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Improving social resilience to forest fire from community perspective

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Improving social resilience to forest fire from community perspective

Abstract

Recently, terms like social and community resilience have provided new ideas in reducing disaster risks especially in forest fire. However, a comprehensive and in-depth review of community social resilience concerning forest fires is lacking. There is little research investigate whether certain social or community resilience factors can initiate forest fires or whether forest fire prevention positively be influenced by them. To fill this gap, this paper aims to identify and discuss the factors influencing the occurrence of forest fires in the scope of community social resilience. It also provides recommendations for forest fire prevention and enhancing community social resilience to forest fires. PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) framework were used to do the systematic review. The results show that there are 4 main factors concerning the social resilience to forest fire such as, social capital, forest fire cultural, community economic, and community characteristics. In addition, this research also suggests future recommendations for preventing forest fires and improving community resilience to forest fires.

Keywords : Community Resilience, Social Resilience, Forest Fire, Literature Review

1. Introduction

Forests account for approximately 30% of the earth's area and play an important role in the ecological environment, providing habitats for currently known animal and plant species(FAO and UNEP, 2020). In recent years, the incidence of forest fires has also increased significantly from a global perspective due to climate change (Abatzoglou, J. T., & Williams, A. P. , 2016; Boer, M. M.et al., 2017). Forest fires cause huge economic losses to humans every year, even affect human lives, and destroy the environment. From an environmental perspective, forest fires also cause great damage to forest resources, and the carbon dioxide and other harmful substances generated during the combustion process also cause considerable air pollution (Kalogiannidis, S. et al, 2023; Han, Z. et al, 2022). Therefore, most countries attach great importance to the prevention of forest fires. The factors that cause forest fires are generally divided into four parts, climate, vegetation, topography, and socioeconomics (Ganteaume, A. et al., 2013; Guo, F.et al., 2016), and the main reasons for fires in different regions will be different(Morgan, P. et al., 2001). Moreover, fires caused by human activities often accompany seasonal irregularities and large fire areas (Costafreda-Aumedes, S. et al., 2017). However, current research on fire factors focuses more on natural factors. Although scholars are generally aware that social factors are also an important cause of fires, it is still necessary to focus on understanding the impact of social factors on fires(McWethy, D. B. et al., 2019; Copes-Gerbitz, K. et al., 2021; Sturtevant, B. R., & Cleland, D. T., 2007).

In recent years, the emergence of terms such as social and community resilience has provided new ideas in disaster risk reduction (Adger, W. N., & Hodbod, J., 2014). Social resilience is the ability of social entities, that is, individuals, organizations or communities, to resist, adapt to, and recover quickly from disasters (Keck, M., & Sakdapolrak, P., 2013). Currently, some scholars are exploring forest fire prevention from the perspectives of community and social resilience (Sari, D. A. P. et al., 2018). Charnley et al., (2017) explore the forest management practices of federal, state, and private forest owners in a fire-prone area of south-central Oregon and then use an agent-based landscape model to assess forest structure and fire indicators by ownership and the trend of. His research points out that forests managed by different land managers exhibit different fire resilience, with forests managed by the federal government exhibiting greater fire resilience; while the private sector is a highly heterogeneous group, but driven by profits, private companies will prefer to plant small logs instead of large trees that have strong resistance to forest fires (Charnley et al., 2017). Loehle, C., 2004 proposed that personal experience of disasters can help increase disaster awareness, prompt oneself to take active measures to reduce future disaster risks, and improve fire resilience (Loehle, C. 2004). However, the current research gap is that there is no in-depth and comprehensive summary of community social resilience on forest fires. Most research focuses on exploring whether a specific factor in social resilience or community resilience may trigger forest fires, or on the impact of forest fires prevention plays a positive role (Yuliani, F., & Saputr, T., 2023; Smith, W., & Dressler, W. H., 2020).

PRISMA is a set of reporting guidelines used for systematic reviews and meta-analyses, aimed at helping researchers and academic journals improve the quality and transparency of their reports. Initially introduced to enhance health research clarity and transparency, PRISMA has been widely applied across various fields, including psychology, education, and the social sciences. Recent studies have shown that PRISMA has a positive impact on improving report quality, enhancing methodological rigor, and promoting research reproducibility(Page, M. J. et al., 2021; Moher, D et al., 2010).

This research aims to sort out and summarize the factors that impact forest fires' occurrence in community social resilience proposed by previous people and suggest future recommendation for preventing forest fires and improving community resilience to forest fires. In addition, the article believes that community participation, the promotion of community awareness and community forest fire education are significant to prevent forest fires. Improving the social resilience of forests to fires from a community perspective is also a fundamental way to prevent forest fires (Bixler, R. P. et al., 2021; Imperiale, A. J., & Vanclay, F., 2021). The objectives of this paper are: 1) to identify factors affecting community social resilience to forest fire; 2) to analyze challenges to measure community social resilience for forest fire. To do that, the paper does an extensive and systematic literature review and suggests some specific pathways on enhancing social resilience to cope with forest fire.

2. Methodology

To systematically summarize the factors affecting community social resilience to forest fires, this study adopted a systematic literature search and selection approach guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The systematic approach is often used to conduct literature reviews, which can comprehensively and quickly screen out articles related to the topic.

