models. The dependent variable is the count of fire incidents, and the models control for factors such as annual real GDP, population density, precipitation anomalies, and temperature anomalies, along with State and year-fixed effects.

In both the Poisson and NB models, there is statistically significant evidence that elections influence human-caused fire ignitions around and during the election year. The NB model, which accounts for overdispersion, provides more reliable estimates and suggests that elections may have a meaningful but complex influence on fire incidents. Overall, the analysis reveals a slight increase in human-caused fire incidents in the year preceding a gubernatorial election, followed by a bigger decline during the election year and the year after. This suggests that gubernatorial elections may exert a strong and consistent influence on human-driven fire events on both Federal and State-owned land.

Table 5.10 - Election years and lag and lead effect on human-driven fire events

Dependent variable: Fire events		
	Poisson	NB
Gubernatorial election year	-0.201* (0.089)	-0.140* (0.065)
Year after the election	0.116 (0.096)	-0.331*** (0.052)
Year before the election	0.092*** (0.009)	0.009*** (0.0002)
Annual real GDP	yes	yes

Annual population density	yes	yes
Annual precipitation anomalies	yes	yes
Annual temperature anomalies	yes	yes
State and year fixed effect	yes	yes
Observations	64	64
AIC	10354	929

*Note: Two models are presented: the Poisson model and the Negative Binomial (NB) model. The NB model is used when data exhibit overdispersion, where variance exceeds the mean, while the Poisson model assumes equal mean and variance. The dependent variable is the count of fire incidents. "Gubernatorial election year" is binary, equal to 1 for the election years. "Year after the election" and "Year before the election" are binary, equal to 1 for the year after and before the election, respectively. All models include State and year-fixed effects, annual population density and control variables for annual average precipitation and temperature anomalies. Standard errors are clustered at the State level in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

The increase in human-caused fire ignitions, however, does not translate into a rise in fire duration or burnt areas. Table 5.11 shows that neither election years nor the years before or after elections have a statistically significant impact on total burnt area, average burnt area, or fire duration. The explanatory power of these models is, in this case, quite weak, varying from 2% to 21%, as indicated by the Adjusted R^2 values.

Table 5.11 - Election years and lag and lead effect on total and average burnt area, and fire duration for human-driven fires

Dependent variable: Total burnt area, fire duration, average burnt area			
	Total Burnt Area	Duration Average	Average Burnt Area
Gubernatorial election year	-0.116 (1.351)	-2.455 (7.489)	-0.001 (0.005)
Year after the election	-0.288 (1.069)	-3.213 (5.927)	-0.001 (0.004)
Year before the election	0.409 (1.702)	-6.559 (9.433)	0.004 (0.006)
Annual real GDP	yes	yes	yes
Annual population density	yes	yes	yes
Annual precipitation anomalies	yes	yes	yes
Annual temperature anomalies	yes	yes	yes
State and year fixed effect	yes	yes	yes
Observations	64	64	64
Adjusted R^2	0.021	0.214	0.072

*Note: The dependent variables are total burnt area, fire duration, and average burnt area by State by year. "Gubernatorial election year" is binary, equal to 1 for the election years. "Year after the election" and "Year before the election" are binary, equal to 1 for the year after and before the election, respectively. All models include State and year-fixed effects, annual population density and control variables for annual average precipitation and temperature anomalies. Standard errors are clustered by State in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

5.5.4 Assessing the past fires effect

To evaluate whether the results change when accounting for the influence of past fires on contemporaneous ignitions, I include lagged fire occurrences as a control variable. Table 5.12

presents the estimates from a dynamic panel regression model (Arellano & Bond, 1991; Arellano & Bover, 1995).

The lagged dependent variables, representing past fire occurrences, are included to capture the effect of previous events on current outcomes. These coefficients are generally small and not statistically significant, suggesting that past fires have minimal influence on the later count of fire incidents.

However, accounting for these past occurrences reveals that the year before and the year after an election exhibit a positive and significant effect in the Poisson model, implying an increase in fire incidents during these periods. In contrast, while the NB model shows similar positive trends, the effects are not statistically significant, indicating that these findings may not be robust across model specifications.

Table 5.12 - Past fires effects

Dependent variable: Fire events		
	Poisson	NB
One-year lagged dependent variable	0.00002 (0.00002)	0.0001 (0.00004)
Two-year lagged dependent variable	0.00002 (0.00001)	0.00003 (0.00003)
Three-year lagged dependent variable	0.00001 (0.00001)	0.00002 (0.00002)
Gubernatorial election year	-0.061 (0.056)	-0.019 (0.066)
Year after the election	0.112** (0.041)	0.052 (0.052)
Year before the election	0.100* (0.041)	0.034 (0.054)
Annual real GDP	yes	Yes
Annual population density	yes	Yes
Annual precipitation anomalies	yes	Yes
Annual temperature anomalies	yes	Yes
State and year fixed effect	yes	Yes
Observations	611	611
AIC	141083	9329

*Note: Two models are presented: the Poisson model and the Negative Binomial (NB) model. The NB model is used when data exhibit overdispersion, where variance exceeds the mean, while the Poisson model assumes equal mean and variance. The dependent variable is the count of fire incidents. "Gubernatorial election year" is binary, equal to 1 for the election years. "Year after the election" and "Year before the election" are binary, equal to 1 for the year after and before the election, respectively. All models include State and year-fixed effects, annual population density and control variables for annual average precipitation and temperature anomalies. Standard errors are clustered at the State level in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

5.5.5 Using MODIS dataset

I repeat the analysis using a different fire dataset from the same period (2003-2018): NASA's MODIS (Moderate Resolution Imaging Spectroradiometer) Active Fire dataset. Part of the Earth Observing System Data and Information System (EOSDIS), MODIS offers near real-time

global data on active fires. Captured by the MODIS instruments aboard the Terra and Aqua satellites, this dataset detects thermal anomalies and wildfires worldwide. With a spatial resolution of 1 km, it is effective for tracking large-scale fires, monitoring fire intensity, size, and temporal variations, and observing regional trends daily.

Table 5.13 presents the estimates from models *R1* and *R2* using the MODIS dataset. Unlike the findings in Table 5.2, the analysis with MODIS shows a slightly significant positive coefficient (0.266) in the NB model, suggesting a weak association between pre-election years and a slight increase in fire incidents. However, the results indicate no significant effect of election years or the years immediately after elections on the frequency of human-driven fires.

Table 5.13 - Election years and lag and lead effect on fire events. MODIS data.

Dependent variable: Fire events		
	Poisson	NB
Gubernatorial election year	-0.020 (0.064)	0.098 (0.055)
Year after the election	0.028 (0.057)	0.192 (0.116)
Year before the election	0.093 (0.073)	0.266* (0.123)
Annual real GDP	Yes	yes
Annual population density	Yes	yes
Annual precipitation anomalies	Yes	yes
Annual temperature anomalies	Yes	yes
State and year fixed effect	Yes	yes
Observations	752	752
AIC	51594	7459

*Note: Two models are presented: the Poisson model and the Negative Binomial (NB) model. The NB model is used when data exhibit overdispersion, where variance exceeds the mean, while the Poisson model assumes equal mean and variance. The dependent variable is the count of fire incidents. "Gubernatorial election year" is binary, equal to 1 for the election years. "Year after the election" and "Year before the election" are binary, equal to 1 for the year after and before the election, respectively. All models include State and year-fixed effects, annual population density and control variables for annual average precipitation and temperature anomalies. Standard errors are clustered at the State level in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

Table 5.14 examines the effects of gubernatorial election timing on wildfire characteristics (total burnt area in hectares, fire duration in days, and average burnt area in hectares) in the U.S. using the MODIS dataset. The dependent variables here are each represented by State-year observations, while the main independent variables of interest include election year timing indicators. The results indicate no statistically significant effect of election years or the years surrounding elections on wildfire characteristics, suggesting that gubernatorial election timing may not strongly influence wildfire management in terms of total area burnt, fire duration, or

average burnt area. The Adjusted R^2 values vary by model: 0.082 for the total burnt area, 0.524 for fire duration, and 0.174 for the average burnt area indicating the models capture fire duration variations better than total or average burnt area.

Table 5.14 - Election years and lag and lead effect on total and average burnt area, and fire duration with MODIS data

Dependent variable: Total burnt area, fire duration, average burnt area			
	Total Burnt Area	Duration Average	Average Burnt Area
Gubernatorial election year	-0.571 (0.560)	0.078 (0.110)	-0.0002 (0.0002)
Year after the election	-0.398 (0.660)	0.135 (0.130)	-0.0002 (0.0003)
Year before the election	-0.322 (0.668)	0.113 (0.131)	-0.0002 (0.0003)
Annual real GDP	yes	yes	Yes
Annual population density	yes	yes	Yes
Annual precipitation anomalies	yes	yes	Yes
Annual temperature anomalies	yes	yes	Yes
State and year fixed effect	yes	yes	Yes
Observations	752	752	752
Adjusted R^2	0.082	0.534	0.174

*Note: The dependent variables are total burnt area, fire duration, and average burnt area by State by year. "Gubernatorial election year" is binary, equal to 1 for the election years. "Year after the election" and "Year before the election" are binary, equal to 1 for the year after and before the election, respectively. All models include State and year-fixed effects, annual population density and control variables for annual average precipitation and temperature anomalies. Standard errors are clustered by State in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

5.6 Conclusions

This chapter examines whether gubernatorial elections and associated political incentives impact wildfire events in the U.S. The objective is not to critique the electoral system but to examine how political motivations may influence the management of public goods, specifically wildfire management. This analysis directly addresses my research question: *What socio-economic and political factors drive wildfire occurrence and severity, and how do they interact? Can political economic theory reveal whether political motivations shape wildfire extent, duration, and frequency?* as well as objectives 1 and 3 of this thesis:

- Identify the socio-economic and political factors that influence wildfire regimes, both directly and indirectly, and answer how these factors interact with one another.
- Determine whether macro-level political factors can be identified through the application of econometric analysis to wildfire characteristics, such as occurrence, duration, and extent of burned areas.

Table 5.2 analyses the link between gubernatorial election cycles and fire events. Poisson and Negative Binomial (NB) models indicate a slight decline in fire occurrences during election years, though the effects are not statistically significant. Lead and lag effects (years before and after elections) suggest a possible rise in fire counts but without statistical significance. Similarly, OLS models in Table 5.3 assess fire duration, total burnt area, and average burnt area, finding no significant impact of election years or surrounding periods. Tables 5.4 and 5.5 incorporate re-election incentives, showing weakly negative effects of election years and term-limited (lame-duck) governors on fire events, though none of the coefficients are statistically significant. No meaningful relationships emerge for burnt area or fire duration. Overall, results across all models using U.S. data from 2003 to 2018 show no strong or consistent association between election timing, governor term limits, and fire characteristics.

Table 5.6 explores the relationship between election cycles and fire events in the Western U.S. This allows us to examine whether results change when focusing on an area historically prone to wildfires. Additionally, the FPA-FOD dataset for the Western States contains no missing data. While the election year itself does not appear to significantly influence fire counts, the year following an election shows a statistically significant increase in wildfire incidents. Additionally, the year preceding an election also exhibits a positive effect, although this is only statistically significant in the NB model. Table 5.7, which presents the total burnt area, fire duration, and average burnt area, reveals no significant effects of election timing on these variables.

A separate analysis of State-owned lands for all the states reveals a stronger link between election cycles and fire incidence (Table 5.8). Election years and the year before see statistically significant increases in fire events, while the year after elections shows a decline. These findings suggest political cycles may influence fire management decisions. When examining other fire characteristics (Table 5.9), the increase in fire events does not translate into a more extensive burnt area, but fire duration in the year after an election shows a significant reduction.

Table 5.10 shows that the year before an election is significantly associated with an increase in human-caused fire incidents. This effect is observed in both models, with the NB model providing more reliable estimates due to its adjustment for overdispersion. Interestingly, the election year itself and the year after the election show a decline in fire incidents, suggesting a cyclical pattern of heightened fire activity before elections, followed by a reduction during and after. Despite the observed increase in fire incidents in the year before elections, these fires do not result in larger or longer-lasting fires (Table 5.11). These findings only partially align with

the results presented in Table 5.8, which focuses on State-owned lands. While fire incidents (both human- and naturally ignited) exhibit a sustained upward trend in state-owned lands during the election year, a different pattern emerges when considering only human-ignited fires across both Federal and State-owned lands, where a decline in such ignitions is observed.

To investigate the role of past fires on current fire occurrences, Table 5.12 includes lagged fire incidents as a control variable in a dynamic panel regression. The results show that past fire occurrences have a minimal effect on current fire incidents. However, when examining the election year effect, the Poisson model reveals a significant increase in fire incidents during the year before and the year after the election, while the NB model suggests no statistically significant coefficients.

