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Review Article

California Wildfires: A Holistic Systemic Management Approach to Urban Resilience

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Abstract

Each year, the environmental degradation, financial losses, psychological health threats, and death toll linked to wildfires in California are worsening. This article explores an urgent issue regarding the growing prevalence and intensity of wildfires in California, which are largely influenced by climate change and further complicated by ineffective urban wildfire management approaches. A comprehensive analysis necessitates an exploration of key themes and concepts articulated in the text, along with an examination of their implications and possible solutions. The intensity of wildfire seasons is on the rise, with records being shattered annually. This trend is largely ascribed to climate change, which engenders hotter and drier conditions that facilitate wildfires. The consequences of these shifting conditions extend beyond environmental harm; they jeopardize ecosystems, human lives, property, and local economies. Wildfire management has historically focused on the ecological and physical dimensions of fire risk, such as fuel availability, meteorological conditions, and fire behavior, often overlooking the crucial social aspects that impact community resilience. This neglect can lead to a misalignment between fire management strategies and the unique vulnerabilities of specific populations, particularly marginalized groups who may lack resources or infrastructure to cope with wildfires. Moreover, the paper presents risk management frameworks for identifying, assessing, and prioritizing risks followed by coordinated efforts to minimize, monitor, and control the probability or impact of unfortunate events. In the context of urban resilience against wildfires, risk mechanisms may include establishing early-warning systems, creating defensible spaces around properties, and employing controlled burns as preventive measures. This involves developing robust recovery plans, optimizing resource allocation, and ensuring effective communication among stakeholders. Integrating these elements fosters a comprehensive approach to not only mitigate the impact of wildfire but also enhance the ability of urban areas to recover swiftly and sustainably from such disasters

Keywords: sustainable urban development, wildfires, fire resilience, mechanism design theory. california wildfires, urban risk management, continuity management systems

1.Introduction

Urban planning methodologies often insufficiently integrate considerations for wildfire risks, leading to inadequate land-use planning, building codes, and emergency response strategies that fail to account for evolving climatic challenges [1, 2]. Incorporating risk mechanisms into wildfire management involves a multifaceted analysis that considers the physical threats posed by wildfires and the social dimensions that influence community resilience. By assessing community engagement levels, socioeconomic conditions, cultural values, and the effectiveness of local governance systems, we can better identify areas of vulnerability and tailor interventions accordingly [3]. For instance, communities with strong social networks may mobilize resources more effectively in the face of disaster, while those with limited governance capacity may struggle to implement effective response strategies [4, 5]. In addition, effective risk management, coupled with structured approaches to assess and create urban climate strategies and continuity management systems, plays a vital role during and after wildfire occurrences. Such frameworks are necessary to maintain the functionality of critical services, such as emergency services, healthcare, and communication systems. Developing comprehensive recovery plans that prioritize equitable resource allocation and foster cooperative frameworks among stakeholders is vital [6,7]. This holistic approach not only mitigates the impacts of wildfires but also strengthens communities by integrating diverse social realities with practical risk management strategies, ultimately enhancing collective resilience against future disasters. Factors such as socioeconomic status, resource availability, and demographic characteristics are vital in shaping how communities prepare for and recover from wildfires [8]. Recognizing social vulnerability in risk assessments could lead to more just and effective management strategies. Moreover, the structure and planning of urban systems play an important role in mitigation and adapting to wildfires. The evolving landscape of wildfire risk demands a comprehensive, multidisciplinary strategy that integrates insights from wildfire behavior, structural vulnerabilities, urban resilience, and vegetation management [9]. The increasing frequency and intensity of extreme wildfires in California have highlighted the inadequacies of traditional fire risk management strategies, calling for a comprehensive transformation in how we address fire hazards [10, 11]. This new integrated framework should encompass multi-faceted strategies that account for various factors including climatic variations, land use, community vulnerabilities, and ecological impacts. By synthesizing data from historical fire events and incorporating adaptive management practices, stakeholders can develop proactive measures that mitigate risks before fires ignite. Furthermore, this approach should foster collaboration among governments, scientists, and local communities, ensuring that resilience-building efforts are informed by both scientific evidence and local knowledge [12, 13]. The health sector is crucial in directly saving lives and indirectly strengthening resilience against adverse climatic impacts [14]. The climate crisis has exacerbated environmental risks, which can significantly threaten public health. This interconnection underscores the necessity for an integrated approach that enables urban health systems to anticipate and navigate these uncertainties [13]. By focusing on anticipatory risk management, health sectors can develop adaptive strategies that not only address immediate health threats but also promote long-term sustainability. Collaborative frameworks among government agencies, healthcare providers, and environmental organizations are vital for effectively sharing data, resources, and best practices. This synergy enhances the capacity to respond to climate-related health challenges, thereby safeguarding communities and promoting overall well-being in the face of escalating environmental changes. By rethinking fire policy and management, stakeholders can better prepare for future wildfire challenges, fostering resilience and sustainable practices in the built environment and natural landscapes.

2. Research Methodology

The research methodology employed in this investigation into the significance of wildfire risk management encompasses a rigorous framework designed to holistically assess and enhance preparedness and resilience in the face of crises. By adopting a mixed-methods strategy, the study integrates qualitative techniques—such as interviews, focus groups, and content analysis of community response plans—to capture nuanced human behaviors, perceptions, and social dynamics associated with wildfire risks. Concurrently, quantitative methods, including surveys and statistical analyses, are utilized to gather empirical data on the effectiveness of risk management strategies and their correlation with various resilience metrics, such as emergency response times and community recovery rates. This dual approach allows researchers to triangulate findings, providing a richer understanding of how factors evolved, such as climate change and urban development, impact risk management practices within California's complex and varied ecosystems. The research unfolds in distinct phases: initial exploratory phases focus on identifying key risk management strategies, followed by in-depth case studies that evaluate their real-world applications and outcomes, and culminating with a synthesis phase that integrates insights to develop actionable recommendations for policy and practice. Through this systematic methodology, the study aims to contribute to the literature on disaster risk reduction by elucidating the transformative potential of strategic wildfire risk management in fostering urban resilience in increasingly vulnerable regions.

2.1 Limitations

Integrating risk mechanisms, climate models, strategic planning, and wildfire management is crucial, yet it must be supported by a flexible, collaborative planning system that emphasizes public engagement among stakeholders, which was lacking in the existing proposed systems. A major limitation of current research is its failure to quantitatively assess the environmental, economic, and social impacts of wildfire risk mitigation policies. To address this, it is important to employ various metrics—such as changes in land use and biodiversity for environmental impacts, property values and employment for economic assessment, and demographic shifts for social implications—utilizing tools like GIS data and statistical techniques. Comprehensive quantitative evaluations will enhance policy effectiveness insights and inform future spatial planning endeavors, underscoring the necessity for ongoing research and development in this field.