This research used keywords such as “forest and fire”, “resilience”, “social resilience”, and “forest fire and community”. These keywords have been selected due to knowledge gap mentioned in introduction part that currently there is no research focuses on social resilience and community. As previous mentioned there is no in-depth and comprehensive summary of community social resilience on forest fires . The Web of Science has 76 papers, and the Scopus has 54 papers until the 30th, of September 2023. English paper and open-access paper are chosen. In addition, the duplicates have been removed, however, there are still 97 papers. Through reading the abstract, 61 papers that did not address the main topic were deleted. Then, after reading all the papers, 4 papers have no access. So, Finally, the 32 papers were selected.

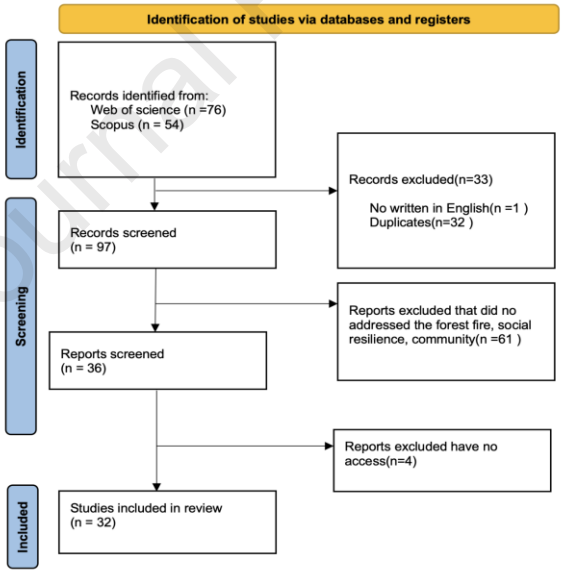

Figure 1. The PRISMA framework for literature search and selection(Source : Authors)

3. Findings— Factors of community social resilience to forest fire

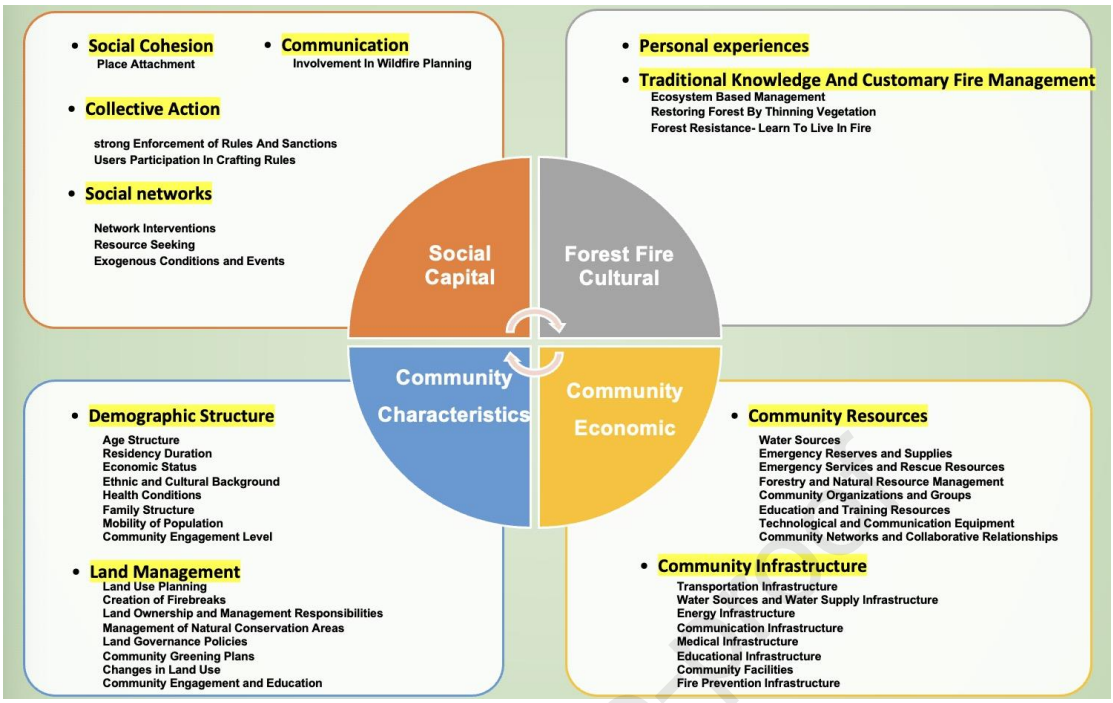

Figure 2. Factors of community social resilience to forest fire based on literature review (Source : Authors)

3.1 Influence of Social Capital in Forest Fire

3.1.1 Social cohesion: Various factors influence forest fire preparedness at both the household and community levels, with substantial social capital emerging as a crucial element in reducing risk (Ryan, R. L., & Wamsley, M. B., 2008). Studies have examined households as single units and found that previous experience with wildfires and place attachment often increase commitment to preparedness efforts, enhancing community social capital and overall disaster preparedness (Ryan, R. L., & Wamsley, M. B., 2008). Individuals with prior exposure to wildfires and a strong emotional connection to their environment significantly influence social cohesion within their communities and their readiness to respond to potential disasters (Paveglio, T. B. et al., 2009). Moreover, residents' deep emotional attachment to their surroundings, or place attachment, significantly shapes their responses to wildfire threats. This emotional bond personalizes the perceived risk of wildfires, motivating individuals to engage in preparedness activities to safeguard their homes and communities (Vincent, K., 2007)