To further assess the robustness of the findings, the analysis is repeated using the MODIS Active Fire dataset (2003-2018). Tables 5.13 and 5.14 show a weak but positive relationship between the year before the election and fire incidents. Again, there is no statistically significant effect on total burnt area, fire duration, or average burnt area.

In summary, while there is some evidence of electoral cycles influencing specific fire characteristics in the U.S., these effects lack consistency throughout the robustness checks and the different model specifications. Overall, the results from the selected models suggest a partial influence of electoral cycles on fire characteristics in the U.S. While gubernatorial election timing may influence fire incidents in some cases - either in relation to human-ignited fires, in the Western States or when focusing on State-owned lands - these incidents do not substantially affect the scale or duration of fire events. This might suggest that while election cycles may influence the occurrence of fires, possibly due to heightened human activity or reduced enforcement, they do not appear to have a significant impact on fire management outcomes, such as the total area burnt, fire duration, or average burnt area.

These results slightly align with previous research that suggested political incentives may distort fire outcomes around election periods in Mediterranean Europe (Skouras & Christodoulakis, 2014; Kountouris, 2020; Álvarez-Díaz et al., 2015). However, the results do not align with earlier studies highlighting the negative effect of lame-duck governors on environmental spending (Fredriksson et al., 2011), which posited that re-electable politicians may be less inclined to prioritise fire prevention efforts, potentially shifting focus away from sustainable land management in pursuit of re-election.

These findings, specific to the U.S., should not be generalised to other countries, as they reflect the unique political and institutional structure where State and Federal entities share fire

management responsibilities. This structure may limit the incentives for State governments to act in a strategically electoral manner. Additionally, States have the option to request extra funding through FEMA, which could reduce incentives for riskier management practices on State lands. Another possibility is that councils or mayors, who have the authority to allocate local resources, may divert funds from fire management or monitoring before gubernatorial elections in anticipation of a potential change in state leadership and the subsequent shifts in land management policies.

In conclusion, this analysis indicates that political factors could play a role in shaping wildfire outcomes. Therefore, evaluating wildfire risk must be done in conjunction with the broader political, economic, and institutional context. In the following chapter, I examine the potential influence of partisanship on fire characteristics in the U.S.

Chapter 6 - Investigating governors' partisanship on fire characteristics in the US.

6.1 Introduction

In Chapter 5, I investigate whether fire characteristics in the U.S. are influenced by electoral cycles and the re-election incentives of governors. Building on the previous results, this chapter focuses specifically on objective 3: determining whether macro-level political factors, through the application of econometric analysis, can influence fire characteristics such as occurrence, duration, and the extent of burned areas. Specifically, this chapter explores whether governors' partisanship, influenced by efforts to satisfy their electorate, significantly impacts the outcomes and characteristics of wildfires.

Polarised partisanship can lead to divisive policies on various topics, ranging from social to environmental concerns (Fankhauser et al., 2015; Ferreira & Gyourko, 2009). Political parties' stances on environmental or climate issues can be remarkably divergent, resulting in the promotion of policies at opposite ends of the spectrum. In this context, scholars argue that decisions concerning natural hazards and disasters are rarely made from an apolitical standpoint (Dunlap & Allen, 1976; Dunlap & Gale, 1974). The partisan theory has been used to analyse socio-economic outcomes in relation to political business cycles (Beland & Oloomi, 2017; Ferreira & Gyourko, 2009), as well as environmental outcomes, such as how left-leaning governments are more likely to pass climate change laws during difficult economic times (Ashworth et al., 2002; Fankhauser et al., 2015).

Partisan ideology might also spill over to fire management strategies; however, research has paid less attention to the role of party affiliation in the determination of fire regimes. Each year, as the fire season approaches, there is a need for effective and sustainable wildfire management strategies to prevent destructive impacts on human and animal lives and properties (French, 2020). Media covered the debate between the Congress representatives in the US on the causes behind large wildfires and the subsequent policy implementation to tackle them (Colorado Public Radio 2021). While Democratic congress representatives showed greater concern about the role of climate change in influencing mega-fires, Republicans identified the federal prevention approach of the last decade leading to denser and, therefore, more flammable forests as the main cause behind the events (Financial Times, 2020).

In this chapter, I examine the influence of government partisan affiliation on various fire characteristics, focusing on fire occurrence, duration, and total and average burned area in the US. Given the predominant bipartisan nature of the US political framework, I aim to assess whether government partisanship significantly affects fire characteristics. To address potential endogeneity that could bias the estimation of the treatment's effect, I use a regression

discontinuity design (RDD) applied in the context of close elections (Caughey & Sekhon, 2011; Cellini et al., 2010; Fredriksson et al., 2005; Gagliarducci & Paserman, 2010). For the analysis, I use data from the Fire Program Analysis Fire-Occurrence Database (FPA-FOD), maintained by the USDA-FS, a comprehensive dataset that integrates information from multiple sources, including Federal databases, State reports, and local fire departments. While for electoral gubernatorial elections, I used dataset from derived from the web archive Ballotpedia (2024).

6.2 Theoretical background

The partisan theory developed by Hibbs (1977) supports the idea that different political parties implement different macroeconomic policies to adhere to their partisan ideology and to favour their electorate (Alesina, 1987). This theory has been applied across various sectors, starting with fiscal and socio-economic domains (Cellini et al. 2010; Gagliarducci & Paserman, 2010). The idea that environmental policies can be influenced by partisan ideologies was first introduced by Dunlap and Gale (1974), who hypothesised that Republicans would give less support to environmental policies than Democrats. Historical evaluations at the State and the Federal level have supported Dunlap and Gale's theory, confirming that pro-environmental policy adoption is more related to partisan differences rather than cultural or sociodemographic characteristics (Engelbert, 1961; Ritt and Ostheimer, 1974).

The partisan theory differs from the Political Business Cycle (PBC) theory, introduced by Nordhaus (1975), which posits that incumbent politicians adopt policies aimed at maximising their chances of re-election. However, the two theories have sometimes been jointly explored in empirical analyses to assess the importance of partisan ideology and constituency representation when incumbent governments seek re-election (Krause, 2005; Leigh, 2008; Ferreira & Gyourko, 2009; Beland and Oloomi, 2017). In the U.S., a study covering the 1948–2000 period shows that, prior to presidential elections, personal income tends to increase under Republican presidents, while in some cases, it decreases in absolute terms under Democratic presidents (Krause, 2005). Another study examining state governors from 1941 to 2002 finds that Democratic governors are associated with reduced post-tax inequality (Leigh, 2008). Furthermore, a study using regression discontinuity design (RDD) finds that Democratic governors tend to increase working hours for dark-skinned labourers, thereby narrowing the racial employment and earnings gap (Beland, 2015). Additionally, Democratic governors allocate a larger share of their budgets to health and education sectors compared to their Republican counterparts (Beland and Oloomi, 2017).

Empirical analyses of partisan polarisation on environmental policies, such as the study on the U.S. Senate and House votes from 1971 to 2013, reveal that electing a Democrat significantly

increases support for environmental policies (Kim & Urpelainen, 2017). The partisan gap in environmental voting has widened over time, though the environment was never fully bipartisan. Other empirical evidence suggests that state-level organisational features, such as the strength of the governor's legislature and/or the presence of a consolidated environmental agency, can mediate the effect of partisanship on environmental policy outcomes (Lester, 1980). Democratic governors tend to allocate more resources to environmental preservation, whereas environmental spending decreases in states where oil companies play a significant economic role (Pacca et al., 2021). Another study finds that Democratic governors generally achieve stronger renewable energy outcomes than Republicans (Bonnet & Olper, 2024). However, the partisan effect is not always clear-cut. For instance, Fredriksson et al. (2011) reveal a large negative effect of lame-ducks' governors on the per capita environmental spending but not a partisan effect, providing evidence that when governors cannot be re-elected, they behave differently.

While the predominantly bipartisan nature of U.S. politics favours the application of studies investigating partisan theory, this phenomenon is not exclusively American. A global study of 66 national jurisdictions spanning the 1990–2013 period found that left-wing governments are less hesitant to pass climate laws during times of economic crisis (Fankhauser et al., 2015). Although significant attention has been devoted to examining various environmental aspects, the literature has yet to explore the potential effects of partisanship on wildfire outcomes. This chapter, therefore, investigates whether governors' partisanship significantly influences fire occurrence, duration, and both total and average burnt areas at the State level in the U.S.

6.3 Method and data

6.3.1 Method

Let the relationship between fire characteristics and partisan affiliation be described by the following equation:

$$(E_1) \quad Y_{it} = \alpha + \beta T_{it} + \epsilon$$

Where Y_i is the dependent variables: fire occurrence, duration, and total and average burnt area in State i at time t and T_i is the partisan affiliation of the governor of State i . Estimating E_1 will likely lead to biased estimates of β as the government's partisan affiliation is not randomly assigned. Partisanship is not an exogenous variable; rather, it is generally shaped by unobserved local characteristics that extend beyond environmental preferences like sociodemographic and cultural characteristics of the population. At the same time, the environmental policy preferences of the population may influence government partisan affiliation, adding further complexity to the analysis.

To address this, I apply a regression discontinuity design (RDD) approach (Fredriksson et al., 2011; Gagliarducci & Paserman, 2010; Lee, 2008; Lee et al., 2004; Lee & Lemieux, 2010), a method increasingly popular in environmental economics for evaluating policies in this domain. RDD offers improved policy assessment through methodological advancements and the integration of new data sources (Wuepper & Finger, 2023). Specifically, I use this approach to compare fire outcomes following closely contested elections.

$$(E_2) \quad Y_{it} = \alpha_{it} + \beta T_{it} + \gamma R_{it} + \delta TR_{it} + \theta E_{it} + \varphi M_{it} + \sigma_i + \mu_t + \epsilon_{it}$$

In E_2 , the dependent variable Y_i is the count of fires occurred at the State i from 2003 to 2018. This count is modelled as a function of the running variable R_i which measures the difference in vote share between candidates and determines whether the State i is treated at time t ($T_{it} = 1$) - when a Republican wins against a Democrat - or untreated ($T_{it} = 0$). E_2 implies that partnership is randomly assigned by the close election outcomes, thus δ would capture the difference in fire outcomes when the public office is run by a Republican governor with respect a Democratic counterpart. Matrix M_{it} controls for annual temperature and rainfall anomaly levels (compared to the 1901-2000 average) and matrix E_{it} includes average annual real GDP and population density. Finally, terms δ_s and μ_t are State and year fixed effects, controlling for State- and year-specific variation respectively.

Another feature of the RDD is the choice of the bandwidth, which should be neither too large nor too narrow to include enough observations to obtain a more precise estimate while reducing selection bias. Guided by Calonico, Cattaneo and Titiunik (2014, 2015, 2018), I first applied the mean square error (MSE) optimal bandwidth selector to all Y_i . Additionally, I conduct a sensitivity analysis of the results with respect to bandwidth selection, which is presented in the robustness checks section.

6.3.2 Data

For the analysis, as for chapter 5, I use the Fire Program Analysis Fire-Occurrence Database (FPA-FOD), which includes 2.17 million fire records from 1992 to 2018 at a 1-square-mile grid resolution across the United States (Liu & Yang, 2020; Pourmohamad et al., 2023; Syphard et al., 2017). I combine this dataset with gubernatorial electoral data from Ballotpedia (Adams, 2020; Jacob, 2023; Kafle et al., 2024). Control variables include meteorological data, such as average annual temperature and precipitation anomaly rates, which are compared to the 20th century average (1901–2000). These data are sourced from the National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NOAA NCEI) database (Liu et al., 2024; Margolis et al., 2025; Oakley et al., 2017).