3. Urban Wildfire Risks and Projections

The development of a robust strategy for resilience against the severe consequences of urban wildfires can benefit from historical analysis [13]. The extensive damage inflicted on public and private infrastructure, along with the threats posed to countless individuals, including displacement and fatalities—demonstrates the gravity of these disasters [14, 15]. The 2025 wildfires in Southern California, particularly in Pacific Palisades and Altadena, illustrate the region's acute exposure to such events, revealing a significant inadequacy in urban system preparedness for disaster response. Additionally, climate change forecasts suggest that the areas susceptible to extreme fire weather are likely to expand worldwide. The California Department of Forestry and Fire Protection has released alarming statistics derived from preliminary and ongoing research concerning the devastating impact of recent wildfires across the region. These fires have tragically claimed the lives of at least 23 individuals at the time of this report, and have ravaged an area exceeding 40,000 acres, a landmass that surpasses the geographical footprint of San Francisco. The destructive force of these infernos has led to the obliteration of more than 12,000 structures, rendering many residents homeless and displacing tens of thousands from their communities. Notably, the Palisades Fire emerged as the largest in scale, with a charred footprint of over 21,000 acres, while the Eaton Fire has similarly wreaked havoc, affecting more than 14,000 acres. This unprecedented scale of devastation underscores the urgent need for improved wildfire management strategies and heightened awareness of climate change impacts, which further exacerbate the frequency and intensity of such catastrophic events [16]. The findings presented by Balch et al. (2024) [17] highlight the alarming trend of rapidly spreading wildfires in the United States, which have significant implications for both environmental management and community safety. Their analysis of over 60,000 wildfires using satellite imagery underscores that nearly half of the country's ecoregions experienced such fast fires—defined by an expansion rate exceeding 1,620 hectares in a day—responsible for a staggering 78% of structures lost and most suppression costs, totaling nearly $19 billion [18, 19]. The data indicates a troubling increase in these wildfires' average peak daily growth rate, particularly in the Western United States, which more than doubled between 2001 and 2020, underscoring a growing threat to infrastructure and ecosystems. Given that approximately 3 million structures were located within a perilous 4-kilometer radius of these fast fires, the urgency for improved firefighting strategies and enhanced community preparedness is critical [20]. Understanding the dynamics of such destructive wildfires can aid policymakers and emergency responders in developing more effective prevention measures, response protocols, and resilience planning, thus mitigating the future impact of wildfires on communities and the environment. Current wildfire management frameworks are often based on oversimplified risk assessments that fail to capture the intricate complexities of fire-prone landscapes [21, 22]. These frameworks neglect the diverse social, ecological, and cultural contexts of wildfire-prone areas, leading to inadequate preparedness and response strategies. As a result, the wildfire crisis persists, with devastating consequences for communities, ecosystems, and the economy [23, 24]. In contrast, treating wildfire as a complex risk acknowledges that it involves interconnected social, ecological, and economic factors that cannot be reduced to simplistic cause-and-effect models. This perspective recognizes that effective wildfire management requires a nuanced understanding of the interplay between human activity, land use, climate change, and ecological resilience. By adopting a complex risk approach, wildfire management organizations and institutions can develop more effective adaptation strategies that prioritize community coexistence with wildfire, foster social cohesion, and promote environmentally sustainable practices [25, 26, 27]. Urbanization influences wildfire dynamics in complex ways. On one hand, the expansion of urban areas can lead to increased human activity and infrastructure development, which raises the potential for human-induced ignitions, as activities such as construction, outdoor burning, or recreational use can inadvertently spark fires. Conversely, as communities expand into wildland areas, they find themselves at heightened risk of wildfire exposure [28. 29]. This proximity often compels local governments to invest more in wildfire management and suppression strategies, including the formation of firebreaks, controlled burns, and community education programs. These proactive measures can enhance overall resilience to wildfires, effectively reducing the frequency and extent of burns in certain regions by prioritizing the protection of human life and property. Therefore, while urbanization may introduce new challenges in terms of wildfire risk, it can also catalyze a more robust framework for fire management that ultimately contributes to a decrease in the global burned area, reflecting a critical intersection between human development and environmental stewardship. Climate undeniably plays a crucial role in shaping the dynamics of wildfires by influencing various interrelated components such as ignition sources, vegetation health, and environmental moisture levels. As global temperatures rise, we observe an increase in atmospheric aridity, which exacerbates the drying out of vegetation and reduces its resilience to fires [30, 31]. This drying effect, combined with decreased precipitation and prolonged drought periods, creates an environment ripe for fire outbreaks, as the fuel load—comprising dry grasses, shrubs, and trees—becomes more abundant and flammable [32]. Moreover, the synergy of these climatic factors not only intensifies the frequency and severity of wildfires but also extends their geographic reach, impacting both regional ecosystems and communities [33]. Southern California, characterized as a biodiversity hotspot with over 23 million residents, faces significant challenges due to wildfires, even as annual fire occurrences have remained stable in recent decades. The research by Dong et al. (2022) [34] highlights a concerning trend: increased wildfire probabilities correlated with future anthropogenic climate change. Utilizing advanced methodologies like random forest algorithms and refined earth system model simulations, the study projects a drastic increase in large fire days from 36 days annually between 1970-1999 to as many as 71 days by the end of the century under high-emission scenarios. The large fire season is also anticipated to start earlier and end later, indicating a shift towards more extreme fire conditions. These insights underline the pressing need for proactive mitigation strategies, as current trends may mask the impending escalation of fire risks driven by greenhouse gas emissions, necessitating urgent attention to climate change impacts on fire management in the region [35, 36]. Understanding these interactions highlights the urgent need for comprehensive climate adaptation strategies to mitigate wildfire risks and manage natural resources sustainably.

3.1 Wildfire Risk Management and Continuity Management System

Inadequate urban planning often leads to a lack of essential services, mismanaged land use, and insufficient infrastructure, which collectively exacerbate social inequalities and limit residents' resilience to crises [37, 38]. This vulnerability is heightened by governance challenges, such as a lack of stakeholder engagement, which can hinder effective policy implementation and community involvement. Therefore, a comprehensive, inclusive approach to urban governance that prioritizes participatory planning can significantly empower residents, reduce vulnerabilities, and foster sustainable urban environments [39, 40]. In urban areas that are ill-equipped to handle wildfires, the dangers extend beyond immediate physical harm; they also include enduring mental health challenges stemming from trauma, heightened socioeconomic inequalities as at-risk populations face greater impacts, and the pressure on public infrastructure and vital services [41, 42]. Ineffectively managed urban environments may lack adequate firebreaks, emergency response strategies, and community education initiatives, which can intensify the likelihood of devastation and complicate recovery efforts following such events [43]. This highlights the critical need for cities to implement proactive and cohesive strategies that emphasize resilience, ensuring that urban settings reduce wildfire risks, enhance community health, and promote social equity [44, 45, 46]. A comprehensive wildfire risk management approach utilizes risk modeling techniques that incorporate hazards, exposure, and vulnerability to assess and mitigate the impacts of wildfires effectively [47, 48, 49]. First, hazards are identified by analyzing climatic factors—such as temperature increases, drought conditions, and wind patterns—that influence wildfire occurrence, leveraging historical data to project future risks [50]. Next, exposure mapping is essential to delineate areas vulnerable to wildfires, wherein human settlements, valuable infrastructure, and natural resources are analyzed concerning their proximity to potential fire sources, considering geometric configurations and economic significance [51, 52]. Finally, assessing vulnerability examines how susceptible these exposed elements are to wildfires, integrating historical event records to establish parameters that inform how populations and assets might respond during such disasters [53]. This approach demands a robust integration of data and community engagement, ensuring that assumptions within hazard models are transparent, while also adapting to evolving dynamics such as urban development and climate change, ultimately facilitating informed decision-making, strategic planning, and rapid recovery efforts in the aftermath of wildfire events [54, 55].