3.1.2 Collective action: Moreover, various societal factors and institutional structures influence homeowners' decisions regarding preparedness, including interactions with other community members, government agencies, and regional fire authorities (Ryan, R. L., & Wamsley, M. B., 2008). Understanding Urban Interface communities' diverse experiences, attitudes, and networks is crucial for effective preparedness initiatives. Social capital, which encompasses the shared identity, group activities, and norms

within a community, plays a significant role in shaping collective behaviors and responses to wildfire threats (Ryan, R. L., &Wamsley, 2008). Communities with substantial social capital may be more inclined to implement measures to control fires and have established institutions to manage fire usage and control effectively.

3.1.3 Communication: Organizational networks play a crucial role in enhancing adaptive capacity by fostering collaboration and information exchange among stakeholders. These networks, characterized by ties between interacting organizations, can form flexible structures that transcend geographical and jurisdictional boundaries (Ryan, R. L., & Wamsley, M. B., 2008). The structure of organizational networks reflects social conditions that support collective action and learning. Dense interactions within the same social group, known as bonding social capital, promote communication, cooperation, and the development of common norms and trust. Interactions between actors from different groups, referred to as bridging social capital, facilitate access to new information and resources necessary for innovation (Marquart-Pyatt et al. 2014, Leiserowitz et al. 2015).

3.1.4 Information structure: Quantifying social capital within these networks involves assessing measures of cohesion and heterogeneity (Ryan, R. L., & Wamsley, M. B. (2008). By understanding the structure of organizational networks and the distribution of social capital within them, policymakers and stakeholders can better promote adaptive capacity and address environmental challenges effect Top of Form (Ryan, R. L., & Wamsley, M. B. (2008).

3.2 Forest fire cultural

3.2.1 Personal experience: Residents with firsthand experience with wildfires often possess a heightened awareness of the inherent dangers of living in fire-prone areas. This firsthand experience likely fosters a sense of urgency and responsibility, prompting them to take proactive measures such as vegetation thinning and clearing around their properties to mitigate the risks posed by future wildfires (Ryan, R. L., & Wamsley, M. B., 2008).Moreover,

Residents who have experienced wildfires may feel a stronger sense of the danger posed by fires in their area (Ryan, R. L., & Wamsley, M. B., 2008). This personal experience makes the threat more real to them. As a result, they are more likely to take action to protect themselves and their homes. One common action they take is thinning and clearing vegetation around their properties to reduce the risk of fires spreading (Vincent, K., 2007). This action is supported by the findings of many other studies, which have also shown that vegetation thinning can help lower the risk of wildfires. Understanding how personal experiences with disasters, such as wildfires, influence preparedness is complex and multifaceted. Some studies suggest firsthand encounters with disasters can be powerful motivators for preparedness actions (González-Olabarria, J. R., &Pukkala, T., 2011). Experiencing a disaster firsthand can make the threat more tangible and real,

leading individuals to take proactive measures to reduce future risks. The psychological distress caused by the loss of personal resources during a disaster can also drive individuals to mitigate potential losses in future events (Loehle, C., 2004).

3.2.3 Local knowledge:

Local knowledge plays a crucial role in forest fire management. Indian proposed that local knowledge is not only a tool in fire planning, but also a key part of community engagement, giving rural communities the opportunity to play a more active role in fire management. Traditional knowledge can inform and guide fuel and fire management, allowing the permanent preservation of biotic and abiotic resources culturally significant to tribes(Lake, F. K., et al., 2017). At the same time, the study also believes that the integration of local knowledge and forest fire management methods is similarly very important, but the researchers emphasize that local knowledge and experience in rural communities can no longer be shelved, and fire managers should actively integrate indigenous fire culture into forest fire management policy (Indian, J. 2008).

3.3 Community Characteristics

Community characteristics encompass two primary components: demographics and land management. Similarly, community economy can be categorized into two components: community resources and community infrastructure.

3.3.1 Demographic structure

Regarding the demographic structure of the community, it can be further subdivided into various factors. This entails considering the population needs and vulnerabilities across different age groups, examining the attitudes of long-term residents towards change, comprehending the impact of economic status and cultural background on fire perception and response, paying attention to populations with specific health conditions, and factoring in the influence of family structure on response and recovery. Such segmentation assists communities in specifically comprehending the needs and potential vulnerabilities of different groups, thereby enabling the development of targeted measures to enhance community resilience in responding to forest fires.