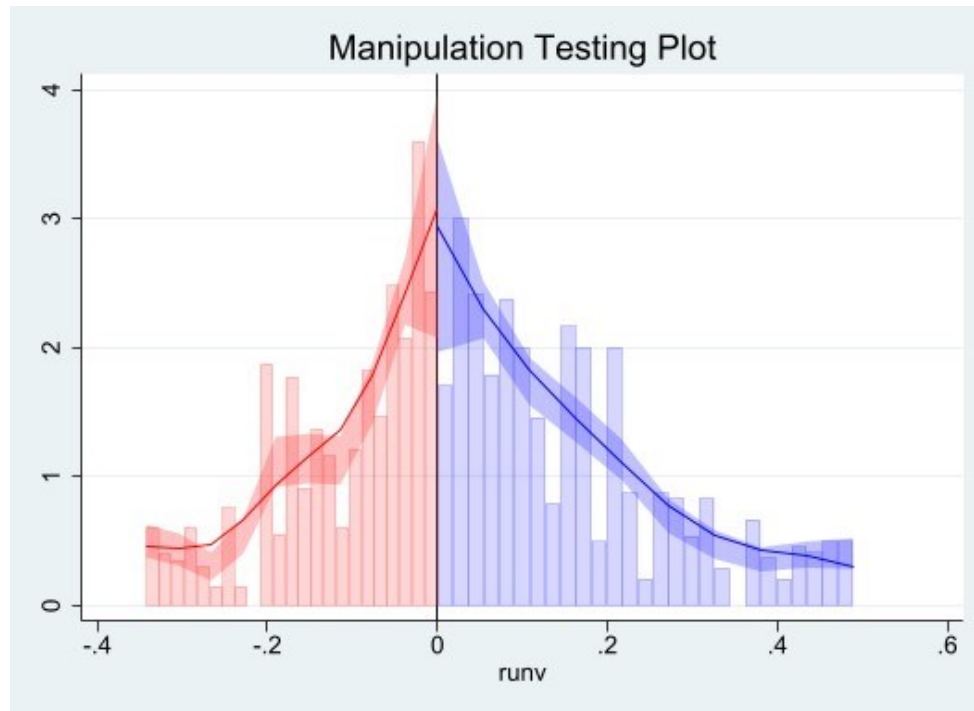
Additionally, State-level socio-economic data -including real GDP (in chained 2017 U.S. dollars) and population density are obtained from the U.S. Bureau of Economic Analysis (BEA) (Barrage & Lint, 2023; Tavor, 2024). The final compiled panel dataset is available on Zenodo.org and can be accessed using the following DOI: 10.5281/zenodo.13684035.

As for the model in chapter 5, before selecting control variables, I perform multicollinearity checks to ensure the robustness of the model. The final panel dataset comprises 789 observations, covering the period from 2003 to 2018 across 49 States. Hawaii is excluded due to missing data in the control variables. Descriptive statistics are presented in Table 5.1 in chapter 5, while Table 6.1 summarises the characteristics of governors across various states during the same period.

Table 6.1 - Descriptive statistics of the Governors in the database

Governors	Number	Percent
Democratic	348	44
Republican	436	56
Re-electable	565	72
Lame-duck	219	28

The Republican vote share for gubernatorial elections varies from a minimum of -52% to a maximum of 58%. Within the panel, Republican governors comprise 56% of the total, while 28% of governors (democratic and Republican) are subject to term limits, classifying them as lame-ducks. Before starting my analysis, I exclude the possibility of data manipulation or some type of observation sorting around the threshold. In other words, the units above and below the cut-off point should be similar, and the density should be roughly continuous. I conducted a manipulation test (McCrary & Justin, 2008) on the density distribution of the running variable. The test does not reject the null hypothesis, suggesting that discontinuity is unlikely. Consequently, there is no evidence of sorting or manipulation around the threshold. Figure 6.1 is a graphical representation of the test reporting the Republican marginal vote share in the form of triangular Kernel density distribution.

Figure 6.1 - Estimated density of the running variable

Note: McCrary density test assesses discontinuity in the running variable's density at the cut-off. A sharp change may indicate manipulation, suggesting subjects influence their treatment assignment by adjusting the running variable.

6.4 Results

6.4.1 Governors and fire regimes

Table 6.2 presents the results from four RDD models, in which the treatment is determined by whether governors are Republicans. All models control for fixed effects to account for unobserved heterogeneity. The models also include covariates such as real GDP (in chained 2017 U.S. dollar), population density, and indicators of whether the State experienced temperature and precipitation anomalies (compared to the 1901–2000 average) each year. To normalise the data, the average and total burnt area are divided by the population size for the corresponding year to account for population differences, and the number of events is divided by 100. Importantly, these covariates do not exhibit multicollinearity, ensuring the robustness of the estimates. I repeated the analysis by incorporating additional variables, including real GDP from the agriculture, oil and gas, and construction sectors, unemployment rates, and average temperature and precipitation by State. Although some changes in magnitude, the results remain consistent in terms of statistical significance compared to those presented in this section.

I employed the optimal bandwidths as determined by Calonico et al. (2018) for each independent variable. The optimal bandwidths vary depending on the selected independent variable, ranging from 0.10 to 0.19. A bandwidth of 0.15 was chosen for the analysis, although

a bandwidth sensitivity analysis was also conducted and reported in the robustness checks (section 6.5). The findings indicate an effect of having a Republican governor on the duration of fires, about one day longer, with treated units experiencing longer fire events compared to the control group, and this effect is statistically significant at the 5% level. While the coefficients for the average burnt area and the number of fire events are positive, and the coefficient for the total burnt area is negative, none of these are statistically significant.

Table 6.2 - Regression results of Republican governors on fire events, duration and average and total burnt area

	Events	Duration	Average burnt area	Total burnt area
Republican governor	3.473 (1.54)	1.110* (2.03)	-0.0000887 (-0.66)	-0.0421 (-0.63)
Precipitation anomalies	Yes	Yes	Yes	Yes
Temperature anomalies	Yes	Yes	Yes	Yes
Density	Yes	Yes	Yes	Yes
Real GDP PC	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	482	482	482	482

*Note: Standard errors clustered at the State level are reported in parentheses. All models control for fixed effects to account for unobserved heterogeneity. Additionally, the models include covariates such as real GDP and population density, as well as temperature and precipitation anomalies by State and year. The average and total burnt area is divided by the population size for the corresponding year to account for population differences. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

I repeated the analysis using the natural logarithm of the dependent variable, with the results summarised in Table 6.3. The findings confirm that having a Republican governor is associated with a 21.4% increase in fire duration, an effect that is statistically significant at the 5% level. Similar to the model using non-log-transformed dependent variables, the number of events and the area affected remain statistically insignificant.

Table 6.3 - Regression results of Republican governors on logarithms of fire events, duration and average and total burnt area

	Log events	Log duration	Log average burnt area	Log total burnt area
Republican governor	0.134 (0.69)	0.214* (2.20)	-0.0000880 (-0.66)	0.000128 (0.01)
Precipitation anomalies	Yes	Yes	Yes	Yes
Temperature anomalies	Yes	Yes	Yes	Yes
Density	Yes	Yes	Yes	Yes
Real GDP PC	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Observations 482 482 482 482

*Note: Standard errors clustered at the State level are reported in parentheses. All models control for fixed effects to account for unobserved heterogeneity. Additionally, the models include covariates such as real GDP and population density, as well as temperature and precipitation anomalies by State and year. The average and total burnt area is divided by the population size for the corresponding year to account for population differences. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

As the FPA-FOD database categorises fires by their causes, I focused my analysis exclusively on human-caused fires. The results from the RDD analysis for this subset, summarised in Table 6.4, confirm the trend discussed earlier. A statistically significant positive coefficient indicates that human-caused fires under Republican governors tend to last approximately 2.2 days longer. However, the results suggest no clear relationship between having a Republican governor and the number of human-caused fire events. Additionally, there is no conclusive evidence of an effect on the total burnt area.

Table 6.4 - Regression results of Republican governors on human-caused fire events, duration and average and total burnt area

	Events	Duration	Average burnt area	Total burnt area
Republican governor	0.416 (0.18)	-0.600 (-0.56)	-0.000000500 (-0.04)	0.00211 (0.76)
Precipitation anomalies	Yes	Yes	Yes	Yes
Temperature anomalies	Yes	Yes	Yes	Yes
Density	Yes	Yes	Yes	Yes
Real GDP	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	528	528	528	528

*Note: Standard errors clustered at the State level are reported in parentheses. All models control for fixed effects to account for unobserved heterogeneity. Additionally, the models include covariates such as real GDP and population density, as well as temperature and precipitation anomalies by State and year. The average and total burnt area is divided by the population size for the corresponding year to account for population differences. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

6.4.2 Re-electable VS lame-duck candidates

To evaluate the influence of political incentives on fire occurrence based on whether the incumbent governor is subject to re-election constraints, I estimate the equation E_3 separately for two groups: re-electable incumbents and lame-duck incumbents. This allows us to assess whether partisan incentives differ when the incumbent faces the binding term limit or is eligible for re-election. By comparing these groups, I can investigate how the potential for re-election may alter gubernatorial behaviour with respect to fire management and whether the absence of electoral pressure in lame-duck governors leads to different outcomes. Considering the dummy variable LD_i as a dummy equal to 1 if governors are lame-ducks, I adopt the following non-parametric approach:

$$(E_3) \quad Y_i = \alpha_{it} + \beta T_i + \gamma R_i + \delta T_i R_i + \varphi LD_i + \theta E_{it} + \varphi M_{it} + \sigma_i + \mu_t \epsilon$$

Table 6.5 presents the RDD results comparing governors who are eligible for re-election (Panel a) with those in their final term (Panel b). A statistically significant effect is found for fire duration, with re-electable Republican governors associated with an increase of approximately 1.92 days ($p < 0.05$). Again, no significant effects are observed for the number of fire events, average burnt area, or total burnt area. For lame-duck governors, no significant effects are detected for any fire outcomes. These results might suggest that while the re-election status of a Republican governor may influence wildfire duration, it has a limited impact on other wildfire-related measures.

Table 6.5 - Effect of re-electable and lame-duck Republican governors on fire events, duration and average and total burnt area

	Events	Duration	Average burnt area	Total burnt area	Events	Duration	Average burnt area	Total burnt area
	(a) Re-electable Republican governors				(b) Lame-duck Republican governors			
Republican governor	2.443 (1.01)	1.923* (2.16)	-0.00029 (-1.04)	-0.0992 (-0.88)	5.548 (1.27)	0.308 (1.05)	0.0000642 (0.96)	0.0302 (1.28)
Precipitation anomalies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Temperature anomalies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Density	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Real GDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	303	303	303	303	164	164	164	164

*Note: Standard errors clustered at the State level are reported in parentheses. All models control for fixed effects to account for unobserved heterogeneity. Additionally, the models include covariates such as real GDP and population density, as well as temperature and precipitation anomalies by State and year. The average and total burnt area is divided by the population size for the corresponding year to account for population differences. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

6.4.3 Western States

Although previous analyses incorporated both State and year-fixed effects to account for the demographic and ideological characteristics of the States (Bonnet & Olper, 2024; Fredriksson et al., 2005; Lee, 2008; List & Sturm, 2006), I now turn my attention to the Western U.S., a region uniquely vulnerable to wildfires. This area is particularly susceptible due to a convergence of climatic and environmental conditions, including prolonged droughts, dry vegetation, strong winds, and challenging topography. These factors make fires more intense, widespread, and difficult to control. In addition, human activities, such as land use changes and urban expansion into fire-prone areas, further amplify the risk and severity of wildfires. Consequently, wildfires in this region tend to be larger and last longer than in other parts of the country (Littell et al., 2009; Miller et al., 2013).

By isolating the Western States in the analysis, I aim to capture the distinctive fire dynamics driven by these extreme environmental conditions. I hypothesise that the heightened wildfire risk in this region could magnify the effects of the treatment variable, specifically the role of Republican governors. This narrower geographic focus allows us to investigate whether the political and policy factors—such as partisan influence—interact differently with fire outcomes in this fire-prone region.

However, the results in Table 6.6 show that the coefficients for having a Republican governor in the Western States are statistically insignificant for wildfire events, duration, average burnt area, and total burnt area.

Table 6.6 - Heterogeneity analysis considering only Western States

	Events	Duration	Average burnt area	Total burnt area
Republican governor	1.710 (0.38)	0.365 (0.23)	-0.00194 (-2.00)	-0.436 (-0.83)
Precipitation anomalies	Yes	Yes	Yes	Yes
Temperature anomalies	Yes	Yes	Yes	Yes
Density	Yes	Yes	Yes	Yes
Real GDP	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	108	108	108	108

*Note: Standard errors clustered at the State level are reported in parentheses. All models control for fixed effects to account for unobserved heterogeneity. Additionally, the models include covariates such as real GDP and population density, as well as temperature and precipitation anomalies by State and year. The average and total burnt area is divided by the population size for the corresponding year to account for population differences. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

6.4.4 Land ownership

The analysis in Table 6.7 considers jurisdictional differences, focusing on human-ignited fires from 2003 to 2018 on State- and Federal-owned lands (e.g., lands managed by the Bureau of Land Management, U.S. Fish and Wildlife Service, National Park Service, and USDA-FS). The analysis is designed with the expectation that gubernatorial election cycles may have a stronger effect on fire occurrences in State-owned lands, given that they are directly managed and financed by the States.