4. Risk Mechanism Theory Index (RMTI) in Wildfire Adaptation and Prevention

The application of Risk Mechanism Theory Index (RMTI) in urban wildfire prevention involves a systematic approach to defining and quantifying risk factors, enabling the development of targeted strategies to enhance resilience against wildfires [56]. By employing the RMTI, urban planners and disaster management professionals can identify critical risk variables—such as vegetation density, urban infrastructure, and community preparedness—that contribute to wildfire susceptibility. The wildfire risk assessment framework appears to leverage computational tools and probabilistic methods to effectively quantify and integrate uncertainties associated with various wildfire hazard scenarios, ultimately providing a more comprehensive and accurate assessment of wildfire risk. By propagating and integrating these uncertainties, the framework aims to provide valuable insights for informed decision-making in wildfire mitigation and management. The outlined processes involve a comprehensive approach to studying and preserving biodiversity through remote sensing and data collection, utilizing mobile technology for species identification and environmental monitoring. Impact evaluations on ecosystems and habitats guide conservation efforts, supported by databases that manage genetic and population information. Ongoing monitoring of environmental changes and organism behavior is crucial, while education and awareness campaigns leverage network and image distribution technologies to engage and inform communities about biodiversity issues [57].

I. Data Acquisition: Analyzing pre-ignition fuel states, identifying active fire sites and their emissions, and assessing the aftermath of fires on vegetation, air quality, climate, temperature, and humidity levels.
II. Impact Assessment: Examination of the consequences on land, ecosystems, and various habitats.
III. Data Management: Compilation of information regarding species, populations, and habitats.
IV. Surveillance: Continuous observation and tracking of environmental transformations.
V. Awareness and Dissemination: Spreading knowledge and raising awareness among communities using network communication technologies and visual distribution methods. [57].

Marolla, 2017 [57] develop quantified strategies, tracked via an index that can show metrics of progress and effectiveness, fostering a concerted community effort toward wildfire readiness, while also facilitating iterative improvements based on real-time data and feedback loops, thereby significantly minimizing fire risks and promoting long-term urban resilience. To effectively apply the Risk Mechanism Theory Index (RMTI) in minimizing and adapting to wildfires in urban areas, each of its three core elements must be integrated into comprehensive urban planning and management strategies. Firstly, RMT Risk Exposure (RMTre) evaluates the physical and environmental factors contributing to wildfire susceptibility, such as proximity to wildfire-prone areas, vegetation types, and local climate conditions. By mapping and analyzing these risks, urban planners can prioritize areas for mitigation measures like controlled burns, vegetation management, and infrastructure improvements.

Secondly, RMT Social, Economic, and Environmental Vulnerability (RMTseen) assesses the socio-economic demographics, housing quality, and community resources that influence a population's ability to respond to and recover from wildfires. This aspect emphasizes the need for community engagement, education, and support systems to enhance preparedness and safety, particularly in vulnerable communities [57].

Lastly, RMT Resilience Level (RMTrl) reflects the capacity of urban systems to withstand and recover from wildfire events; enhancing resilience may involve investing in fire-resistant building codes, emergency response training, and coordinated evacuation strategies.

- RMT Risk Exposure *(RMT_{re})*
- RMT Social and Economic and Environmental Vulnerability *(RMT_{seen})*
- RMT Resilience Level *(RMT_{rl})*

Collectively, this framework facilitates a multifaceted approach to wildfire risk management, effectively enabling urban areas to reduce vulnerabilities and bolster resilience against future wildfire threats.

The Risk Mechanism Theory (RMT) index [57] serves as a foundational framework for assessing and mitigating wildfire risks in urban areas by partitioning key elements of exposure and vulnerability. In this formula, RMTre (risk from environmental factors), RMTseen (risk perceived by the community), and RMTrl (risk from response and readiness levels) are integrated to produce a comprehensive risk assessment, which is then normalized by population density (Pd). This approach allows urban planners and emergency responders to evaluate how environmental conditions contribute to wildfire threats, how community awareness and preparedness influence resilience, and the efficacy of response strategies. By systematically analyzing these components, cities can implement targeted interventions, such as community education programs, improved land management practices, and enhanced emergency response planning to minimize wildfire impacts and adapt to changing conditions, ultimately fostering greater urban resilience [56]. The methodology's mathematical framework would allow stakeholders to model various fire risk scenarios and simulate the effects of proposed mitigation actions—like creating defensible spaces, implementing zoning regulations, or enhancing emergency response protocols—as a series of executable steps guided by algorithmic assessment.

$$RMT = \left(\frac{RMTre\ * RMTseen * RMTrl}{Pd}\right) \geq 0$$

(a)

The Risk Mechanism Theory Index (RMTI) provides a structured approach to evaluate and address the multifaceted challenges posed by wildfires in urban areas. By integrating risk exposure (RMTre), social-economic and environmental vulnerabilities (RMTseen), and resilience levels (RMTrl), RMTI (a) quantifies the inherent risks faced by communities while accounting for population density (Pd) to gauge the magnitude of potential impacts. High-quality, comprehensive data on factors such as population growth, economic conditions, technological advancements, and the specific needs of disadvantaged communities enhance the accuracy of risk assessments. Furthermore, the economic, social, and environmental vulnerability index offers insights into the capacity of affected populations to cope with wildfire threats, identifying gaps in resources and technology access. Ultimately, the RMTI serves as a valuable tool for policymakers, enabling them to prioritize interventions, allocate resources effectively, and develop adaptive strategies that bolster community resilience against wildfires while minimizing associated risks [57].

$$RMTI = \frac{\sum_{c=seen\,\gamma_{i=1}}^{t} \widehat{W_{\iota(a,b,..)}}^{\,c} \quad i^{*}_{r\,*\,[re\,*\,rl]}}{p_d}$$