Banks et. al., (2012) based two alternative social predictions on the impacts of fire on population density, genetic structure, and resources. A stepwise approach based on classification trees and random Forest methods was applied to identify the best discriminant variables between the groups Oliveira et. al., (2017). The second step used random Forest analysis to evaluate the remaining variables' importance in distinguishing the groups. The social network analysis reveals that the social network is divided into fire protection and fire restoration subnetworks that only a few organizations could bridge. The special feature also includes papers that examine how the use of an agent-based model influences social science research, and what has been learned about the process of conducting social-ecological study and engaging with

stakeholders to improve understanding of and adaptation to fire-frequent landscapes Spies et. al., (2018). Palaiologou et. al., (2019) assess fire transmission patterns using fire behavior simulations to understand spatial variations across three diverse study areas (North-central Washington; Central California; and Northern New Mexico) to know how different land tenures affect highly socially vulnerable populated places. Although high social vulnerability block groups covered small areas, they had high population and structure density and were disproportionately exposed per area burned by fire.

Resilience is an emergent property that reflects the disruption a system can withstand before its structure or organization uncharacteristically shifts. Before the advent of intensive forest management and fire suppression, western North American forests exhibited a naturally occurring resilience to wildfires and other disturbances. Using evidence from ten ecoregions, spanning forests from Canada to Mexico, Hessburg et. al., (2019) reviewed the properties of these forests that reinforced those qualities. Tree recruitment, mortality, and growth were estimated using demographic models. The spatial characteristics including gap structure were identified using an inter-tree distance algorithm and the empty space function (Pawlikowski et. al., 2019). Potential fire behavior and effects in 2016 were estimated to determine if the current forest would soon be resilient to a wildfire. Hart et. al., (2019) use geospatial and field data to assess the resistance and resilience of eight common vegetation states to frequent fire by quantifying the occurrence of short-interval fires and their effect on recovery to a similar vegetation state. Hart et. al., (2019) use this model to ask if and how: (a) feedback between vegetation and wildfire may modify fire activity on the landscape and (b) more frequent fire may affect landscape forest composition and age structure. Hart et. al., (2019) use geospatial and field data to assess the resistance and resilience of eight common vegetation states to frequent fire by quantifying the occurrence of short-interval fires and their effect on recovery to a similar vegetation state. Hart et. al., (2019) use this model to ask if and how: (a) feedbacks between vegetation and wildfire may modify fire activity on the landscape, and (b) more frequent fire may affect landscape forest composition and age structure.

3.3.2 Land management

Communities can achieve a more comprehensive understanding of their wildfire risk by delving into various aspects of land management. Concerning land use planning, it is essential to consider the frequency of plan updates and assess whether they adequately address wildfire risk. The design and maintenance of firebreaks should align with the ecosystem's needs. Clarity in allocating land ownership and management responsibilities is crucial for an effective wildfire response. Additionally, policies related to natural reserve management, land governance, and community greening plans should align cohesively with the overall wildfire prevention strategy. Reviewing the reasons behind land use changes and anticipating future changes aids in better planning

for fire prevention. Community residents' active involvement and education are key factors in enhancing overall wildfire risk management. Through in-depth analysis of these aspects, communities can tailor their wildfire prevention and recovery plans, thereby enhancing their overall resilience to wildfire risks.

The link between forest management and the well-being of communities in forested areas has traditionally been defined by forest sector employment opportunities. The aim of Daniels, (2004) is to evaluate socioeconomic resilience and forest dependence in Washington counties to identify counties where forest management changes could negatively affect nearby residents' well-being, allowing land managers and decision-makers to anticipate the effects of land management policies.

Historically, oak-dominated ecosystems throughout the U.S. have been perpetuated through periodic disturbances, such as fire. However, it has declined more recently given shifting disturbance regimes associated with human land management decisions. Knoot et. al., (2010) characterize the state of the social-ecological oak forest ecosystem in the midwestern U.S. through the perspectives of 32 natural resource professionals. Most disaster research by anthropologists focuses on vulnerability; Charnley et. al., (2015) focus on natural hazards. Variables highlighted include policy direction to prioritize wildfire risk reduction in the wildland-urban interface, laws and policies that make treating fuels in some national forest land management allocations challenging, social and political constraints on using prescribed fire, agency budget and target pressures, and integrating fire hazard reduction into forest management projects having multiple objectives.

One of the most difficult challenges to revising forest fire policy is that agency organizations and decision-making processes are not structured in ways that ensure that fire management is thoroughly considered in management decisions. Stephens et. al., (2016) propose that forest restoration should be equal to other land management priorities because large-scale restoration is necessary for the sake of forest ecosystem integrity now and in the future. Coupled human and natural systems (CHANS) research highlights reciprocal interactions (or feedbacks) between biophysical and socioeconomic variables to explain system dynamics and resilience Kline et. al., (2017). Project social scientists were tasked with identifying actors' forest management activities and biophysical and socioeconomic factors influencing them and developing decision rules for incorporating into the ABM to represent actor behavior. Palaiologou et. al., (2019) assess fire transmission patterns using fire behavior simulations to understand spatial variations across three diverse study areas (North-central Washington, Central California, and Northern New Mexico) to understand how different land tenures affect highly socially vulnerable populated places. Federal lands proportionately exposed, on an area basis, populated places with high social vulnerability, with fires ignited on Forest Service administered lands mostly affecting north-central Washington and northern New Mexico communities. Other influential

work includes Suyanto (2007), Mateus et. al., (2014), Shanley et. al., (2016), Shanley et. al., (2016).