Table 6.7 presents the results of these estimates, which indicate that there are no statistically significant effects in the outcomes when analysing either state-owned or federally owned land separately. This suggests that the ownership structure does not substantially influence the observed effects.

Table 6.7 - Analysis considering only wildfires in State and Federal lands

	Events	Duration	Average burnt area	Total burnt area	Events	Duration	Average burnt area	Total burnt area
	(a) State-owned lands				(b) Federal-owned lands			
Republican governor	-0.153 (-0.24)	0.403 (0.76)	-0.00004 (-0.76)	-0.00048 (-0.02)	0.209 (0.42)	0.755 (1.37)	0.000053 (0.97)	0.00408 (1.08)
Precipitation anomalies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Temperature anomalies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Density	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Real GDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	469	469	469	469	466	466	466	466

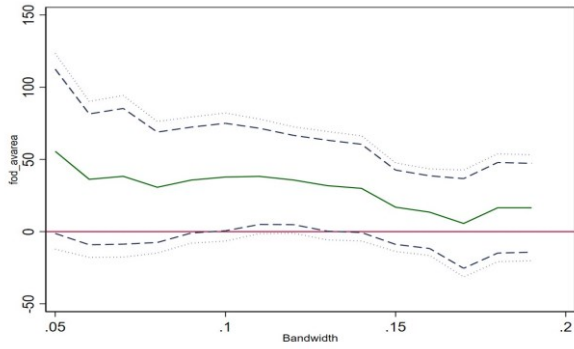
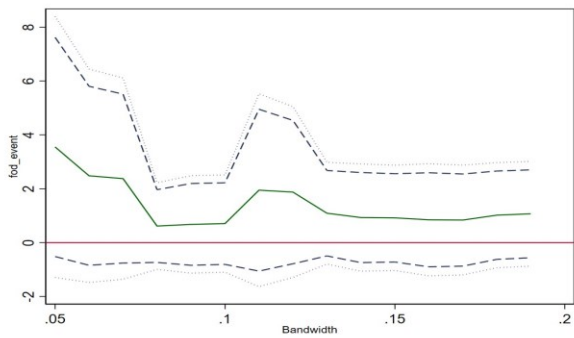
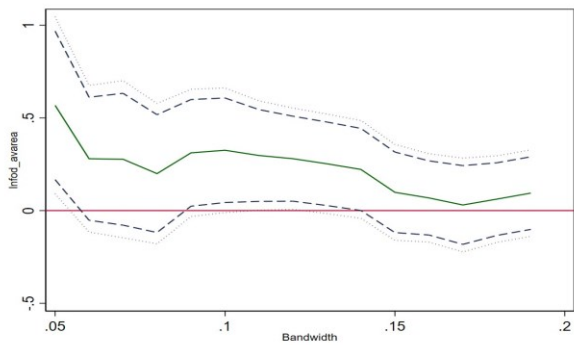
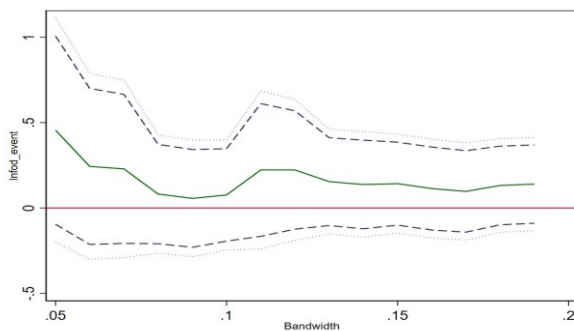
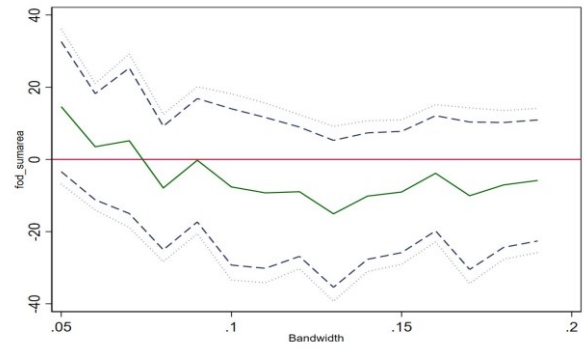
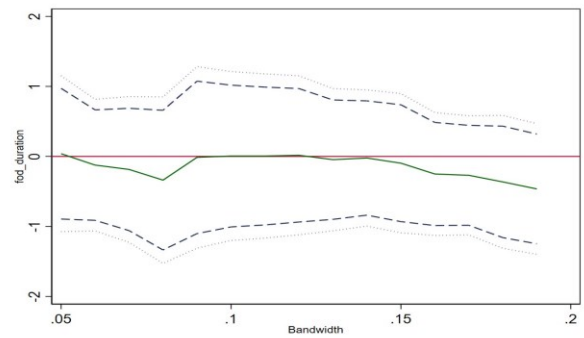
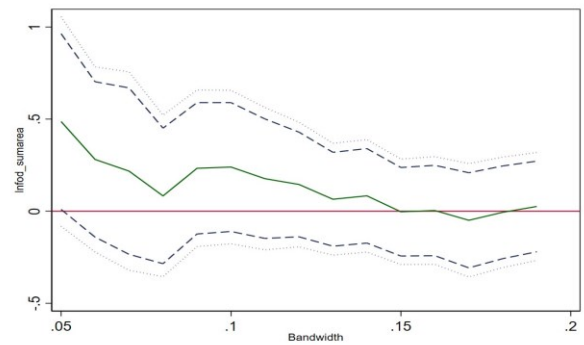
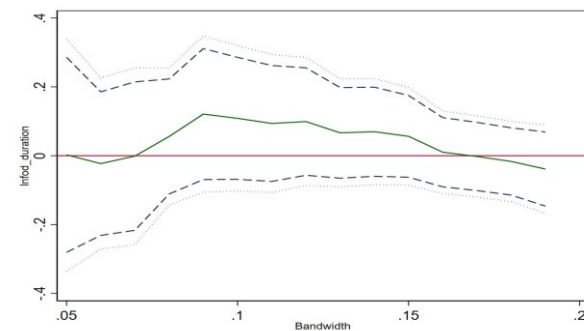
*Note: Standard errors clustered at the State level are reported in parentheses. All models control for fixed effects to account for unobserved heterogeneity. Additionally, the models include covariates such as real GDP and population density, as well as temperature and precipitation anomalies by State and year. The average and total burnt area is divided by the population size for the corresponding year to account for population differences. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

6.5 Robustness checks

6.5.1 Including different bandwidths

To assess the sensitivity of my results to various modelling choices, I perform a series of robustness checks. Table 6.8 presents the results of the bandwidth sensitivity analysis for all independent variables, including their logarithmic transformations. This analysis studies bandwidth selections ranging from 0.05 to 0.20, as different bandwidth choices can potentially introduce selection bias. The graphs display the estimates along with 90% and 95% confidence intervals.

Each figure represents a different independent variable, providing insights into the factors influencing fire characteristics in the US. The zero line indicates the null hypothesis (i.e., no effect or difference). If a confidence interval intersects the zero line (i.e., the lower bound is below 0 and the upper bound is above 0), this suggests that the effect is not statistically significant, and the null hypothesis cannot be rejected. Overall, the figures illustrate the sensitivity of the results to the chosen bandwidth for the analysis.

Table 6.8 - Bandwidth sensitivity analysis**Figure 1: Average Burnt Area****Figure 3: Fire Events****Figure 5: Logarithm of Average Burnt Area****Figure 7: Logarithm of Fire Events****Figure 2: Total Burnt Area****Figure 4: Fire Duration****Figure 6: Logarithm of Total Burnt Area****Figure 8: Logarithm of Fire Duration**

Note: Dotted and grey lines represent estimates and confidence intervals at the 90% and 95% levels. Each figure corresponds to different independent variables studied to understand the regimes of fire in the U.S. The zero line indicates the null hypothesis (i.e., no effect or no difference). If the confidence interval crosses the zero line (i.e., the lower bound is less than zero and the upper bound is greater than zero), it implies that the effect is not statistically significant, and the null hypothesis cannot be rejected.

6.5.2 The donut hole discontinuity regression

Another sensitivity analysis investigates how results are influenced by observations located closest to the cutoff in the regression discontinuity design (RDD). This method, known as the "donut hole" approach, systematically excludes data points near the cutoff point (zero) to evaluate whether their proximity affects the observed treatment effects.

Table 6.9 presents the results of a sensitivity analysis conducted by excluding observations around the cutoff, using different radius values (0.05, 0.10, and 0.15). By expanding this radius, I can assess the robustness of the treatment effect (where treatment = 1) and evaluate the model's sensitivity to these exclusions. As anticipated, increasing the radius reduces the number of observations included in the analysis and narrows the optimal bandwidth.

With a radius of 0.05, coefficients are not statistically significant for any of the outcomes, suggesting that when the cutoff window is narrow (0.05), the impact of a Republican governor is less pronounced or not detectable. When the radius is 0.10, results show a statistically significant effect on the number of wildfire events ($p < 0.05$), indicating that Republican governors are associated with a higher number of fire events. With a radius of 0.15, coefficients are not statistically significant. In summary, the sensitivity analysis suggests that the results vary depending on the radius used to exclude observations near the cutoff.

Table 6.9 - Sensitivity analysis when excluding observations around the cut-off

	Events	Duration	Average burnt area	Total burnt area	Observations
Radius 0.05	8.536 (1.63)	0.537 (1.35)	-0.000185 (-1.04)	-0.182 (-0.93)	380
Radius 0.10	10.76** (3.03)	1.263 (1.69)	0.0000482 (1.28)	0.0257 (0.93)	287
Radius 0.15	37.20 (1.50)	2.228 (1.28)	0.0000504 (0.28)	0.00108 (0.02)	166

6.5.3 Analysis with a different dataset

I conducted the same analysis using an alternative dataset to rule out potential issues related to data collection. Specifically, I employed the Moderate Resolution Imaging Spectroradiometer (MODIS) dataset, which uses satellite sensors to detect thermal anomalies and fire hotspots, offering a spatial resolution of 1 square kilometre. Table 6.10 suggests that, based on the MODIS dataset, Republican governors have little to no statistically significant effect on the frequency, duration, or size of fires, whether considering the raw data or the logarithmic transformations.

Table 6.10 - Regression results examining the impact of Republican governors on fire events, duration, and both average and total burnt area, and their logarithmic transformations, using the MODIS dataset.

	Events	Duration	Average burnt area	Total burnt area	Log Events	Log Duration	Log Average burnt area	Log Total burnt area
Republican governor	-1.354 (-1.71)	-0.00227 (-0.01)	0.000279 (1.09)	-0.0539 (-0.67)	-0.0626 (-0.91)	-0.0270 (-0.51)	0.000274 (1.09)	-0.00127 (-0.07)
Precipitation anomalies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Temperature anomalies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Density	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Real GDP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	482	482	482	482	482	482	482	482

*Note: Standard errors clustered at the State level are reported in parentheses. All models control for fixed effects to account for unobserved heterogeneity. Additionally, the models include covariates such as real GDP and population density, as well as temperature and precipitation anomalies by State and year. The average and total burnt area is divided by the population size for the corresponding year to account for population differences. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

6.6 Discussion and conclusions

In this chapter, I further explore the research question: *Can political economic theory reveal whether political motivations shape wildfire extent, duration, and frequency?* This analysis aligns with Objective 3 of my thesis: *To determine whether macro-level political factors, through the application of econometric analysis, influence fire characteristics such as occurrence, duration, and extent of burned areas.* Specifically, I examine the impact of gubernatorial partisanship on fire characteristics in the U.S. using a regression discontinuity design (RDD) and data spanning the years 2003–2018. Findings indicate that having a Republican governor is associated with a significant increase in fire duration. Specifically, fire events in States governed by Republicans are approximately one day longer than those in States with Democratic governors, a difference that is statistically significant at the 5% level. However, I found no significant effects for the number of fire events, the average burnt area, or the total burnt area. Further analysis using the natural logarithms of the dependent variables confirms that Republican governors are linked to a 21.4% increase in fire duration, again statistically significant at the 5% level. The number of events and the affected area remained statistically insignificant, consistent with the results from the non-log-transformed models.

When focusing specifically on human-caused fires, the analysis confirms that Republican governors are associated with a statistically significant increase in fire duration, with such fires

lasting approximately 2.2 days longer. However, no clear effect was observed on the number of fire events or the total burnt area. I also examine the impact of governors' re-election incentives, comparing re-electable and lame-duck Republican governors to their Democratic counterparts. The results show that re-electable Republican governors are associated with an increase of approximately 1.92 days in fire duration. No significant effects were detected for the number of fire events, average burnt area, or total burnt area. Conversely, for lame-duck Republican governors, no significant effects were observed across any fire-related outcomes. This suggests that the larger effect on fire duration in States governed by Republicans might not only be driven by partisan affiliation but also by the possibility of re-election, which diminishes when the Republicans face term limits.