To effectively minimize and adapt to wildfires in urban areas, a comprehensive risk mechanism must be employed that synthesizes historical data with predictive analyses [58]. First, aggregating a detailed database of past fire incidents, paired with severity metrics and spatial distribution maps, offers insights into the most vulnerable areas. This data should be cross-referenced with changes in land use, particularly the encroachment of urban development into fire-prone zones, to identify patterns that exacerbate risks [59]. Furthermore, analyzing climatic trends—such as temperature changes, precipitation patterns, and extreme weather events—helps in predicting future fire activity and informing proactive strategies. Understanding population density dynamics enables planners to assess potential evacuation challenges and resource allocation needs during wildfire events. Evaluating historical fire suppression strategies provides critical lessons on effectiveness, guiding the adjustment of current practices to enhance community resilience. Finally, assessing socio-economic impacts ensures that strategies are inclusive and consider the needs of affected communities, fostering a collaborative approach to urban planning that prioritizes fire risk reduction while promoting sustainable development [60]. This holistic framework not only prepares urban areas for potential wildfires but also integrates risk management into the broader context of community safety and environmental stewardship [60]. Marolla, 2018, p. 183 [61] illustrates the intensity rate of economic, environmental, and social impacts, denoted as (i_r^*). It is crucial to emphasize that the intensity rate correlates with the nature of the risk impact, which will yield varying degrees of socio-economic and environmental repercussions for the urban area. The concept of extreme wildfire events (EWE) has been developed to better understand and analyze the increasing severity and frequency of wildfires, particularly in the context of climate change and human activity. EWEs are characterized by their intensity, duration, and the impact they have on ecosystems, communities, and air quality [62]. By establishing a standardized framework for identifying and studying these events, researchers and policymakers can more effectively assess risks, implement mitigation strategies, and allocate resources to combat the growing threat of wildfire globally. This paper moves beyond traditional physical paradigms of wildfire research by employing a transdisciplinary analysis of EWE, as proposed by Tedim et al. (2018), emphasizing that wildfires are complex phenomena resulting from the interaction of natural and social conditions. It highlights the significance of examining various factors, processes, and temporal phases involved in wildfires, fostering a more holistic understanding of their dynamics and impacts on ecosystems and communities [62, 63]. A comprehensive evaluation and modeling of wildfire risks necessitates a thorough comprehension of essential contributing elements, including arid vegetation, rugged landscapes, intense winds, high temperatures, and socioeconomic conditions. For instance, data on soil moisture can act as an adjunct or alternative to drought indices and is frequently incorporated into models that predict wildfire risk. This information can be instrumental in assessing fuel moisture and other associated variables [58].

Assessing wildfire likelihood and risk involves analyzing the fire's behavior through critical questions about:

1. its ignition sources,
2. timing,
3. likely locations,
4. and propagation patterns

These elements are essential for effective management and mitigation strategies. The following evidence delineates the levels of risk and impact, arranged by intensity, thereby supporting the RMT's strategic approach to a diverse array of proposed solutions. These solutions encompass modifications to regulatory statutes, policy adjustments, adaptations, and the creation of innovative methods for risk assessment [59, 60]. We develop frameworks for assessing the intensity of economic, environmental, and social impacts based on the likelihood and severity of potential risks. By categorizing risks as low, moderate, or high, stakeholders can prioritize their responses effectively; low risks warrant minimal attention, moderate risks require preventive measures, while high risks necessitate urgent and focused intervention to mitigate severe socio-economic and environmental consequences. Extreme risks pose a significant threat to the viability of an organization or project due to their potential for severe consequences and high likelihood of occurrence. It is imperative to address these risks without delay to mitigate their impact, as neglecting them can jeopardize overall success and stability. Immediate intervention strategies, risk assessment, and contingency planning are essential to safeguard against these catastrophic risks. Understanding this correlation is essential for informed decision-making and risk-management strategies [61, 62]. In communicating confidence within the assessment process, the Intergovernmental Panel on Climate Change (IPCC) adopts a calibrated language approach. This approach is specifically crafted to consistently assess and articulate uncertainties that may result from incomplete information or from varying interpretations of what is known or knowable. The calibrated language employed by the IPCC features qualitative assessments of confidence that are grounded in the robustness of the evidence for a particular finding, and, when possible, it also includes quantitative expressions to convey the likelihood of such findings [63, 64]. This description outlines a comprehensive approach to evaluating the certainty of significant findings, encompassing both qualitative and quantitative assessments. It emphasizes the importance of considering diverse aspects, including evidence type, data consistency, expert opinions, and theoretical underpinnings to gauge the confidence in a finding. The addition of quantified measures of uncertainty, based on statistical analyses or expert evaluations, provides a probabilistic framework to express the level of uncertainty associated with the finding, allowing for a more nuanced evaluation of its reliability and significance [65].

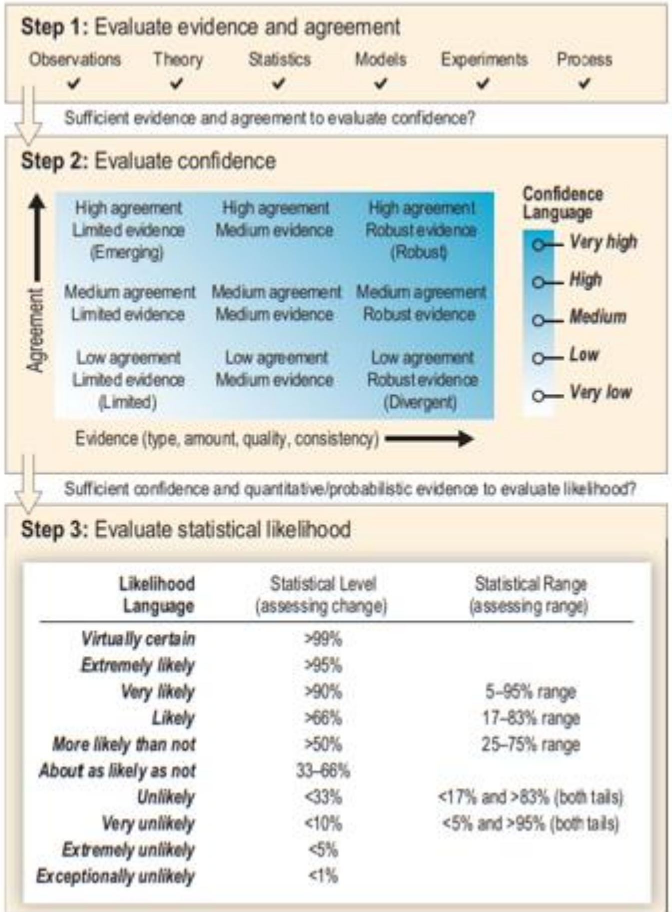

Figure 1: Schematic of the IPCC usage of calibrated language [65]

The evidence weight table delineates the extent of risk and impact, arranged by intensity, thereby supporting the RMT strategic framework for a diverse array of proposed interventions. These interventions may encompass modifications to regulatory statutes, policy adjustments, adaptations, and the formulation of novel methodologies for risk assessment. According to Marolla (2018), the risk mechanism theory includes risk exposure indicators, socioeconomic influences, environmental conditions, and resilience capacity. This theory offers an extensive perspective on the various risks that obstruct the efficient management of wildfire hazards [56]. This framework is structured around three critical dimensions: risk exposure, socio-economic and environmental vulnerabilities, and resilience capacity. Urban areas exhibit significant risk vulnerability due to their limited capacity to manage disruptive events. Table 1.3 illustrates several impacts across these three dimensions, with some effects transcending individual categories. Such detrimental impacts possess the potential to affect society broadly, as exemplified by how community exposure to severe weather events can compromise public health, overwhelm healthcare systems, and induce social and economic instability. The process of assigning weights to the indicators utilized in the vulnerability index yields varying outcomes. Consequently, the significance of indicator weighting and its impact on decision-making is illustrated in Table 1.