3.4 Community economy

3.4.1 Community resources

Comprehensive preparedness for community fire prevention and emergency response necessitates a thorough assessment from various perspectives. Firstly, ensure an ample water supply within the community and the integrity of the water supply system, both crucial for firefighting and daily living. Secondly, analyze the community's emergency reserves and supplies, encompassing food, medical supplies, and communication devices, to ensure meeting residents' needs during emergencies. Emergency services and rescue resources are also focal points, encompassing fire brigades, emergency medical services, police forces, and the support of community networks and organizations. Forestry and natural resources management require expertise, facilities, and collaborative efforts among various organizations and groups within the community. Providing educational and training resources enhances residents' understanding of fire prevention and emergency procedures. The reliability of technological and communication infrastructure is vital for effectively disseminating information. Finally, establishing community networks and collaborative relationships, including neighboring communities, local governments, and non-governmental organizations, provides broader support. By comprehensively considering these aspects, a community can better prepare and respond to potential fire threats, ensuring safety and sustainable development.

A clear relationship exists between social and ecological resilience, especially for social groups or communities reliant on ecological and environmental resources. Adger (2000) examines the utility of resilience in characterizing the social and economic circumstances of social groups and investigates potential connections between social and ecological resilience. Continuously eroding fragmented forest edges represent unintended ecological disturbances that extend beyond deforestation, leading to the degradation of extensive areas of standing forest, thereby reducing ecosystem services and the economic potential of these natural resources. Cochrane (2003) provides recommendations for progress. Efforts to redefine this relationship have yielded more comprehensive methods, integrating economic and social indicators to assess community well-being. Drawing on literature from various disciplines, Norris et al. (2008) proposes a theory of resilience that integrates modern perspectives on stress, adaptation, wellness, and resource dynamics. They identify four key sets of adaptive capacities—Economic Development, Social Capital, Information and Communication, and Community Competence—that collectively form a strategy for disaster preparedness. Purnomo et al. (2017) conducted a political economy study on fire and haze to enhance policymakers' understanding of the economic, social, and political factors contributing to forest and land fires. They focus on four districts in Riau

Province that have encountered fires and witnessed forest conversion to palm oil plantations. Prior to the era of intensive forest management and fire suppression, western North American forests demonstrated inherent resilience to wildfires and other disruptions. Hessburg et al. (2019) review evidence from ten ecoregions, covering forests from Canada to Mexico, to examine the characteristics of these forests that bolstered such resilience， further discuss the role of regional climates in episodically or abruptly reorganizing plant and animal biogeography, as well as forest resilience and resistance to disturbances. Conversely, they have come under pressure from economic entities to participate in an ecologically unequal exchange that exports natural resources and creates social and environmental challenges at the local level.

Espada et al. (2019) aims to examine the resilience of forest-based communities to the global economic system in scenarios where multiple stakeholders govern common properties. Wahyuni et al. (2021) aims to develop an understanding of the sustainability of communities heavily reliant on forest resources for the livelihood of vulnerable members of society, as well as the significance of secure land and forest rights in adjusting to and coping with livelihood challenges during pandemics and other adverse circumstances. They identified factors influencing community resilience, including population size, autonomy, community leadership, economic diversity, and infrastructure base. Fire, one of the most prevalent forest disturbances, profoundly impacts the people, societies, economies, and environments of countries worldwide. Kalogiannidis et al. (2023) demonstrate that forest fires have resulted in numerous economic costs, primarily impacting the incomes of various investors in the forest sector in Greece. Additional influential research is provided by Lawlor et al. (2019).

3.4.2 Infrastructure

In the context of community resilience to forest fires, the economic aspect involves subdividing community infrastructure into several key factors. This includes assessing the robustness of transportation networks, water supply systems, and energy sources. Additionally, the reliability of communication networks, medical facilities' availability, and educational institutions' functionality are crucial considerations. Public facilities, such as community centers and parks, play a role in post-disaster support and gatherings. Furthermore, specialized fire prevention infrastructure, including fire stations and firefighting equipment, directly influences the community's ability to respond effectively to forest fires. By conducting a comprehensive analysis of these infrastructure components, communities can enhance their understanding of available resources, facilitating the formulation of more targeted and effective strategies for response and recovery in the face of forest fires.

Lyon (2014) proposes a three-part framework for analyzing place's physical and social components as a system in community adaptation to crisis. Strengthening and enhancing social capital and enforcing rules and sanctions facilitate communal efforts in forest fire management (Sapkota et al., 2014). Aldrich et al. (2015) emphasize the

critical role of social capital and networks in disaster survival and recovery and provide an overview of recent literature and evidence on the topic. They conclude with concrete policy recommendations for disaster managers, government decision-makers, and non-governmental organizations aimed at enhancing resilience to catastrophe by fortifying social infrastructure at the community level. Community resilience has been the subject of study across various disciplines, encompassing environmental sciences, engineering, sociology, psychology, and economics. Koliou et al. (2018) summarize previous community resilience studies, primarily focusing on hazards, including models of individual infrastructure systems, their interdependencies, and community economic and social systems.