Additionally, I conducted a heterogeneity analysis for Western States, an area particularly vulnerable to wildfire, but reducing the sample to only this set of States leads to no significant effects found for the role of Republican governors in influencing fire events, duration, or the burnt area in these States. In addition, I ran robustness checks, including the bandwidth sensitivity analysis and employed a "donut hole" approach to confirm the stability of the results. These sensitivity analyses show that the results vary across different bandwidth selections and are sensitive to the exclusion of observations near the cutoff.

Overall, the analysis provides evidence that Republican governors are associated with longer fire durations, particularly in re-electable contexts, while effects on other fire-related measures, such as fire events and burnt areas, remain largely insignificant. This might suggest either a delayed response in fire suppression efforts or a strategic decision to allow fires to burn longer, potentially influenced by policies or resource allocation priorities. It could also reflect differences in how fire duration is managed or reported under Republican governance. Nonetheless, while fires may last longer under Republican leadership, this does not appear to result in larger fire events. These findings highlight the complexities of political influences on wildfire dynamics and underscore the need for future research to examine the potential mechanisms driving these effects.

These results provide partial support for the theory that partisanship plays a more significant role than demographic characteristics and environmental factors in shaping fire management, as proposed by Ritt and Ostheimer (1974). While previous research highlights political polarisation as a key driver of environmental policy adoption (Kim & Urpelainen, 2017), these findings suggest a statistically significant impact of Republican governance on the extended duration of wildfires under Republican governors, which could indicate less aggressive

suppression efforts. However, this finding is sensitive to robustness checks and different bandwidth selections, which weaken the partisan effect on fire management.

The uncertainty surrounding these results likely arises from the complexity of wildfire regimes, which are shaped by a wide range of social, economic, and ecological factors, as discussed in the previous chapters, particularly Chapters 2, 3, and 4. The multifaceted nature of these factors may attenuate the influence of political partisanship on wildfire occurrence and characteristics across the U.S. Future research could examine the role of lobbying efforts in shaping State-level wildfire prevention policies, with a focus on how interest groups may influence the adoption of sustainable practices. Moreover, a qualitative approach involving communities, stakeholders, and program leaders on the ground could provide valuable insights into the nuanced interactions between political actors, environmental policy, and wildfire management.

Chapter 7 - Discussion, conclusions, and recommendations

7.1 Thesis summary

This thesis examines the anthropogenic drivers of wildfires, focusing on the complex interplay of socio-economic and political factors that contribute to wildfire management crises in vulnerable regions. Concentrating on fire-prone areas in the Mediterranean and the United States (US), it investigates both macro-level trends and localised dynamics that are often overlooked in wildfire incident reports and datasets. Employing a multidisciplinary approach, the research integrates qualitative and quantitative methodologies to analyse the roles, interests, and influences of diverse stakeholders, leading to the current fire management approaches. Specifically, it applies core political economy theories, econometric analysis, and social science methods to investigate the human factors shaping wildfire outcomes, with particular emphasis on the incentives and decision-making processes of policymakers in democratic systems. The findings underscore the critical importance of integrating socio-economic and political dimensions into comprehensive fire management strategies to effectively address the challenges posed by present and future wildfires.

The central research questions guiding my thesis, introduced in Chapter 1 and explored throughout the following chapters, are: 1) *What socio-economic and political factors drive wildfire occurrence and severity, and how do they interact?* 2) *To what extent are stakeholders aware of the primary human causes of wildfires, and do hidden interests influence fire management decisions?* 3) *Can political-economic theory reveal whether political motivations shape wildfire extent, duration, and frequency?*

Each chapter employs distinct methodologies tailored to address specific aspects of these questions. Aligning with the three objectives of the thesis.

Objective 1: *Identify the socio-economic and political factors that influence wildfire regimes, both directly and indirectly, and answer how these factors interact with one another.*

This objective, specifically linked to the first research question, reframes wildfires not solely as natural disasters but as phenomena influenced by socio-economic and political factors, thereby broadening the socio-ecological framework for governance. Each chapter contributes to this objective by examining the perspectives, roles and actions of various stakeholders within societies. Chapter 1 establishes the groundwork and theoretical framework, presenting the objectives and research questions that guide the thesis while highlighting how it expands current knowledge. Chapter 2 presents a comprehensive global overview of the existing literature through a scoping review, evaluating the state of knowledge in the field and establishing a foundation for the novel areas explored in subsequent chapters. Chapters 3, 4,

5, and 6 then delve into specific aspects, providing complementary insights into the interconnected dynamics of wildfire management and governance. These chapters examine perspectives ranging from local stakeholders to high-level political decision-making, highlighting the diverse interests linked to fire use.

Objective 2: *Investigate whether local stakeholders, based on their background and affiliation, can recognise the human dynamics - including interests - driving the ignition, distribution, and spread of fires.*

This objective is addressed through the methodologies and findings presented in Chapters 3 and 4, which detail qualitative social fieldwork conducted in Sicily. Chapter 3 explores participatory methods within a multistakeholder workshop aimed at fostering collaborative discussions and identifying key challenges and drivers of wildfires in a Mediterranean case study, Monreale. The workshop elicited perspectives from diverse stakeholders, highlighting conflicting views while mapping potential areas of agreement. These outcomes provide valuable starting points for reshaping governance in a currently fragmented context.

Building on these insights, Chapter 4 employs Q methodology to analyse stakeholder perspectives on the causes and factors contributing to the critical wildfire situation in Monreale. Through factor analysis, the study identifies and ranks stakeholders' views, uncovering areas of consensus and conflict while distinguishing three distinct groups of perspectives. The findings underscore the need to move away from fragmented, siloed institutional approaches and towards an integrated land and fire governance model centred on those directly involved with the local landscape.

Objective 3: *Determine whether macro-level political factors, through the application of econometric analysis, can influence fire characteristics, such as occurrence, duration, and extent of burned areas.*

I focus on this objective in Chapters 5 and 6, in which I use quantitative econometric analyses rooted in political economy theories. Chapter 5 applies generalised linear models to investigate the effects of electoral cycles on fire management practices. Chapter 6 investigates the role of state governors' political affiliations, examining how partisanship influences wildfire policies and outcomes. Together, these chapters offer a multidisciplinary analysis of the socio-political and economic drivers of wildfires, providing insights into political incentives within democratic systems and their implications for developing integrated fire management strategies.

7.2 Thesis contributions

7.2.1 What socio-economic and political factors drive wildfire occurrence and severity, and how do they interact?

The scoping review presented in Chapter 2 highlights the complex interplay of socio-economic and political factors influencing fire incidence and management. Much of the existing research on the human dimensions of fire regimes examines these factors in isolation rather than considering their interconnectedness and cross-dependencies. The scoping review maps the broader research landscape on the social, economic, administrative, and governance drivers of fires, highlighting key socio-economic factors, incentives, and institutional frameworks that are deeply interrelated.

More specifically, economic growth exhibits a nuanced relationship with fire occurrence, depending on the underlying economic system. In service-based economies, economic growth often reduces fire ignitions due to decreased reliance on resource extraction (Kirillina et al., 2020; Ren et al., 2018). Conversely, in primary sector-based economies, higher GDP correlates with increased fire ignitions due to agricultural practices and livestock farming (Chergui et al., 2018). Land-use and land-change dynamics further complicate wildfire management, with farmland abandonment in Mediterranean regions creating extensive fuel beds (Pausas et al., 2004) and increased human access to certain areas leading to higher wildfire frequency (Cardille et al., 2001; Sze et al., 2019).

Historical wildfire management strategies have contributed to widespread misconceptions about fire's ecological role. Early 20th-century fire suppression policies in Western countries led to fuel accumulation and heightened fire risks (Daniel, 1990; Donovan et al., 2008). Despite escalating firefighting budgets, suppression strategies have proven inadequate, as demonstrated by the persistent increase in fire incidents (Xanthopoulos et al., 2019). Proactive management techniques, such as prescribed burns and mechanical treatments, have proven effective in reducing fire severity. Institutions play a crucial role in promoting and implementing these practices. However, the influence of political incentives on global fire outcomes remains largely unexplored in the reviewed literature.

Stakeholder perspectives are crucial in shaping management approaches, with private companies often favouring mechanical methods, while environmentalists and public agencies advocate controlled burns (McCaffrey et al., 2008; Shrestha et al., 2021). However, these approaches face significant barriers, including high costs, resource constraints, and public resistance (Al Abri, 2022; Reinhardt et al., 2008). Public attitudes, influenced by cultural norms, media, and cognitive biases, frequently lead to risk-averse policies (Gkinopoulos & Mari, 2023;

Thompson, 2014). However, strategies such as Asset Protection Zones in Australia and defensible spaces in the United States highlight the importance of fuel management near urban areas (Gill & Stephens, 2009).

Economic instruments play a pivotal role in shaping proactive wildfire management behaviours and promoting protective actions among homeowners, ultimately influencing wildfire occurrences and outcomes (Donovan et al., 2008; Venn & Calkin, 2009). Despite evidence showing that economic incentives and behavioural programs can drive change, challenges persist, such as misinformation, spatial optimisation issues, and rural depopulation (Wunder et al., 2021). Incentive-based programs, including cost-sharing and fuel stock regulations, have proven effective in reducing free-riding among forest owners and aligning actions with social objectives (Al Abri, 2022). Additionally, international frameworks like the Paris Agreement and programs such as REDD+ demonstrate how monetary incentives can enhance fire prevention and sustainable land management, particularly in developing regions (Yamamoto et al., 2020). Complementary measures, including community engagement and capacity building, further bolster these efforts (Sundari et al., 2022).

Overall, the scoping review emphasises the importance of adopting localised, tailored strategies rather than one-size-fits-all approaches. Generic solutions often fail to account for the unique ecological, cultural, and socio-economic contexts of different regions. Lessons from flood management suggest that localised solutions are more effective, though they are often hindered by high costs, resource shortages, and public resistance. Effective wildfire strategies require collaboration with local communities and trust-building among stakeholders to integrate diverse interests into planning and implementation processes (Faas et al., 2017; Nyongesa & Vacik, 2019). Indigenous and local communities often offer valuable traditional ecological knowledge, employing techniques like cultural burning or patch-mosaic burning in Mali and the Cerrado to manage landscapes and prevent large fires (Laris, 2002; Pivello et al., 2021). Integrating these traditional approaches into modern fire management strategies could enhance their effectiveness, despite legal like burn bans and liability concerns limiting the adoption of prescribed burns (Eloy et al., 2019; Langer & McGee, 2017).

7.2.2 To what extent are stakeholders aware of the primary human causes of wildfires, and do hidden interests influence fire management decisions?

The fieldwork in Monreale, presented in Chapters 3 and 4, offers new insights into how local institutions, NGOs, and community members perceive fire governance, uncovering trust issues, governance inefficiencies, and socio-cultural barriers to proactive management. It also provides evidence of the limitations of suppression-heavy strategies, advocating for incentive-

driven, participatory approaches. The workshop brought together stakeholders from various sectors involved in fire management policy, marking the first effort to engage them in a participatory approach to identify fire management issues in the region. Activities such as rich pictures and problem tree exercises highlighted the negative effects of wildfires on human health and safety, the economy, biodiversity, and ecosystems, including soil erosion, water disruptions, and increased risks of landslides and floods. These findings are consistent with existing literature (Doerr & Santín, 2016; Frankenberg et al., 2005; Robinne, 2021; Stephenson et al., 2013)

Participants expressed strong emotional responses, particularly concerning negligent and malicious fire triggers, aligning with research on wildfires' negative impacts on human well-being, including anger, despair, depression, anxiety, and post-traumatic stress disorder (Hefferon et al., 2009; Knez et al., 2018; To et al., 2021). Additional emotions, such as grief and the loss of solace derived from the landscape, were also observed in the discussions, aligning with findings in the literature (Eisenman et al., 2015).

The workshop provided valuable insights into fire and land management, revealing diverse socio-economic and political perspectives. Discussions highlighted notable differences between institutional bodies and civil society. NGO representatives expressed distrust toward governing institutions, citing inadequate responses to wildfire challenges and structural barriers to addressing socio-economic issues such as agricultural land abandonment and property disputes, which are further exacerbated by climate risks (Ascoli et al., 2022; Gasparini et al., 2022). Key challenges in Sicily include an understaffed and aging Forestry Corps, limited preventive measures, and siloed institutional operations that hinder effective wildfire management (Legambiente, 2022). The discussions emphasised the institutional fragmentation regarding objectives and responsibilities, underscoring the need for integrated strategies, collaborative frameworks, and shared decision-making to improve outcomes (Ascoli & Bovio, 2013; Hasnaoui & Krott, 2019; Palaiologou et al., 2021).