Weight of Evidence and Category

Weight of Evidence	Category
1. Sufficient evidence from empirical studies and quantitative and qualitative data analysis to support a contributory relationship between risk exposure to the agent and the consequences of the intensity of the impact	$\widehat{w_{ia}}$
2. Limited evidence from empirical studies and sufficient data	$\widehat{w_{ib}}$
3. Sufficient evidence from empirical and quantitative and qualitative data studies but inadequate or no evidence or no data from the aforementioned studies	$\widehat{w_{ic}}$
4. Limited evidence from empirical and quantitative and qualitative data studies or an absence of evidence or data	$\widehat{w_{id}}$
5. Inadequate evidence from empirical and data studies or no data	$\widehat{w_{ie}}$
6. No evidence from empirical studies in at least two adequate empirical studies, coupled with no evidence from quantitative and qualitative data analysis	$\widehat{w_{if}}$

Table 1: Weight of Evidence and Category [60].

RMT is strategically positioned to implement a comprehensive and systematic approach to address the multifaceted risks associated with wildfires. This strategy is meticulously designed to not only mitigate the potential impacts of wildfires but also to reduce the likelihood of these risks materializing significantly. By integrating advanced risk assessment methodologies, proactive preventive measures, and community engagement initiatives, RMT aims to enhance resilience against wildfires. This proactive stance involves not just identifying and analyzing potential wildfire threats but also actively fostering environments that discourage such incidents through careful land management, effective resource allocation, and the promotion of fire-smart practices among residents. Through this well-rounded framework, RMT seeks to safeguard both natural ecosystems and communities, ultimately fostering a safer and more sustainable environment in the face of increasing wildfire challenges [60].

5. Integrating Risk Management Theory with Practical Applications in the Context of Wildfires and Disaster Risk Mitigation.

The complex, systems-based nature of urban resilience, where various subsystems such as transportation, utilities, public health, and communication networks interact and influence one another is necessary to understand and assess to determine urban vulnerability to disasters [66]. A city's resilience depends not solely on individual systems functioning independently, but also on the interdependence between them [67]. The recognition of the intricate interplay between various components in a risk management framework highlights the necessity of a holistic approach, which does not merely address individual risks in isolation but instead examines the broader context and interdependencies among them. This perspective is grounded in systems thinking, which encourages a comprehensive view of organizations and their environments, promoting an understanding of how changes in one area can impact others [67, 68, 69, 70]. Additionally, complexity theory supports this approach by acknowledging that systems are often dynamic, adaptive, and influenced by numerous factors, making traditional linear models inadequate. By embracing a holistic methodology, organizations can better anticipate potential risks, respond proactively, and foster resilience against unforeseen challenges [71, 72]. This understanding acknowledges that the whole is more than the sum of its parts and that emergent properties and behaviors arise from the interactions among these components. Complexity theory further emphasizes the importance of understanding the interdependence and feedback loops that exist within and between systems, which can amplify or mitigate the effects of external stressors such as climate change [73]. Within the realm of wildfire risk management, it is acknowledged that conventional reactive emergency management strategies may fall short in effectively addressing the escalating threat of wildfires, particularly in California and, by extension, worldwide [74]. By embracing a more holistic risk management framework that integrates various viewpoints and emphasizes prevention and mitigation, urban areas can improve their preparedness and response to wildfires, thereby bolstering their resilience and safeguarding the welfare of their inhabitants [75, 76]. Incorporating Risk Management Theory (RMT) [77] within wildfire risk management emphasizes a systematic approach to risk assessment and adaptation strategies, outlined in the mathematical formulation provided. This approach not only highlights the significance of preparing for financial disasters through the integration of a business continuity management system based on ISO 22301 but also underscores the need for a holistic understanding of the socio-economic implications of wildfires [78]. The comprehensive assessment of risks, including critical areas, ensures that both structural and non-structural mitigation strategies are effectively prioritized to enhance community resilience. A lack of focus on risk management related to disasters points to deficiencies in business continuity planning and exposes communities to heightened vulnerabilities, emphasizing the necessity for a proactive and cohesive framework that addresses both the immediate and long-term consequences of wildfire risks on individuals and societies [79, 80]. Considering the current urban landscape, there is an imperative need to establish an international framework that prioritizes risk as a central issue. At present, risk analysis models function in isolation and lack dynamism. Consequently, the existing frameworks utilized in major urban centers fail to consider the interdependence between various risks and do not provide forecasts regarding their potential future interactions. It is crucial to acknowledge the significance of risk management, particularly through the lens of ISO 31000, alongside the business continuity management system (BCM) outlined in ISO 22301 [81, 82]. These frameworks facilitate the restoration of urban systems to operational status and ensure the safety and well-being of city inhabitants. To effectively address wildfire risks and adopt a proactive stance towards disasters, risk and continuity management systems must be integrated into urban strategic planning [83]. Prioritizing climate risk management in fire and rescue services (FRS) is essential due to their pivotal role as first responders to crises, necessitating a prepared and resilient stance against increasing climate-related emergencies such as wildfires, floods, and pandemics [84]. Given that climate change significantly heightens both the frequency and severity of these disasters, FRS must adapt its strategies not only to manage these emergencies but also to safeguard the continuity of critical services and infrastructure [85]. Additionally, understanding the impacts of climate change on FRS operations enables a more integrated approach to Disaster Risk Reduction, emergency medical services (EMS), and Climate Change Adaptation, ultimately leading to the development of more effective local policies and strategies that bolster community resilience against future risks [86, 87]. Creating a culture where the city's workforce actively engages with risk is crucial for effectively developing and implementing plans for potential events, particularly in responding to climate change impacts [88]. This engagement fosters a collective understanding and standardized risk management metrics that improve the community's responsiveness while avoiding excessive caution. Incorporating ISO 31000 principles, the approach aims to safeguard value, integrate risk management into organizational processes, and enhance decision-making at all levels. It focuses on navigating uncertainty, ensuring timely responses, utilizing relevant information, and customizing strategies to organizational needs, while also considering human and cultural factors. Furthermore, it emphasizes transparency, inclusivity, and a responsive framework that drives continuous improvement within the organization [89, 90].

- To analyze the different fire-related hazards, emphasizing their impact on the functioning of urban systems.
- To analyze a range of strategies that can enhance the resilience of the urban area against the backdrop of wildfires. This includes adaptive measures, technological innovations, and policy-driven approaches.
- To evaluate the effectiveness of these strategies in mitigating wildfire risks and ensuring the continuity of operations under different scenarios [91, 92].

Within the context of wildfire risk management, fostering a risk-informed culture within the city's workforce is vital for effective planning and response. By actively engaging with risk, employees can develop a collective understanding of wildfire risks and contribute to standardized risk management metrics, ultimately enhancing the community's responsiveness [93, 94]. This approach aligns with the ISO 31000 principles, which prioritize safeguarding value, integrating risk management into organizational processes, and improving decision-making at all levels. By considering uncertainty, utilizing relevant information, and customizing strategies to organizational needs, while also acknowledging human and cultural factors, the city can respond promptly to climate change impacts and wildfires, ensuring transparency, inclusivity, and continuous improvement in risk management practices 95]. A continuity management strategy is crucial in ensuring the continuity of essential operations, services, and functions during and after a wildfire event. The development and execution of a continuity management system plan involves several key components: formulating policies and guidelines for continuity management, designating individuals with specific responsibilities, establishing management processes for planning, implementation, and operational activities, and conducting regular performance evaluations and management reviews to identify areas for continuous improvement [96, 97]. This plan should also include documentation that provides verifiable evidence of the organization's preparedness, such as risk assessments, emergency response plans, and communication protocols. Additionally, any business continuity management processes specific to the organization, such as disaster recovery plans, evacuation procedures, and supply chain continuity arrangements, should be incorporated into the overall continuity management strategy [98, 99]. By incorporating these components, an organization can effectively mitigate the impacts of wildfires and ensure the continuity of its operations, ultimately fostering a more resilient society.