Preceding the era of intensive forest management and fire suppression, western North American forests naturally displayed resilience to wildfires and other disturbances. Palaiologou et al. (2019) assess fire transmission patterns using fire behavior simulations to comprehend spatial variations across three diverse study areas and to understand how different land tenures affect highly socially vulnerable populated places. They find that federal lands, in terms of area, proportionately expose populated places with high social vulnerability, with fires ignited on Forest Service-administered lands primarily affecting communities in north-central Washington and northern New Mexico.

Spínola et al. (2020) highlight six critical considerations for fire reduction amid unprecedented forest fires affecting large portions of what were previously fire-free Amazonian forests, including extensive areas of community-managed reserves. These considerations include inclusive management and community leadership, adapting to demographic and cultural changes, identifying examples of best practices, socially just alternative livelihoods, forecasting and planning, and bridging scientific research and innovation. Parajuli et al. (2022) delve into the perceptions of community forest managers actively engaged in grassroots forest management to comprehend the relationship between their priorities, needs, and attitudes towards forest fire management. The questionnaire was structured into three main sections: forest fuel management and infrastructure, forest fire management strategies and actions, and public education and awareness on forest fire management. When ratings across regions were compared in the forest fuel management and infrastructure sections of the study's conclusion, high fire risk areas (rated very high for all activities except controlled burning) were compared to medium and low risk areas. Local forest stakeholders attach significant importance to forest infrastructure development(Parajuli et al., 2022).

4. Future Suggestion For Improving Social Resilience to Forest Fire

Forest fire activity is predicted to increase in the global over the next century (Abatzoglou J.T. et al, 2016; Moritz M.A. et al., 2012). Increased exposure of communities to wildfire is also expected with additional warming (Liu Z. &Wimberly M.C., 2015). After analyzing the factors involved in community social resilience to

forest fires in the previous section, this study attempts to give innovative suggestions for preventing forest fires. Suggestions include the following aspects: From the perspective of transformative resilience, we explore constructing a more resilient social capital operation model that can develop post-disaster society to a higher level. Explore collective action in the community to enhance the community's adaptability to forest fires, create a forest fire culture in the community to improve social resilience, and improve forest fire prevention and monitoring capabilities from a technical perspective.

4.1 The combination of informal & formal social capital in community

In recent years, transformative resilience has received widespread attention in resilience research, especially in the environmental field (Asadzadeh, A. et al.,2022). Generally speaking, transformative resilience is the highest stage in resilience theory, meaning that it cannot only adapt to and resist current disasters, but also transform the social system to a new stage, which is different from the previous stage that was vulnerable to fire . The new social system will have stronger social resilience and be more flexible in responding to future disasters. (McWethy, D. B. et al., 2019). Transformative-resilience approach requires profound changes to the structure and feedback of the social–ecological system across broad regions and/or across broad social and political groups (Kulig, J. C. et al., 2013). This study starts from the reconstruction of community social capital, hoping to provide feasible suggestions for forest fire prevention from the perspective of transformative resilience. The definition of social capital can include network connections among citizens, and between citizens and institutions, such as the relationship between citizens and government (Coleman, J. S. ,1988; Szreter, S., & Woolcock, M., 2004). Figure 3 addressed four stakeholders: government, community social organization, and other communities.

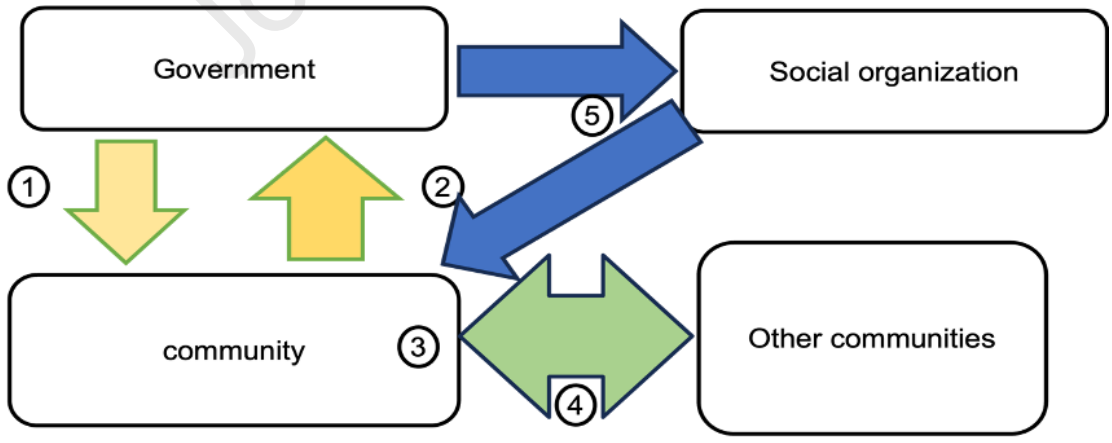

Figure 3. Reshape the community social capital (Source : Authors)

① The government conveys new forest fire thinking to residents, allowing residents to switch from resisting and preventing fires to coexisting with fires and improving the community's resilience. At the same time, the government should provide relevant

resources to the community, such as building fire shelters and providing residents with essential fire escape supplies. The government conveys scientific forest fire knowledge to residents and increases the importance of fire.

② Establish channels for communities to express their opinions and demands to the government. Since most residents affected by forest fires have lived near forests for a long time, they have rich experience. Communities must fully integrate local fire knowledge and inform the government of their special situation, such as elderly or disabled people at home.