Participants also stressed that public engagement in firefighting has declined since the establishment of the Department of Civil Protection in 1992, reducing community involvement in resource management. This mirrors trends observed in the US since the 1960s, where social capital has diminished (Putnam, 1995). Additionally, participants noted the lack of a long-term prevention plan, reflecting an over-reliance on and excessive investment in suppression-focused fire practices. Trust in the government has fluctuated due to wildfire events and issues of corruption (Ellison et al., 2015; Rust et al., 2020; Sharp et al., 2013). Municipalities face

significant challenges in securing funding for fire prevention, while hiring freezes in Sicily's Forest Corps further exacerbate sustainability issues (Legambiente, 2022).

The Q-study conducted in Monreale, presented in Chapter 4, builds on the participatory workshop among stakeholders, offering valuable insights into the diverse perspectives influencing wildfires. It identifies three distinct stakeholder groups based on their primary viewpoints: prevention advocates, pro-government supporters, and privatisation proponents. Factor 1 advocates for modernised practices and extended winter silvicultural management, emphasising the limitations of reactive fire management. In contrast, Factor 3 supports privatisation, while Factor 2 calls for strong government involvement to ensure public safety, stressing the importance of retaining public forest workers for their expertise. These findings reinforce the critical role of public forest workers in wildfire management in Italy (Fagarazzi et al., 2021). This divergence reflects a broader debate on balancing public and private roles in wildfire prevention and response. Despite the clear stakeholder groupings, the influence of participants' societal affiliations on their perspectives remains ambiguous, highlighting the complexity of this socio-ecological issue and revealing nuanced views that challenge traditional narratives based solely on professional roles.

There is a lack of consensus on the primary or most common wildfire triggers, pointing to incomplete disclosure of causes and the perpetuation of myths. Participants in the Q-study raised concerns about neglected roads and paths contributing to fuel accumulation and fire risk, echoing findings from Greece (Karanikola et al., 2011). Factor 1 emphasises land abandonment as a key driver of wildfires, aligning with research on socio-economic changes and landscape alterations (Ascoli & Bovio, 2013; Martínez et al., 2009; Williams, 2013).

While stakeholders hold contrasting views, the findings provide valuable insights for enhancing fire policies by focusing on areas of consensus. There is moderate stakeholder support for prescribed burning, particularly in fragmented forests of abandoned rural areas in Sicily. However, cultural resistance and regulatory barriers pose challenges (Ascoli & Bovio, 2013; Fernandes et al., 2013; Miller et al., 2013). Factor 1 advocates for modernised silvicultural practices, improved forest worker skills, and collaboration, reflecting similar trends in other Mediterranean countries (Alcasena et al., 2018; Troumbis et al., 2022). However, an over-reliance on reactive suppression strategies has led to the neglect of preventive measures, exacerbating wildfire impacts (Ellison et al., 2015; Xanthopoulos et al., 2019). In Sicily, suppression efforts are hindered by limited personnel, an ageing Forestry Corps workforce, poor coordination, and top-down approaches that overlook local fire culture and landscape characteristics (Legambiente, 2022). Geographic and climatic challenges, combined with

insufficient firefighting resources in protected areas, further impede effective management. Integrating agricultural incentives into forest programmes and adopting context-sensitive policies could help address these gaps.

Factor 3 supports the private ownership of firefighting aircraft, contrasting with Factor 2's preference for public sector accountability. The European Commission's plans to expand firefighting aircraft fleets by 2027 may lead to long-term private contracts, offering cost predictability and operational stability (OECD, 2018). Meanwhile, both Factor 1 and Factor 3 share a distrust of political institutions, reflecting fluctuating public confidence caused by corruption and ineffective disaster management (Rust et al., 2020; Sharp et al., 2013).

7.2.3 Can political-economic theory reveal whether political motivations shape wildfire extent, duration, and frequency?

As highlighted in the scoping review and observed during the fieldwork, institutions play a crucial role in implementing and promoting integrated management strategies that shape wildfire outcomes. Stakeholders working in isolation tend to rely on a top-down approach for improved governance. However, the lack of effective management strategies has led some stakeholders to call for more efficient resource management through privatisation. Despite these insights, the influence of political incentives on global fire outcomes remains largely unexplored in the reviewed literature. With the objective to assess if and how political motivations may influence wildfire outcomes and management, I run an econometric analysis in Chapter 5 to investigate whether gubernatorial elections and associated political incentives impact wildfire events in the United States using FPA-FOD data from 2003 to 2018. The analysis indicates that election cycles and re-election incentives have minimal impact on wildfire occurrences, burnt areas, or duration.

The Poisson and Negative Binomial (NB) models reveal no consistent or statistically significant changes in wildfire events during election years or in the years immediately before or after. Although there is a slight decrease in fire events during election years (Poisson model) and small increases in the years surrounding elections, these effects lack statistical significance. Similarly, OLS models analysing the total burnt area, average burnt area, and fire duration find no significant influence of election timing on these fire metrics. The analysis of re-election incentives further shows that lame-duck governors do not significantly impact wildfire occurrences or characteristics. When investigating the relationship between election cycles and wildfire events in the Western U.S., results reveal a lag and lead effect of elections, with fire events increasing the year before and after elections.

The analysis of state-owned lands reveals a strong link between election cycles and fire incidence, with fire events increasing in the year before and during elections, followed by a decline afterwards. However, this does not lead to larger burnt areas, though fire duration decreases in the post-election year. Human-caused fires also rise before elections but decline during and after, suggesting a cyclical pattern influenced by political dynamics. Robustness checks using MODIS Active Fire data confirm a weak but positive relationship between the year before an election and fire incidents.

Overall, while gubernatorial elections may influence fire occurrences - particularly in state-owned lands and Western states - these fires do not substantially alter fire management outcomes, at least from what is perceived by the change in fire duration and extent of burnt area. The findings partially align with research on electoral incentives influencing wildfire management in Mediterranean Europe (Kountouris, 2020; Skouras & Christodoulakis, 2014; Álvarez-Díaz et al., 2015). However, they do not provide additional evidence to support previous studies suggesting that lame-duck governors in the U.S. reduce environmental spending (Fredriksson et al., 2005).

These findings, specific to the U.S., should not be generalised to other countries, as they reflect the unique political and institutional structure in which State and Federal entities share wildfire management responsibilities. This structure may limit the incentives for State governments to act strategically in an electoral manner. Additionally, States can request extra funding from the Federal Emergency Management Agency (FEMA) for fire suppression, which may reduce the incentive to adopt more preventative management practices on State lands.

Overall, while this study may support the hypothesis that electoral cycles influence certain fire characteristics, there is no concrete evidence that resources are being diverted from fire prevention strategies. In other words, these results neither confirm nor rule out a link between political incentives and changes in fire management. Rather, they suggest that any potential influence of political cycles remains uncertain under the current model and data.

In Chapter 7, I examine the influence of gubernatorial partisanship on fire characteristics in the U.S. during the same period, using regression discontinuity design (RDD). The findings suggest that Republican governors are associated with a significant increase in fire duration, with fires lasting approximately one day longer in Republican-led states. However, there are no significant effects on the number of fire events, average burnt area, or total burnt area. Further analysis shows that fire duration increases by 21.4% under Republican governors.

When focusing on human-caused fires, the results confirm a significant increase in fire duration, with such fires lasting around 2.2 days longer under Republican governors. The impact of re-

election incentives is also considered, revealing that re-electable Republican governors are linked to a 1.92-day increase in fire duration, whereas lame-duck Republican governors show no significant effects. This suggests that the influence on fire duration in Republican-led states may be driven not only by partisanship but also by the re-election incentive, which diminishes under term limits.

A heterogeneity analysis of Western States, particularly vulnerable to wildfires, reveals no significant effects on fire events, duration, or burnt area in these states when the sample is reduced. However, this effect is sensitive to robustness checks and varying bandwidth selections, which diminish the strength of the partisan impact on fire management. Overall, the analysis indicates that Republican governors are associated with longer fire durations, especially in re-electable contexts, while other fire-related measures remain largely unaffected. This may suggest either a delayed response in fire suppression efforts or a strategic decision to allow fires to burn longer, influenced by policies or resource allocation priorities. However, longer fire durations under Republican leadership do not appear to result in larger fire events. These results offer partial support for the theory proposed by Ritt and Ostheimer (1974) that partisanship plays a more significant role than demographic and environmental factors in shaping fire management. While previous research highlights political polarisation as a key driver of environmental policy (Kim & Urpelainen, 2017), findings suggest a statistically significant link between Republican governance and longer wildfire durations, potentially reflecting less aggressive suppression efforts.

7.3 Limitations, further research opportunities and recommendations

The limitations of the research are tied to the research questions and the scope of the objectives. The mixed-methods approach applied, which integrates both qualitative and quantitative methods, ensures a comprehensive investigation of the research questions, promoting complementarity and diversity in the findings (Newman & Ridenour, 2008) while advancing knowledge toward the three defined objectives. However, this approach inevitably relies on geographically contextualised data throughout the chapters. While well-suited to the research goal, it also means that the findings are specific to the regions studied.

The qualitative data is drawn from a fieldwork case study in Sicily, representing Southern European countries with a Mediterranean climate and landscape that have struggled with the impacts of wildfires in recent decades. Meanwhile, the quantitative data focuses exclusively on the United States to investigate political dynamics. Given this geographical and institutional specificity, the findings are not easily transferable or generalisable to other contexts. The

insights are strongly tied to the cultural, geographical, and political-institutional frameworks of the regions studied, which limits their applicability to other countries, especially where approaches to wildland fire management, institutional structures, and cultural dynamics differ significantly.

A key feature of this research is its social science-based approach in the field study, which relies on participants' subjective opinions to draw conclusions. While this is mitigated by the expertise of the stakeholders interviewed or participating in the workshop, their responses remain influenced by personal experiences and societal roles. Additionally, while the interpretation of these responses was conducted following the inductive approach, it is worth mentioning that my own subjective experiences and interpretations may have unintentionally influenced the meaning derived from the stakeholders' responses.

The exploratory nature of the research, which applies political economics theories and social science approaches to a complex socio-ecological phenomenon, leads to open-ended findings. Rather than providing definitive conclusions, the study offers valuable insights and suggests directions for future research without claiming conclusive answers. This research lays the groundwork for future, more detailed studies that can build on its insights and address its inherent constraints. From the identified limitations and the findings of this study, several avenues for future research emerge:

- Further research could provide a more detailed understanding of stakeholder perspectives within the fire management sector across different Italian regions or, more broadly, across southern European countries. Studies involving larger samples, such as those using survey methods, could yield more generalisable results and facilitate more detailed comparisons between different groups within the sector.
 - Policy research could focus on designing new democratic processes that enhance transparency among stakeholders and promote cooperation, ultimately leading to more integrated and site-specific fire management strategies. This democratic decentralisation could foster more participatory and accountable communities, empowering local stakeholders to take greater responsibility for wildfire prevention and mitigation. By addressing these issues, studies could guide policy development aimed at enhancing community resilience to wildfires, particularly in regions prone to frequent fire events. This approach should account for local specificities and involve collaboration with diverse stakeholders to foster knowledge on how they can collectively contribute to
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a paradigm shift - transitioning to living and coexisting with fires in a managed and sustainable way.

- Research could investigate scenarios where stakeholders, such as insurance providers for homeowners and businesses, actively engage in wildland-urban interface fire prevention practices. This might involve rethinking their roles to contribute to crisis management and exploring new models of collaboration in areas with high wildfire risk.
- The uncertainty surrounding political incentives in U.S. fire management likely arises from the complex interaction of social, economic, and ecological factors, which may weaken the influence of political partisanship on wildfire outcomes. This underscores the need for further research into alternative driving mechanisms. Exploring other political economic theories or employing macro-level econometric analyses could shed light on the role of political factors in shaping wildfire characteristics, both in the U.S. and in countries with similar institutional frameworks. For instance, future research might investigate if the structure of dual-sovereign systems, such as the American Federal-State framework, creates bureaucratic challenges that hinder effective fire management. Additionally, it would be valuable to explore how political polarisation affects fire management policies, including those regulating deforestation and timber production, and how lobbying and interest groups influence the adoption of sustainable practices at the state level.
- Another avenue for research is the role of property rights in shaping fire management, considering not only the Federal-State division but also lands managed by indigenous communities and counties. Research into the potential benefits of decentralising jurisdiction and funding to the county level could provide useful insights. Such decentralisation might foster more participatory and accountable communities, empowering local stakeholders to take greater responsibility for wildfire prevention and mitigation. Addressing these areas could offer valuable guidance for policy development, enhancing community resilience to wildfires, particularly in regions prone to frequent fire events.