6. Discussion and Conclusion

The increasing focus on wildfire management is driven by the challenges of climate change and urban development, highlighting the need to improve urban risk management and integrate private and public sector strategies. Despite improvements in planning processes, significant gaps remain in systemic evaluations of these strategies. Learning from past wildfire events is crucial for advancing societal management, but post-disaster analyses often suffer from political influences and psychological biases, which can undermine the effectiveness of evaluations, and the methods used. Effective communication, planning, and coordination are crucial in addressing the complexities of wildfire management. By fostering continuous dialogue among stakeholders, both in routine settings and through drills and exercises, planners can identify and address potential issues before a disaster strikes. A structured approach to idea generation and problem-solving, such as using frameworks or methodologies, can also help to mitigate the impact of wildfires. Ultimately, proactive organizations that prioritize collaboration and effective planning are better equipped to manage disasters and develop strategies that can effectively tackle future wildfire crises. The effective implementation of risk mechanisms aimed at mitigating wildfires necessitates a comprehensive understanding of the interactions between extreme wildfire events and the strategies available for management. A systematic methodology begins with a precise articulation of the problem, which includes the establishment of objectives, the identification of relevant stakeholders, and the formulation of evaluation criteria. Inadequately defined risk management strategies can hinder effective monitoring and result in insufficient mitigation efforts. Wildfire risk management encompasses decision-making across various spatial and temporal dimensions, engaging multiple stakeholders such as federal and state agencies, local authorities, response teams, and private landowners, all while navigating considerable uncertainty and complexity.

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References

1. Gonzalez-Mathiesen C, Ruane S, March A. (2021). Integrating wildfire risk management and spatial planning–A historical review of two Australian planning systems. *International Journal of Disaster Risk Reduction*; 53:101984.
2. Wunder S, Calkin DE, Charlton V, Feder S, de Arano IM. et al. (2021). Resilient landscapes to prevent catastrophic forest fires: Socioeconomic insights towards a new paradigm. *Forest policy and economics*. 128:102458.
3. Wu J, Lyu S. (2024). Public Participation in Wildfire Rescue and Management: A Case Study from Chongqing, China. Fire. 7(9):300.
4. Rosenthal A, Stover E, Haar RJ. (2021). Health and social impacts of California wildfires and the deficiencies in current

recovery resources: An exploratory qualitative study of systems-level issues. *PloS one*. 16(3):e0248617.
5. Abrahams J, Foster H, McColl G. (2024). Disaster risk management frameworks. InDisaster Health Management (pp. 51-64). Routledge.
6. Bacciu V, Sirca C, Spano D. (2022). Towards a systemic approach to fire risk management. Environmental Science & Policy. 129:37-44.
7. Thomas AS, Escobedo FJ, Sloggy MR, Sanchez JJ. (2022). A burning issue: Reviewing the socio-demographic and environmental justice aspects of the wildfire literature. *PLoS One*.17(7):e0271019.
8. Bacciu V, Sirca C, Spano D. (2022). Towards a systemic approach to fire risk management. *Environmental Science & Policy*. 129:37-44.
9. Lambert JH, Dorn RR, Ayyub BM, Barletta WA, Organek JF. et al. (2024). Wildfire Risk Mitigation through Systems Analysis of the Planetary Emergency. ASCE OPEN: *Multidisciplinary Journal of Civil Engineering*. 2(1):04024010.
10. Varga K, Jones C, Trugman A, Carvalho LM, McLoughlin N. et al. (2022). Megafires in a warming world: what wildfire risk factors led to California's largest recorded wildfire. Fire. 5(1):16.
11. Synolakis CE, Karagiannis GM. (2024). Wildfire risk management in the era of climate change. PNAS nexus. 3(5):pgae151.
12. Gonzalez-Mathiesen C, March A. (2018). Establishing design principles for wildfire-resilient urban planning. *Planning Practice & Research*. 33(2):97-119.
13. McEntire DA. (2021). Disaster response and recovery: strategies and tactics for resilience. John Wiley & Sons.
14. Calhoun K. (2023). Mechanisms of Resilience to Megafire in Californian Wildlife Communities. University of California, Berkeley.
15. California Department of Forestry and Fire Protection. Current Emergency Incidents. Ongoing emergency responses in California, including all 10+ acre wildfires. 2025. Retrieved from: https://www.fire.ca.gov/Incidents
16. Kendell A, Galloway A, Milligan C, editors. (2023). The Path of Flames: Understanding and Responding to Fatal Wildfires. CRC Press.
17. Balch JK, Iglesias V, Mahood AL, Cook MC, Amaral C. et al. (2024). The fastest-growing and most destructive fires in the US (2001 to 2020). Science. 386(6720):425-431.
18. James GL, Ansaf RB, Al Samahi SS, Parker RD, Cutler JM. et al. (2023). An efficient wildfire detection system for ai-embedded applications using satellite imagery. Fire. 6(4):169.
19. McGinnis S, Kessenich L, Mearns L, Cullen A, Podschwit H. et al. (2023). Future regional increases in simultaneous large Western USA wildfires. *International Journal of Wildland Fire*;32(9):1304-14.
20. Russo M, Fischer AP, Huber-Stearns HR. (2024). Wildfire narratives: Identifying and characterizing multiple understandings of western wildfire challenges. Environmental Science & Policy. 160:103824.
21. Kovvuri S, Chatterjee P, Basumallik S, Srivastava A. (2024). Wildfire-Induced Risk Assessment to Enable Resilient and Sustainable Electric Power Grid. Energies. 17(2):297.
22. Lambrou N, Kolden C, Loukaitou-Sideris A, Anjum E, Acey C. (2023). Social drivers of vulnerability to wildfire disasters: A review of the literature. Landscape and Urban Planning. 237:104797.
23. De Abreu SJ. (2021). Toward a holistic approach: considerations for improved collaboration in wildfire management. *Open Journal of Forestry*. 12(1):107-121.
24. Essen M, McCaffrey S, Abrams J, Paveglio T. (2023). Improving wildfire management outcomes: shifting the paradigm of wildfire from simple to complex risk. *Journal of Environmental Planning and Management.* 66(5):909-927.
25. Russell A, Fontana N, Hoecker T, Kamanu A, Majumder R. et al. (2024). A fire-use decision model to improve the United States' wildfire management and support climate change adaptation. *Cell Reports Sustainability*.1(6).
26. McKelvey KS, Block WM, Jain TB, Luce CH, Page-Dumroese DS. et al. (2021). Adapting research, management, and governance to confront socioecological uncertainties in novel ecosystems. *Frontiers in Forests and Global Change*.4:644696.
27. Wu C, Venevsky S, Sitch S, Mercado LM, Huntingford C. et al. (2021). Historical and future global burned area with changing climate and human demography. One Earth; 4(4):517-530.
28. Chas-Amil ML, Nogueira-Moure E, Prestemon JP, Touza J. (2022). Spatial patterns of social vulnerability in relation to wildfire risk and wildland-urban interface presence. Landscape and urban planning. 228:104577.
29. Gutierrez Aurora, A. et al. Wildfire response to changing daily temperature extremes in California's Sierra Nevada. *Sci. Adv.* **7**, eabe6417 (2021).
30. Williams, A. P. et al. (2019). Observed impacts of anthropogenic climate change on wildfire in California. *Earth's Future* **7**, 892–910.
31. Richardson D, Black AS, Irving D, Matear RJ, Monselesan DP. et al. (2022). Global increase in wildfire potential from compound fire weather and drought. *NPJ climate and atmospheric science*;5(1):23.
32. Mansoor S, Farooq I, Kachroo MM, Mahmoud AE, Fawzy M. et al. (2022). Elevation in wildfire frequencies with respect to the climate change. Journal of Environmental management. 301:113769.
33. Dong C, Williams AP, Abatzoglou JT, Lin K, Okin GS. et al. (2022). The season for large fires in Southern California is projected to lengthen in a changing climate. Communications Earth & Environment;3(1):22.
34. Senande-Rivera M, Insua-Costa D, Miguez-Macho G. (2022). Spatial and temporal expansion of global wildland fire activity in response to climate change. Nature Communications.13(1):1208.
35. Rahaman MA, Kalam A, Al-Mamun M. (2023). Unplanned urbanization and health risks of Dhaka City in Bangladesh: uncovering the associations between urban environment and public health. *Frontiers in public health*. 11:1269362.
36. Gonzalez-Mathiesen C. (2024). Resilience to wildfires: Comparative insights of barriers and facilitators for spatial planning in Victoria and Chile. Cities. 154:105389.
37. La Mela Veca DS, Piroli E, Bacciu V, Barbera G, Brunori A. et al. (2024). Governare gli incendi in Italia: superare