③ A strong social support network should be established among residents in the community. The special nature of forest fires determines that fires spread very quickly. Help from neighbors is the most important when a disaster occurs.

④ Areas where forest fires occur generally have lower population densities, so different communities need to be more closely connected to minimize casualties. Social networks must also be established between communities, especially the sharing of resources and information, to reduce the probability of fires and mitigate the impact of fires.

⑤ In addition, communities affected by forest fires are generally located far away from urban centers and lack government resources. Therefore, the help of social organizations is significant. Social organizations can use professional knowledge to provide the government with reasonable planning of fuel resources and land use to reduce the frequency of fires.

The combination and reconstruction of informal social capital, represented by social capital between neighbors, and formal social capital between governments and social organizations in the community can better transfer professional fire prevention awareness and culture among residents, helping to raise residents' awareness of preventing forest fires. In addition, it can also enhance trust among community residents. A lot of studies have proven that social capital between neighbors is very important. Neighbors are often the most capable of helping each other after a disaster. At the same time, we should fully mobilize various resources in the community, such as human resources, organize fire prevention drills, integrate disaster prevention resources, and improve social resilience in response to forest fires.

4.2 Collective action

Dependency on Daily Wages: Individuals reliant on daily wages from unskilled labour often face challenges in participating effectively in forest management initiatives (Ryan, R. L., & Wamsley, M. B., 2008) The nature of their work frequently requires them to be away from their community for extended periods, limiting their availability for collective decision-making and action regarding forest conservation.

Distance to Important Centres: The geographical distance between communities and crucial centres such as district headquarters, forest offices, and markets can significantly impact their ability to engage in collective forest management (Ryan, R. L., & Wamsley, M. B., 2008). Communities situated far from these centres may experience barriers to participation due to logistical challenges and reduced access to resources and support. However, while distance plays a role, the specific differences in distances between these centres and communities might not have a substantial effect on collective action (Ryan, R. L., & Wamsley, M. B., 2008)

Length of Engagement: Communities with a longer history of involvement in forest conservation and management initiatives tend to demonstrate more effective responses to collective forest management efforts. Over time, these communities accumulate knowledge, experience, and institutional memory, which enhance their capacity to address forest-related challenges collectively (Leiserowitz, A., E. et al., 2015).

Scarcity and Monitoring: Communities facing resource scarcity exacerbated by excessive harvesting and stringent monitoring by government forest authorities often exhibit greater engagement in forest management activities. The combination of limited resources and strict oversight motivates these communities to take proactive measures to sustainably manage their forests and mitigate the risk of resource depletion (Leiserowitz, A., E. et al., 2015).

Social Capital: The strength of social bonds, cooperation, and trust within a community significantly influences its level of engagement in forest management. Communities with robust social capital tend to demonstrate higher levels of collective action and collaboration, as trust and cooperation facilitate effective communication, decision-making, and implementation of forest management strategies (Leiserowitz, A., E. et al., 2015).

Leadership and Power Sharing: Communities characterized by balanced leadership roles and equitable distribution of power among members are more likely to achieve effective forest management outcomes. When leadership responsibilities are shared fairly and power dynamics are transparent and inclusive, community members feel empowered to contribute actively to forest conservation efforts (Marquart-Pyatt, S. T. et al., 2014).

Rule Enforcement and Sanctions: Communities that enforce forest management rules rigorously and impose meaningful sanctions for non-compliance tend to exhibit more effective forest management practices. Strong enforcement mechanisms deter individuals from engaging in unsustainable activities and reinforce the importance of adhering to established rules and regulations for the collective benefit of the community (Marquart-Pyatt, S. T. et al, 2014).

Collective Monitoring and Incentives: Communities that implement collective monitoring mechanisms and provide incentives for participation often experience enhanced effectiveness in forest management. By actively monitoring forest resources

and rewarding individuals for their contributions to conservation efforts, these communities foster a sense of ownership and responsibility among members, driving sustainable forest management practices (Marquart-Pyatt, S. T.et al., 2014).

4.3 Forest Fire Culture

Ecosystem based management in terms of reducing wildfires refers to fire regulating services that reduce the intensity and catastrophic fires associated with environment and human beings (Hurteauet al., 2014). Ecosystems containing native species that have adapted to fire tend to face lower fire risks because these species are less flammable and have lower biomass. After a fire, these species often thrive in the post-fire environment (González-Olabarria, J. R., & Pukkala, T. , 2011).

Diverse landscapes with varied land uses and vegetation patterns can help reduce the intensity and spread of fires (Loehle, 2004). For instance presence of patches of broadleaf, deciduous forests, amid evergreen forest is more fire resilient. Sustainable farming methods, grazing livestock, and controlled burns contribute to this diversity, making landscapes more resilient to fires (González-Olabarria, J. R., & Pukkala, T. , 2011).

Practices such as controlled grazing and thinning vegetation are effective ways to lower fire risks by reducing the amount of fuel available for fires and decreasing the density of vegetation. Livestock grazing and mechanical thinning methods are examples of how this can be achieved while also maintaining ecosystem health (González-Olabarria, J. R., & Pukkala, T. , 2011). Natural features like bodies of water, strips of grasslands, and areas with less flammable vegetation serve as barriers that slow down the spread of fires. While these natural fire breaks are effective, artificial fire breaks created by humans can sometimes disrupt soil and contribute to erosion (González-Olabarria, J. R., & Pukkala, T. , 2011).