Since my research began, public interest in the topic of this thesis has remained consistently high, driven by extensive global media coverage of devastating events and their pressing implications for communities worldwide. This sustained attention is evident in the growing body of academic articles, increased focus from the press and popular media, and bold policy initiatives introduced in the United States during the most recent Democratic administration. These trends underscore the timeliness and significance of the thesis subject. However, this

marks only the beginning of a long process of restructuring and rethinking conservation strategies.

7.4 Concluding remarks

This thesis advocates for integrated fire management strategies that address both ecological and human factors, emphasising the complexity of balancing diverse behaviours, interests, and incentives. It underscores the importance of incorporating socio-economic factors and political considerations into fire management. Both the quantitative results from the U.S. and qualitative findings in the Mediterranean highlight the complexities of political influences on fire dynamics and its role in driving and adopting a change. The uncertainty surrounding the quantitative results, particularly in establishing a clear link between political incentives, partisanship, and their role in shaping fire management in the U.S., likely stems from the intricate nature of fire systems, which are influenced by a wide range of social, economic, and ecological factors.

The literature and results highlight how wildland fire might be framed as a political issue, with competing land-use priorities among stakeholders and conflicting ideologies, particularly in relation to the climate crisis. However, rather than focusing on resolving ideological disputes or competing land-use interests, national policies should prioritise fire management by setting clear national standards, concentrating on areas of broad agreement and trying to build consensus. No single national policy can effectively address the diverse needs of all ecosystems; that is why it should be focused on creating priorities, structures, and institutions for managing fires in an integrated way. This means that policies should not suggest a one-size-fits-all approach, acknowledging the risks associated with both overdependence on fire exclusion strategies and indiscriminate fuel removal through mechanical thinning or prescribed burning (Blatner et al., 2001; Moritz et al., 2014; Pyne, 2001; Sundari et al., 2022).

Effective fire management strategies require a deep understanding of site-specific dynamics, including local land use patterns, fire ecology, and the natural fire regimes under which native species have evolved. Additionally, fire managers must possess expertise in ecology, watershed function, long-term forest management, smoke control, and public engagement. Given these complexities, fire management decisions should be informed by local stakeholders and experts, who are best positioned to develop strategies tailored to their unique environmental and social contexts. Decentralising decision-making power is essential for promoting this integrated governance, ensuring that fire management approaches are both effective and locally relevant

As the fire historian Pyne stresses out, the fire crisis is accelerating a transformation that was already inevitable (Pyne, 2022). Policymakers and relevant stakeholders are urged to adopt flexible, multifaceted, and long-term approaches that address the socio-economic and spatial dimensions of fire management. These strategies should incorporate both incentives and disincentives to influence the behaviour of homeowners, farmers, forest managers, and other key actors, such as insurance providers. Often underestimated, the role of insurance providers could be restructured to actively support wildfire management, enhancing community resilience and fostering cooperation. The wildlands of the western U.S., much like those in Australia and Canada, could greatly benefit from the revival and modernisation of cultural burning practices. These traditional fire practices, which have enabled humans to coexist with fire for millennia, hold the potential to restore both ecosystems and cultural heritage, not only among Indigenous communities but also beyond them (Christianson et al., 2013; Laris, 2002; Paveglio et al., 2024).

In contrast, the fire issues in Mediterranean Europe could be substantially mitigated by reintroducing a modernised approach to the traditional cultivation and herding practices that shaped its landscapes for centuries (Castellnou et al., 2010). Sustainable solutions include prescribed burning, strengthening the forestry sector, hiring and training specialised personnel, modernising silvicultural practices, leveraging technology for territorial control, and establishing investigative units to enforce residue-burning bans. Additional recommendations include Payments for Ecosystem Services, education on cultural and natural heritage, and strategic grazing to build and maintain firebreaks where it is ecologically coherent and sound (Jack et al., 2022).

As interests and affiliations significantly influence policy adoption and outcomes, highlighting the importance of engaging and educating policymakers to enhance cooperation and the effectiveness of fire management. Public awareness of the benefits of fire use is growing, but much more education is needed, particularly in the Mediterranean, where the cultural heritage of traditional burning is often overlooked. Public education and information campaigns can help improve perceptions of controlled burning and fuel removal, as well as the broader benefits of fire.

Overall, this thesis highlights how tackling the wildfire crisis demands a bold shift: from rigid, top-down policies to dynamic, context-based strategies that blend science, tradition, and politics, empowering local voices, modernising fire practices, and forging resilient, inclusive fire governance for the future. Kaufmann states: *“The future of humanity’s relationship with fire is dependent on humanity’s relationship with itself.”* Addressing modern wildfire challenges

requires moving beyond the search for a one-size-fits-all fire policy. It is crucial to develop policies that support democratic processes and transparency, embracing multi-stakeholder dialogues to reflect the ecological and cultural nuances of fire regimes while also reducing wildfire impacts on society and economies. Political actors and officials should foster substantial collaboration among diverse stakeholders, including researchers and policymakers, without exacerbating the ideological debate. It is essential to create policies that move beyond outdated approaches, offering genuine opportunities for the public to actively participate in driving changes that promote ecologically sustainable fire management.

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Appendix A.1 – Initial search strings used in the scoping literature review prior to refinement

Search Terms
("wildfire" OR "fire" OR "forest fire" OR "bush fire" OR "brushland fire" OR "grassland fire" OR "woodland fire" OR "land fire" OR "field fire" OR "bushfire" OR "wildland fire" OR "vegetation fire" OR "grass fire" OR "wildland-urban interface fire" OR "WUI fire" OR "wildland urban interface fire")
AND
("stakeholder" OR "stake-holder" OR "participant" OR "contributor" OR "shareholder" OR "partner" OR "investor" OR "interested party" OR "involved party" OR "player" OR "actor" OR "individual" OR "agent" OR "doer" OR "decision-maker" OR "socio-economic" OR "social-economic" OR "socio-financial" OR "socio-demographic" OR "social and economic" OR "social" OR "sociological" OR "communal" OR "societal" OR "cultural" OR "society-based" OR "economic" OR "financial" OR "fiscal" OR "monetary" OR "commercial" OR "business" OR "relevant party" OR "party involved" OR "concerned party" OR "interest group" OR "advocacy group" OR "pressure group" OR "lobby group" OR "coalition" OR "constituency" OR "campaigning group" OR "relevant entity" OR "key player" OR "person of interest" OR "key individual" OR "important figure" OR "focus of attention" OR "involved person" OR "people of interest" OR "relevant individuals" OR "key figures" OR "concerned individuals" OR "focus group" OR "politic*" OR "governmental" OR "legislative" OR "civic" OR "public" OR "political" OR "state-related" OR "policy-related" OR "parliamentary")
AND
("incentive" OR "motivation" OR "reason" OR "interest" OR "concern" OR "focus" OR "attention" OR "involvement" OR "preference" OR "motiv*" OR "barrier" OR "obstruction" OR "imped*" OR "constraint" OR "limitation" OR "obstacle" OR "challenge" OR "factor" OR "determinant" OR "influence" OR "problem" OR "prevent*" OR "avert" OR "hinder" OR "restrain" OR "avoid" OR "preclude" OR "practice" OR "method" OR "procedure" OR "technique" OR "approach" OR "habit" OR "custom" OR "behavio*" OR "priorit*" OR "give precedence" OR "favour" OR "give priority" OR "trade-off" OR "compromise" OR "balance" OR "concession" OR "exchange")

Appendix A.2 - Reference list resulting from the scoping review

Author	Title	Year	Source
Ager, Alan A;Day, Michelle A;Vogler, Kevin	Production possibility frontiers and socioecological tradeoffs for restoration of fire adapted forests	2016	Scopus
Al Abri, Ibtisam	Evaluating Incentive-Driven Policies to Reduce Social Losses Associated with Wildfire Risk Misinformation	2022	Web of sci
Arsanjani, Jamal J;Vázquez, Ruben López	Exploring the potential socio-economic and physical factors causing historical wildfires in the Western USA	2020	Scopus
Bennetton, J;Cashin, P;Jones, D;Soligo, J	An economic evaluation of bushfire prevention and suppression	1998	Web of sci
Bowman, Maria S.;Amacher, Gregory S.;Merry	Fire use and prevention by traditional households in the Brazilian Amazon	2008	LIFE
Brown, Douglas R.	Personal preferences and intensification of land use: Their impact on southern Cameroonian slash-and-burn agroforestry systems	2006	LIFE
Canepa, Alessandra	Socio-economic risk factors and wildfire crime in Italy: a quantile panel approach	2024	Scopus
Cardille, Jeffrey A;Ventura, Stephen J;Turner, I	Environmental and social factors influencing wildfires in the Upper Midwest, United States	2001	Scopus
Chergui, Brahim;Fahd, Soumia;Santos, Xavier	Socioeconomic Factors Drive Fire-Regime Variability in the Mediterranean Basin	2018	Scopus
Chicas, Santos Daniel;Østergaard Nielsen, Jo	Who are the actors and what are the factors that are used in models to map forest fire susceptibility? A systematic review	2022	Scopus
Christianson, Amy;McGee, Tara K.;L'Hirondell	How historic and current wildfire experiences in an Aboriginal community influence mitigation preferences	2013	LIFE
Chuvieco, Emilio;Martínez, Susana;Román, M	Integration of ecological and socio-economic factors to assess global vulnerability to wildfire	2014	Scopus
Clark, Autumn S;McGranahan, Devan Allen;Gr	Barriers to Prescribed Fire in the US Great Plains, Part I: Systematic Review of Socio-Ecological Research	2022	Scopus
Costanza, Jennifer K;Moody, Aaron	Deciding Where to Burn: Stakeholder Priorities for Prescribed Burning of a Fire-Dependent Ecosystem	2011	Scopus
Daniel, T C	Social/political obstacles and opportunities in prescribed fire management	1990	Scopus
Daniels, Molly C;Braziunas, Kristin H;Turner, M	Multiple social and environmental factors affect wildland fire response of full or less-than-full suppression	2024	Scopus
Donovan, G. H., Brown, T. C., Dale, L.	Incentives and wildfire management in the United States	2008	Scopus
Eloy, Ludivine;Schmidt, Isabel Belloni;Borges,	Seasonal fire management by traditional cattle ranchers prevents the spread of wildfire in the Brazilian Cerrado	2019	LIFE
Faas, A J;Velez, Anne-Lise K;FitzGerald, Clare	Patterns of preference and practice: bridging actors in wildfire response networks in the American Northwest	2017	Scopus
Gill, A Malcolm;Stephens, Scott L	Scientific and social challenges for the management of fire-prone wildland-urban interfaces	2009	Scopus
Gkinopoulos, Theofilos;Mari, Silvia	How exposure to real conspiracy theories motivates collective action and political engagement? The moderating role of primed	2023	Web of sci
Heines, Betsy;Lenhart, Suzanne;Sims, Charle	Assessing the economic trade-offs between prevention and suppression of forest fires	2018	Scopus
Kirillina, Kionnei;Shvetsov, Evgeny G;Protopop	Consideration of anthropogenic factors in boreal forest fire regime changes during rapid socio-economic development: case stu	2020	Scopus
Kyryla, Nataliya;Chernenko, Varvara	Fire risk assessment in light of socio-economic factors	2017	Scopus
Laris, Paul	Burning the seasonal mosaic: Preventative burning strategies in the wooded savanna of southern Mali	2002	LIFE
Mavsar, Robert;Farreras, Veronica	Economic Evaluation of Forest Fire Prevention Programme in Catalonia, NE Spain	2009	Web of sci
McCaffrey, Sarah;Moghaddas, Jason J;Stephe	Different interest group views of fuels treatments: Survey results from fire and fire surrogate treatments in a Sierran mixed conifer	2008	Scopus
Nelson, M. C., Monroe, J. Fingerman Johnson,	Living with fire: homeowners assessment of landscape values and defensible space in Minnesota and Florida, USA	2004	Scopus
Nyongesa, Kevin W;Vacik, Harald	Evaluating management strategies for Mount Kenya Forest Reserve and National Park to reduce fire danger and address interes	2019	Scopus
Otero, Iago;Nielsen, Jonas Ø	Coexisting with wildfire? Achievements and challenges for a radical social-ecological transformation in Catalonia (Spain)	2017	Scopus
Pant, Krishna Prasad	Monetary Incentives to Reduce Open-Field Rice-Straw Burning in the Plains of Nepal	2013	LIFE
Reilley, Caitlyn;Crandall, Mindy S;Kline, Jeffre	The Influence of Socioeconomic Factors on Human Wildfire Ignitions in the Pacific Northwest, USA	2023	Scopus
Ren, Hao;Zhou, Chang;Li, Anglin	Social and economic factors' impact on fire safety risks-panel data model based analysis	2018	Scopus
Rideout, Sandra;Oswald, Brian P;Legg, Micha	Ecological, political and social challenges of prescribed fire restoration in east Texas pineywoods ecosystems: A case study	2003	Scopus
Roder, W	Slash-and-Burn Rice Systems in Transition: Challenges for Agricultural Development in the Hills of Northern Laos	1997	LIFE
Shrestha, A., Grala, R. K., Grado, S. C., Robert	Landowner Concern about Wildfires and Implementation of Fuel Reduction Treatments.	2021	Scopus
Shrestha, A., Grala, R. K., Grado, S. C., Robert	Likelihood of implementing fuel reduction treatments on nonindustrial private forest lands.	2021	Scopus
Shrestha, A., Grala, R. K., Grado, S. C., Robert	Nonindustrial private forest landowner willingness to pay for prescribed burning to lower wildfire hazards.	2021	Scopus
Stockmann, Keith;Burchfield, James;Calkin, C	Guiding preventative wildland fire mitigation policy and decisions with an economic modeling system	2010	Scopus
Sundari, Cici;Purnomo, Eko Priyo;Fathani, Aqi	Civil society participation model: forest and land fire prevention policy in Jambi Province	2022	Scopus
Sze, Jocelyne Shimin;Jefferson;Lee, Janice Se	Evaluating the social and environmental factors behind the 2015 extreme fire event in Sumatra, Indonesia	2019	Scopus
Thompson, Matthew P	Social, Institutional, and Psychological Factors Affecting Wildfire Incident Decision Making	2014	Scopus
Toledo, David;Sorice, Michael G;Kreuter, Urs I	Social and ecological factors influencing attitudes toward the application of high-intensity prescribed burns to restore fire adapt	2013	Scopus
Varela, Elsa;Giergiczny, Marek;Riera, Pere;M	Social preferences for fuel break management programs in Spain: A choice modelling application to prevention of forest fires	2014	Scopus
Varela, Elsa;Jacobsen, Jette Bredahl;Soliño, M	Understanding the heterogeneity of social preferences for fire prevention management	2014	Scopus
Varela, Elsa;Soliño, Mario	Incorporating economic valuation into fire prevention planning and management in Southern European countries	2015	Scopus
Venn, Tyron J;Calkin, David E	Challenges of socio-economically evaluating wildfire management on non-industrial private and public forestland in the Western	2009	Scopus
Vogler, Kevin C;Ager, Alan A;Day, Michelle A;J	Prioritization of forest restoration projects: Tradeoffs between wildfire protection, ecological restoration and economic objectiv	2015	Scopus
Wang, Xin;Zhao, Hang;Zhang, Zhengxiang;Yin,	The Relationship between Socioeconomic Factors at Different Administrative Levels and Forest Fire Occurrence Density Using	2023	Scopus
Wunder, Sven;Calkin, Dave E;Charlton, Val;Fe	Resilient landscapes to prevent catastrophic forest fires: Socioeconomic insights towards a new paradigm	2021	Scopus
Yamamoto, Yuki;Takeuchi, Kenji;Köhlin, Gunn	Preventing Peatland Fires in Central Kalimantan, Indonesia: The Role of Economic Incentives and Social Norms	2020	Scopus
Pivello, Vânia R.Vieira, ImaChristianini, Alexar	Understanding Brazil's catastrophic fires: Causes, consequences and policy needed to prevent future tragedies	2021	Scopus

Appendix B.1 – Ethics approval

IMPERIAL

**Science Engineering
Technology Research Ethics
Committee**
Imperial College London
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17 April 2023

Dear Piroli Erika

Study Title: Understanding the relationships between stakeholders' interests, and behaviours, and wildfire outcomes

SETREC number: 6497365

The above study was reviewed by the Science Engineering Technology Research Ethics Committee on 17 Apr 2023, 10:12.

This study was given a favourable opinion subject to revisions reviewed by the RGIT. Following the review of your amended documents submitted on 1 Nov 2023, 12:05, the Research Governance and Integrity Team would like to grant full approval of the study on the basis described in the revised documents:

Documents

The documents reviewed were:

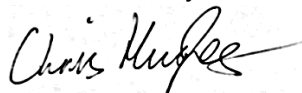
- Application Form
- Protocol
- Participant Information Sheet
- Consent Form
- Recruitment Wording

Membership of the Committee

The members of the Ethics Committee who reviewed the study were:

Chris Hughes	Chris Watkins
Ira Bhattacharya	Stephen Webster
Vivienne Kuh	Stefano Sandrone
Becky Ward	

Yours sincerely,



Chris Hughes,
Chair, Science Engineering Technology Research Ethics Committee

Appendix B.2 - Definition of the concepts of interest and power as presented to the participants for the Power-Interest Matrix

“To assess the interest of the different actors, we ask you to consider the following:

- *The extent to which they are vulnerable to wildfire activity in the area;*
- *The extent to which they are positively affected to wildfire activity in the area;*
- *Their direct and indirect economic dependence on wildfire;*
- *Their interests in the cultural services associated with wildfires (outdoor recreational activities, tourism, landscape aesthetics, etc.);*
- *Their interests in the ecosystem services associated with wildfires (pest and disease control, carbon sequestration, biodiversity, soil and water quality, etc.).”*

“To assess the power resources of actors, we ask you to consider their ability to use the following mechanisms to influence behaviour:

- *Coercion, which involves altering behaviour through the use of force, including laws and regulations, control of territory or access rights, as well as the threat of force.*
 - *The power to establish incentives, which can be both economic and moral in nature, to influence behaviour aimed at obtaining material and immaterial advantages or avoiding disadvantages.*
 - *Finally, the power to disseminate dominant information, which involves altering behaviour by using unverified but deemed reliable information by subordinates, ideologies, or specialized knowledge, through lobbying activities, public relations, contributions to research projects, technical documents, and participation in public events such as workshops, seminars, meetings, or working groups, as well as through the media.”*
-

Appendix C.1 - Original statements in Italian

Number	Statements
1	Il Corpo Forestale della regione Sicilia assicura l'espletamento dei servizi di sicurezza pubblica e del controllo del territorio.
2	Le attività di prevenzione, quali gestione selviculturale e pulizia dei territori, sono aggiornate e adeguate alle esigenze del territorio.
3	Le attività di prevenzione selviculturale, compresi i viali parafulco, dovrebbero essere effettuate in anticipo e non solo a ridosso della stagione degli incendi per essere efficaci.
4	L'uso della tecnologia nella sorveglianza e nel controllo del territorio ridurrebbe il numero degli incendi.
5	La creazione di un apparato investigativo specializzato all'interno dell'Arma dei Carabinieri e/o il Corpo Forestale per individuare le cause e i responsabili migliorerebbe la situazione degli incendi.
6	Il fuoco prescritto non dovrebbe essere adottato come strumento di prevenzione.
7	Investire sulla prevenzione piuttosto che sullo spegnimento migliorerebbe la situazione incendi.
8	L'abbandono delle campagne ha contribuito all'estensione degli incendi.
9	Gli attuali divieti di combustione dei residui vegetali scoraggiano efficacemente l'uso del fuoco in agricoltura.
10	La programmazione e l'organizzazione di cui i lavoratori forestali dispongono sono sufficienti per svolgere le attività di prevenzione.
11	L'attuale assetto organizzativo e il livello di coordinamento nelle procedure di spegnimento è sufficiente a contrastare gli incendi.
12	La collaborazione sinergica tra i diversi stakeholders può favorire lo sviluppo di una politica integrata di gestione degli incendi.
13	Le sanzioni e le pene previste contro i responsabili degli incendi dovrebbero essere inasprite.
14	Gli interventi a terra durante la soppressione degli incendi sono spesso sufficienti a contenerli.
15	La soppressione degli incendi si affida troppo all'utilizzo dei canadair.
16	La gestione dei canadair non dovrebbe passare allo Stato.
17	Il governo dà la priorità alla spesa per la soppressione rispetto al finanziamento di una prevenzione lungimirante.
18	L'obbligo dei Comuni di censire annualmente le aree percorse dal fuoco (catasto incendi) non viene adempiuto per interessi politici.
19	Un completo e accurato catasto delle aree percorse dal fuoco può prevenire gli incendi.
20	Confido che la politica sia al servizio degli interessi e della tutela del bene comune.
21	I responsabili degli incendi non vengono puniti per carenza di sorveglianza e controllo del territorio.
22	I responsabili degli incendi non vengono scoperti e puniti per negligenza delle istituzioni.
23	L'illegalità e gli interessi dei singoli o gruppi di cittadini a discapito del bene comune sono ampiamente tollerati dalla società.
24	Gli incendi sono causati dalle società elettriche che non eseguono una corretta manutenzione dei cavi dell'alta tensione.
25	I gestori stradali sono rigorosi nella pulizia dei bordi delle strade.
26	Il fuoco è spesso utilizzato come strumento di ritorsione e di regolamento dei conti per le concessioni dei terreni.
27	Gli incendi sono difficili da spegnere a terra perché le zone sono spesso di difficile accesso.
28	Si dà fuoco ai terreni per interessi edilizi.
29	Allungare i periodi delle concessioni sui terreni fidelizzerebbe gli agricoltori e allevatori al terreno e migliorerebbe la situazione degli incendi.
30	I cittadini si preoccupano solo quando gli incendi arrivano nei centri abitati.
31	Non c'è modo di prevenire gli incendi boschivi.
32	La maggior parte degli incendi sono causati da pratiche agricole.
33	La maggior parte degli incendi sono causati dai pastori per il rinnovo dei pascoli.

34	I fuochi vengono accesi dagli operai forestali come strumento di protesta e pressione sulle condizioni di lavoro.
35	La maggior parte degli incendi avvengono a causa di incendiari senza tornaconto e/o piromani.
36	Privatizzare il settore forestale migliorerebbe la salvaguardia dei boschi.
37	Le aree protette vengono date alle fiamme nella speranza di rimuovere i vincoli ambientali.
38	I lavori forestali vengono effettuati secondo competenze tecniche.
39	La maggior parte degli incendi sono di origine colposa o involontaria legata all'imprudenza delle persone.
40	Gli incendi nel territorio di Monreale avvengono per mano della criminalità organizzata.

Appendix C.2 - Three-factors Z-score and distinguishing or consensus statements for the 40 statements.

Statement	Z-score	Z-score	Z-score	C/D	Statement	Z-score	Z-score	Z-score	C/D
S1	-0.9	0.0	1.1	D	S21	1.4	0.7	-0.5	D
S2	-1.4	-0.5	0.6	D	S22	0.2	0.3	0.3	C
S3	1.5	1.4	-0.7	D	S23	0.0	-0.4	0.1	C
S4	1.2	1.2	-0.8	D	S24	-1.4	-0.7	1.0	D
S5	1.5	0.0	-0.9	D	S25	-1.4	-0.5	-1.8	C
S6	-0.4	-0.6	-0.1	C	S26	0.7	-0.5	-0.6	D
S7	1.7	1.0	-0.7	D	S27	-0.5	0.7	-0.1	D
S8	0.4	1.0	-1.0	D	S28	0.2	-0.3	0.0	C
S9	0.0	-0.8	0.1	C	S29	-0.1	0.2	-0.1	C
S10	-1.3	-1.6	-2.3	C	S30	0.2	1.2	0.6	D
S11	-1.6	-1.9	-1.9	C	S31	-1.9	-0.1	-0.8	C
S12	1.1	0.3	-0.5	D	S32	0.3	0.4	2.1	D
S13	1.2	1.1	0.8	C	S33	1.4	-0.3	1.4	D
S14	-0.2	-1.3	-0.1	C	S34	0.6	-1.6	0.5	D
S15	0.5	0.8	-0.2	D	S35	-1.2	1.9	0.7	D
S16	-1.2	-0.3	0.3	D	S36	-0.9	0.2	0.7	D
S17	0.8	2.0	-0.3	D	S37	0.1	-1.0	-0.1	D
S18	0.5	-1.5	1.5	D	S38	-0.7	-1.0	0.7	D
S19	1.2	0.2	2.1	D	S39	-0.4	1.4	0.5	D
S20	-0.9	0.0	-1.6	D	S40	0.0	-0.9	0.0	D

Notes: The Z-scores reflect how strongly each factor aligns with a statement.