l'emergenza, pianificare la prevenzione. Forest@-Journal of Silviculture and Forest Ecology. 21(1):37.
38. Kirschner JA, Clark J, Boustras G. (2023). Governing wildfires: toward a systematic analytical framework. *Ecology and Society*. 28(2).
39. Varshney K, Makleff S, Krishna RN, Romero L, Willems J. et al. (2023). Mental health of vulnerable groups experiencing a drought or bushfire: A systematic review. Cambridge Prisms: *Global Mental Health.* 10:e24.
40. Lawrance EL, Thompson R, Newberry Le Vay J, Page L, Jennings N. (2022). The impact of climate change on mental health and emotional wellbeing: a narrative review of current evidence, and its implications. *International Review of Psychiatry*. 34(5):443-98.
41. Sun Z. (2023). Actionable Science for Wildfire. InActionable Science of Global Environment Change: From Big Data to Practical Research (pp. 149-183). Cham: *Springer International Publishing.*
42. Kalapodis N, Sakkas G. (2024). Integrated fire management and closer to nature forest management at the landscape scale as a holistic approach to foster forest resilience to wildfires. *Open Research Europe*. 4(131):131.
43. Kirschner JA, Clark J, Boustras G. (2023). Governing wildfires: toward a systematic analytical framework. *Ecology and Society*. 28(2).
44. Tampekis S, Sakellariou S, Palaiologou P, Arabatzis G, Kantartzis A. et al. (2023). Tsiaras E. Building wildland–urban interface zone resilience through performance-based wildfire engineering. A holistic theoretical framework. *Euro-Mediterranean Journal for Environmental Integration*;8(3):675-89.
45. Sakellariou S, Sfougaris A, Christopoulou O, Tampekis S. (2022). Integrated wildfire risk assessment of natural and anthropogenic ecosystems based on simulation modeling and remotely sensed data fusion. *International Journal of Disaster Risk Reduction*. 78:103129.
46. Salavati G, Saniei E, Ghaderpour E, Hassan QK. (2022). Wildfire risk forecasting using weights of evidence and statistical index models. Sustainability. 14(7):3881.
47. Marolla C. (2016). Climate Health Risks in Megacities: Sustainable Management and Strategic Planning. CRC Press; 40-41
48. Kovvuri S, Chatterjee P, Basumallik S, Srivastava A. (2024). Wildfire-Induced Risk Assessment to Enable Resilient and Sustainable Electric Power Grid. Energies. 17(2):297.
49. Miranda A, Carrasco J, González M, Pais C, Lara A, Altamirano A. et al. (2020). Evidence-based mapping of the wildland-urban interface to better identify human communities threatened by wildfires. *Environmental Research Letters*. 15(9):094069.
50. Sirca C, Casula F, Bouillon C, García BF, Ramiro MM. et al. (2017). A wildfire risk oriented GIS tool for mapping Rural-Urban Interfaces. Environmental modelling & software. 94:36-47.
51. Tedim F, Leone V, Amraoui M, Bouillon C, Coughlan MR. et al. (2018). Defining extreme wildfire events: Difficulties, challenges, and impacts. Fire. 1(1):9.
52. Luu C, Forino G, Yorke L, Ha H, Bui QD. et al. (2024). Integrating susceptibility maps of multiple hazards and building exposure distribution: a case study of wildfires and floods for the province of Quang Nam, Vietnam. Natural Hazards and Earth System Sciences. 24(12):4385-4408.
53. Rivière M, Lenglet J, Noirault A, Pimont F, Dupuy JL. (2023). Mapping territorial vulnerability to wildfires: A participative multi-criteria analysis. Forest Ecology and Management. 539:121014.
54. Tedim F, Leone V, Amraoui M, Bouillon C, Coughlan MR. et al. (2018). Defining extreme wildfire events: Difficulties, challenges, and impacts. Fire. 1(1):9.
55. Marolla C. (2018). Information and communication technology for sustainable development. CRC Press; pp. 181-185.
56. Maezawa Y, Hatakeyama Y, Saito M, Hirota T. (2014). Conservation of biodiversity by making use of ICT. FUJITSU Scientific & Technical Journal (FSTJ). 50(4):44-51.
57. Arango E, Jiménez P, Nogal M, Sousa HS, Stewart MG. et al. (2024). Enhancing infrastructure resilience in wildfire management to face extreme events: Insights from the Iberian Peninsula. Climate Risk Management. 44:100595.
58. Krueger, E.S., Levi, M.R., Achieng, K.O., Bolten, J.D., Carlson, J.D. (2022). Using soil moisture information to better understand and predict wildfire danger: a review of recent developments and outstanding questions. *International Journal of Wildland Fire*, 111–132. URL: https://www.publish.csiro.au/wf/WF22056, doi:10.1071/WF22056. publisher: CSIRO PUBLISHING
59. Marolla C. (208). Information and communication technology for sustainable development. CRC Press; pp. 186-187.
60. Marolla C. (2016). Climate Health Risks in Megacities: Sustainable Management and Strategic Planning. CRC Press.
61. Kogan F. (2023). Remote Sensing Land Surface Changes: The 1981-2020 Intensive Global Warming. Springer Nature.
62. Román MV, Azqueta D, Rodrígues M. (2013). Methodological approach to assess the socio-economic vulnerability to wildfires in Spain. Forest Ecology and Management. 294:158-165.
63. Tedim F, Leone V, Xanthopoulos G. (2016). A wildfire risk management concept based on a social-ecological approach in the European Union: Fire Smart Territory. *International Journal of Disaster Risk Reduction*. 18:138-153.
64. Mastrandrea MD, Field CB, Stocker TF, Edenhofer O, Ebi KL. et al. (2010). Guidance note for lead authors of the IPCC fifth assessment report on consistent treatment of uncertainties.
65. Dong MW. (2023). A Critical Analysis on Complex Urban Systems and Complex Systems Theory. Journal of Computing and Natural Science. 3(1):024-034.
66. Haggag M, Ezzeldin M, El-Dakhakhni W, Hassini E. (2022). Resilient cities critical infrastructure interdependence: a meta-research. Sustainable and resilient infrastructure. 7(4):291-312.
67. Sudmeier-Rieux K, Arce-Mojica T, Boehmer HJ, Doswald N, Emerton L. et al. (2021). Scientific evidence for ecosystem-based disaster risk reduction. Nature Sustainability. 4(9):803-810.
68. Bacciu V, Sirca C, Spano D. (2022). Towards a systemic approach to fire risk management. Environmental Science & Policy. 129:37-44.

69. Simpson NP, Mach KJ, Constable A, Hess J, Hogarth R. et al. (2021). A framework for complex climate change risk assessment. *One Earth*. 4(4):489-501.
70. Shi Y, Zhai G, Xu L, Zhou S, Lu Y. et al. (2021). Assessment methods of urban system resilience: From the perspective of complex adaptive system theory. Cities. 112:103141.
71. Abujder Ochoa WA, Iarozinski Neto A, Vitorio Junior PC, Calabokis OP, Ballesteros-Ballesteros V. (2024). The Theory of Complexity and Sustainable Urban Development: A Systematic Literature Review. Sustainability. 17(1):3.
72. Adediran E. (2024). Complexity Theory; Unraveling the Fabric of Intricacy. Unraveling the Fabric of Intricacy (June 26, 2024).
73. Gjedrem AM. *Innovative and Sustainable Solutions for Wildland-Urban Interface Fire Risk Management in Costal Norway* (Doctoral dissertation, European University of Cyprus (Cyprus)).
74. Nastos PT, Dalezios NR, Faraslis IN, Mitrakopoulos K, Blanta A. et al. (2021). Risk management framework of environmental hazards and extremes in Mediterranean ecosystems. Natural Hazards and Earth System Sciences. 21(6):1935-1954.
75. Taylor S, Roald LA. (2022). A framework for risk assessment and optimal line upgrade selection to mitigate wildfire risk. *Electric Power Systems Research*. 213:108592.
76. Marolla, C. Risk Mechanism Theory. Information and communication technology for sustainable development. CRC Press, Taylor and Francis Group. DOI https://doi.org/10.1201/9781351045230
77. Leal OJ, Fekete A, Eudave RR, Matos JC, Sousa H. et al. (2024). A Systematic Review of Integrated Frameworks for Resilience and Sustainability Assessments for Critical Infrastructures. *Structural Engineering International*. 34(2):266-280.
78. Arab A, Khodaei A, Eskandarpour R, Thompson MP, Wei Y. (2021). Three lines of defense for wildfire risk management in electric power grids: A review. IEEE access. 9:61577-1593.
79. Kevin Weyand MP. Continuity of Operations Planning: Enhancing the Operational Resilience of the Olathe Fire Department.
80. Zacharakis I, Tsihrintzis VA. (2023). Integrated wildfire danger models and factors: A review. Science of the total environment. 165704.
81. Calder A. (2021). ISO 22301: 2019 and business continuity management–Understand how to plan, implement and enhance a business continuity management system (BCMS). IT Governance Publishing.
82. Bendell T. (2023). Time to Rethink Risk Management: Surviving Future Global Crises. World Scientific.
83. Vylund L, Jacobsson J, Frykmer T, Eriksson K. (2024). Improving Complex Problem-Solving in Emergency Response: A Study of the Fire and Rescue Service in Sweden. *International Journal of Disaster Risk Science*. 15(6):867-878.
84. Belcher CM, Brown I, Clay GD, Doerr SH, Elliott A. et al. (2021). UK wildfires and their climate challenges. Expert Led report prepared for the third climate change risk assessment.
85. Björck J, McNamee M, Wahlqvist J, Larson M, Inamdeen F. (2024). A methodology for assessing multiple hazards applied to Sweden. *International Journal of Disaster Risk Reduction*. 114:104934.
86. Sköld Gustafsson V, Andersson Granberg T, Pilemalm S, Waldemarsson M. (2024). Identifying decision support needs for emergency response to multiple natural hazards: an activity theory approach. *Natural Hazards*. 120(3):2777-2802.
87. Bhagavathula S, Brundiers K, Stauffacher M, Kay B. (2021). Fostering collaboration in city governments' sustainability, emergency management and resilience work through competency-based capacity building. *International Journal of Disaster Risk Reduction*. 63:102408.
88. Noble JI, Kilag OK, Viscara C. (2023). Bridging Academia and Community: A Holistic Approach to Disaster Risk Management. Excellencia: *International Multi-disciplinary Journal of Education* (2994-9521). 1(6):36-45.
89. Palsa E, Bauer M, Evers C, Hamilton M, Nielsen-Pincus M. (2022). Engagement in local and collaborative wildfire risk mitigation planning across the western US—Evaluating participation and diversity in Community Wildfire Protection Plans. PLoS one. 17(2):e0263757.
90. Mizrak KC. (2024). Crisis management and risk mitigation: Strategies for effective response and resilience. Trends, Challenges, and Practices in Contemporary Strategic Management. 254-278.
91. Marolla C. Climate Health Risks in Megacities: Sustainable Management and Strategic Planning. CRC Press; 2016 Dec 1.
92. Thompson MP, MacGregor DG, Calkin D. (2016). Risk management: core principles and practices, and their relevance to wildland fire. Gen. Tech. Rep. RMRS-GTR-350. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station. 29 p. 350.
93. De Maio FV, De Stefano R, Lanfranconi C, Osmani S, Fuggini C. et al. Multi-hazard and risk informed system for Enhanced local and regional Disaster risk management.
94. Kamyabniya A, Sauré A, Salman FS, Bénichou N, Patrick J. (2024). Optimization models for disaster response operations: a literature review. OR Spectrum. 1-47.
95. Corrales-Estrada AM, Gómez-Santos LL, Bernal-Torres CA, Rodriguez-López JE. (2021). Sustainability and resilience organizational capabilities to enhance business continuity management: A literature review. Sustainability. 13(15):8196.
96. Sawalha IH. (2020). A contemporary perspective on the disaster management cycle. foresight. 22(4):469-482.
97. Sawalha IH. (2021). Views on business continuity and disaster recovery. International Journal of Emergency Services. 10(3):351-365.
98. Crask J. (2020). Business continuity management: A practical guide to organization resilience and ISO 22301. Kogan Page Publishers. Janzwood S. Confident, likely, or both? The implementation of the uncertainty language framework in IPCC special reports. Climatic Change. 162(3):1655-1675.

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