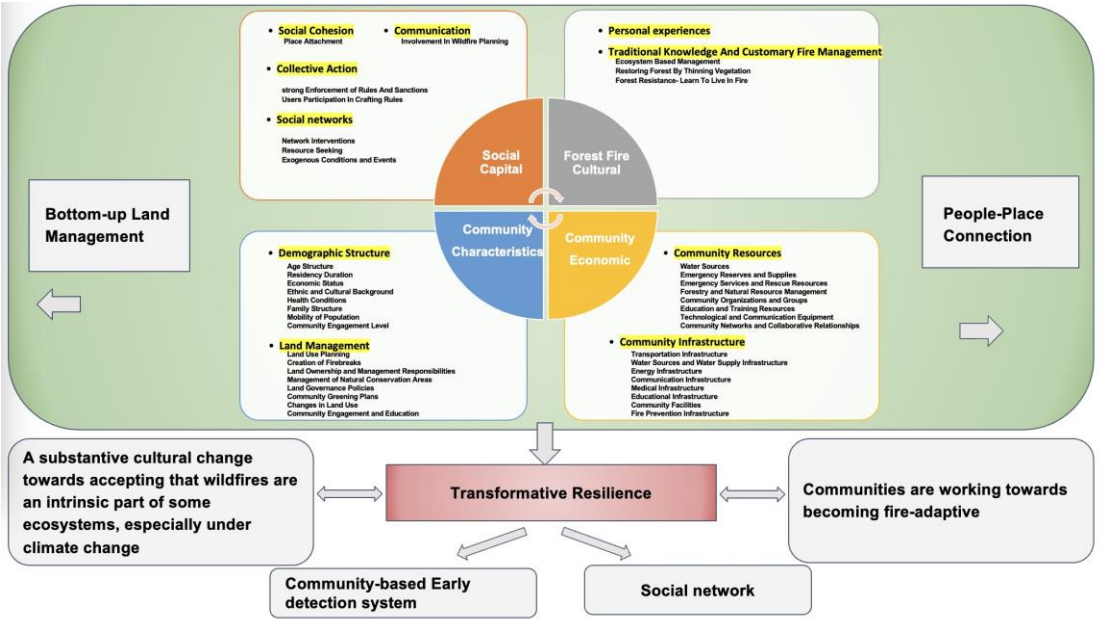

Figure 4. Framework between Social Resilience Factors and Future Suggestions (Source : Authors)

5. Conclusion

The literature study identifies the factors that impact social resilience in the context of community response to forest fires. These factors include social capital, forest fire culture, community characteristics, and community economics. It is through the encouragement of preparedness at the household and community levels that social capital plays an essential role in reducing the risk of forest fires. Research highlights that one of the most significant aspects of resilience theory is the concept of transformational resilience. This advanced form of resilience not only goes beyond basic adaptation and resistance to ongoing disasters but also facilitates a profound systemic shift within society. Instead of simply responding to and managing current challenges, transformational resilience drives a fundamental change, transforming a society from its previous, fire-prone state into an entirely new and more resilient state. This shift involves rethinking and restructuring societal systems to address vulnerabilities and build capacities that prevent future disasters and improve overall sustainability.

The suggested recommendation for enhancing social resilience is the adoption of transformative resilience strategies. To effectively bolster this form of resilience, it is crucial to increase residents' awareness of the importance of preventing forest fires. This can be achieved through a multifaceted approach that includes both the integration and restoration of formal social capital—such as strengthening collaborations and partnerships between community organizations and government agencies—and the enhancement of informal social capital, which involves fostering stronger, more supportive relationships among neighbors. By building and reinforcing these networks of support and communication, communities can develop a more cohesive and proactive approach to forest fire prevention, ultimately leading to greater overall resilience in the face of potential disasters.

For the limitation of this study, which centers solely on a literature review and relies primarily on database analysis, it is important to acknowledge that more detailed and practical research is needed. Specifically, future research should include empirical studies, such as conducting one or two case studies, to assess social resilience within communities and evaluate effective measures for reducing the risk of forest fires. These case studies would provide concrete examples and insights into how social resilience operates in real-world settings. Additionally, there is a need for the development and examination of more comprehensive frameworks that can guide governmental agencies in crafting and implementing strategies aimed at enhancing social resilience. Such frameworks would support the creation of targeted policies and interventions that address the unique challenges faced by different communities, ultimately improving their ability to manage and mitigate the risks associated with forest fires.

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Highlights:

- This study focuses on the significant role of community social resilience to prevent the risk of forest fire.
- There are 4 main factors concerning the social resilience to forest fire such as, social capital, forest fire cultural, community economic, and community characteristics.
- It also provides recommendations for forest fire prevention and enhancing community resilience to forest fires.

Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐ The author is an Editorial Board Member/Editor-in-Chief/Associate Editor/Guest Editor for *[Journal name]* and was not involved in the editorial review or the decision to publish this article.

☐ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: