Local community participation and volunteerism in wildfire area management: A systematic review

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Abstract: Wildfires have caused considerable economic, ecological, and social damage in recent years. For this reason, decision-makers in wildfire management (WFM) have face increasingly difficult challenges. While decision support systems help decision-makers, it is clear that some deficiencies still persist. In this context, it is thought that the active role of local people involved in wildfire management can eliminate these deficiencies because they have experience and direct knowledge about fighting wildfires in Wildland Urban Interface (WUI) areas. Hence, their expertise can be utilized in future wildfire containment efforts. In this study, the author presents some general information about WUI, public participation, and the decision-making process and its relation to wildfires. In addition, the author will also examine previous studies on the participation of local people in wildfire management and investigate the decision-making processes regarding this issue by using Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) technique. The results of this study suggest that there should be a widespread adoption of the community-based integrated fire management (CBIFM) approach, instead of the top-down management approach commonly employed in wildfire management. The results strongly suggest that decision-makers should reach a consensus as to how the principle of participation in fire management should work by reviewing the socio-economic interests of the local community.

Keywords: Forest fire, Wildland urban interface, Attendance, Decision-making

Yerel halkın orman yangın yönetimine katılımı ve gönüllülüğü - Sistematik bir inceleme

Özet: Orman yangınları son yıllarda çok fazla ekonomik, ekolojik ve sosyal zarara neden olmuştur. Bu nedenle Orman Yangını yönetiminde (OYY) karar vericilerin işi giderek zorlaşmaktadır. Gelişen karar destek sistemleri karar vericilere yardımcı olsa da hala bazı eksikliklerin olduğu aşikardır. Bu bağlamda, yerel halkın orman yangını yönetiminde aktif rol almasının, hem bilgi toplayabilmesi hem de Yabanıl Kentsel Arayüz (YKA) alanlarında orman yangınıyla doğrudan karşılaşması nedeniyle bu eksiklikleri giderebileceği ve orman yangınıyla mücadelede faydalı olabileceği düşünülmektedir. Bu çalışmada, YKA, Halkın katılımı ve karar verme süreci hakkında genel bilgiler ve bunların orman yangını ile ilişkileri sunulduktan sonra, yerel halkın orman yangını yönetimine katılımı ve bu konudaki karar verme süreçlerinin nasıl ilerlediğine dair son çalışmalar Sistematik İncelemeler ve Meta-Analiz için Tercih Edilen Raporlama Öğeleri (PRISMA) tekniği kullanılarak incelenmiştir. Çalışma sonucunda, orman yangını yönetiminde yukarıdan aşağıya yönetim yaklaşımı yerine Toplum Tabanlı Entegre Yangın Yönetimi (TEGY) yaklaşımının yaygınlaştırılması gerektiği ortaya çıkmıştır. Sonuçlar, karar vericilerin yerel toplumun sosyo-ekonomik çıkarlarını gözden geçirerek yangın yönetimine katılım ilkesinin nasıl işlemesi gerektiğine karar vermeleri gerektiğini kuvvetle önermektedir.

Anahtar kelimeler: Orman yangını, Yaban arazisi kentsel arayüz, Katılım, Karar verme

1. Introduction

Climate change is expected to exacerbate the incidence of wildfires and further complicate the lives of fire managers and forest engineers, who are regularly called upon to solve increasingly complex decision-making problems (Martell, 2011). Furthermore, fire management decisions should be made by establishing a balance between the economic, ecological, and social effects of the fire, and the benefits and harms caused by the fire should be carefully examined in this context (Martell, 2015; Nyongesa and Vacik, 2019). The urgency of this environmental crisis necessitates a review of the existing Wildfire Management (WFM) (Santos et al., 2021).

Global WFM strategies are transitioning from a response-based paradigm to a more collaborative/resilience-oriented framework based on prevention and community participation (Patrão, 2014; Khatun et al., 2017). Researchers have examined numerous interactive approaches, revealing that there are effective ways to increase homeowners' knowledge and support of fire management (McGee, 2011; Welch and Coimbra Jr., 2021).

When an appropriate institutional framework is provided, the CBIFM approach facilitates the efficient use of resources, the integration of domestic and modern information systems, and remote fire management (Dube, 2013; Lineal and Laituri, 2013). Marta-Costa et al. (2016) state that the early adoption of a participatory

methodologies stage in the planning process encourages dialogue and open communication between various stakeholders and considers community views when drafting policies. Furthermore, this stage is essential in order to prevent damages that may occur as a result of wildfire and creating appropriate management for the region (Marta-Costa et al., 2016).

The involvement of private forest owners in WFM has been discussed in many studies (Aguilar and Montiel, 2011; Santos et al., 2021), many of which tend to be related to fuel management. The result of the increasing marginal costs of burnt land necessitates that this new paradigm must also include the economic relationship between private forest owners. Fuel treatment activities to maintain the landscape represents a significant challenge with important societal implications. However, the planning of fuel treatment activities raises complex decision-making problems with spatial and temporal dimensions (Minas et al., 2014).

Valuing and integrating different forms of information and understanding locally lived realities are prerequisites to creating a more systemic approach to anticipate and collectively adapt to the increased risk of future bushfires. This could be achieved by developing bottom-up strategies that focus on combining traditional fire knowledge and scientific ecological knowledge (Devisscher et al., 2019; Mistry et al., 2019). The Integrated Fire Management (IFM) approach is established and implemented to understand the diverse uses of fire and the traditional ecological knowledge of local people and its practical applications. Thus, it can be said that the IFM framework aids the implementation of cost-effective approaches by preventing damage caused by fires and maintaining the desired fire regimes and participation of local people (Nyongesa and Vacik, 2018). Moreover, the difficulties regarding decision-making processes will reduce thanks to the active local community participation in WFM (Nyongesa and Vacik, 2019).

In general, due to the increase in the rate of global migration from rural to urban areas, urban sprawl enters abandoned agricultural areas, and at the same time, it is seen that there is a similar trend of migration from rural areas to cities due to the decreasing population in rural areas (Fischer et al., 2016b). For this reason, people's living spaces and natural areas are intertwined, and potential wildfires can result in great damage in terms of economical, ecological, social, and public health (Bouillon et al., 2018; Moritz et al., 2014). The inclusion of WUI in WFM is thus crucial to minimizing loss of life and property and because there are many elements that can increase the severity of fire in the city (Ferster et al., 2013; Fischer et al., 2016a; Reams et al., 2005).

Some policies that reduce the risk of wildfire in the WUI interface have been indicated in studies by J. Cohen (2008, 2010) and Kramer et al. (2018). These policies combine enhanced modeling, the investigation of forest fire risk in densely populated areas, fuel reduction in the home ignition zone (HIZ), the use of fireproof landscaping and construction materials, and the strategic placement of fuel reduction treatments around communities, and given the dangers posed by wildfires, community education and the planning of building locations (Cohen, 2008, 2010; Kramer et al., 2018). Further, Fischer et al. (2016a) stated the benefits of assessing wildfire risk by recognizing and accounting for the interactions of socio-ecological systems, also known as coupled human and natural systems (CHNS). Figure 1 shows the CHNS components and their related scales, along with a list of prevention, mitigation, preparedness and suppression methods. The social capital regarding preparedness and the acceptance of preparedness requirements of fire directorate for wildfires is more accepted in WUI areas where this wildfire disaster has been experienced before (Bihari and Ryan, 2012; Ghasemi et al., 2020).

Recent developments in the decision support system (DSS) have led to significant enhancements in the evaluation of the participation factor in forest fire management. In WFM planning, in order to help integrate activities, which are usually carried out independently, research has been conducted to further develop decision support tools (Pacheco et al., 2015).
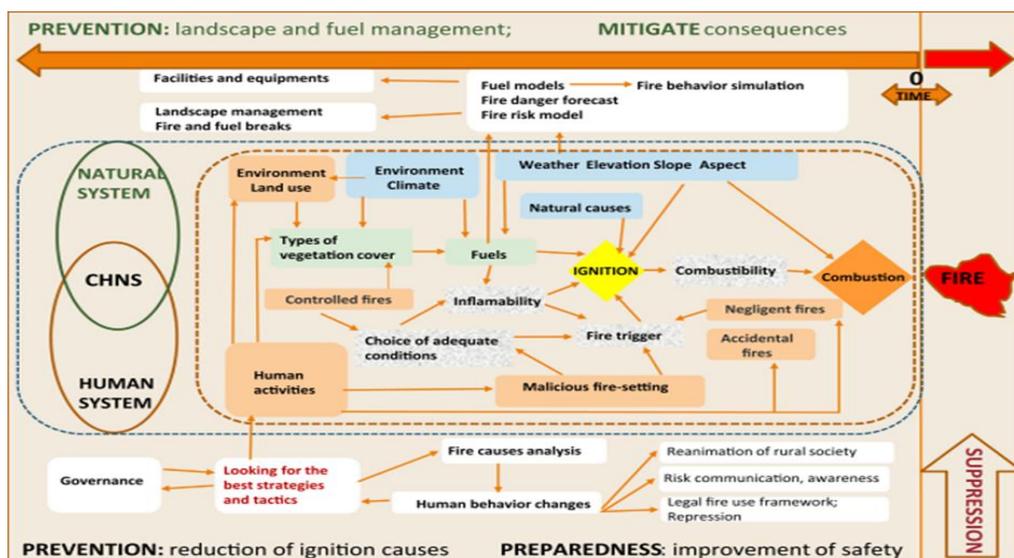
Figure 1. The CHNS: a synthetic view of the ingredients, human and natural causes of ignition, and possible initiatives for disaster risk reduction (Tedim et al., 2016).

The complex decision environment in WFM is characterized by changing fire conditions, partial control, and uncertainty. Therefore, the development and implementation of systematic and risk-based approaches to support decision-making where forest fire risk is expressed as a function of the likelihood of the fire, fire severity, and fire effects has boosted confidence (Pacheco et al., 2015; Wei et al., 2018). However, additional efforts are required to mitigate the destructive impacts of fire, such as replacing combustible fuel complexes (fuel management); reducing the number of human-induced fires (prevention); detecting fires with destructive potential (detection); acquiring, deploying, and dispatching initial attack resources (suppression, deployment, acquisition, dispatch); and mobilizing incident management teams to address escalating fires (large fire management). At present, forest and wildland fire management appears to be a supply chain management perspective. This concept is defined as delivering the right amount of the right fire to the right place at the right time and at the right cost, and this review deals with decision-making and planning concerning the suppression aspects of the forest and wildland fire management supply chain (Martell, 2015).

Transition to a new fire management paradigm requires advanced planning and support for decision-making that assesses the natural tradeoffs between alternative management strategies and better monitoring of fire management decisions, actions, and outcomes (Marques et al., 2017). These elements form the basis of risk management. In addition, the following elements are evaluated: sufficient consideration of uncertainty, commitment to generating and using the most appropriate knowledge available, transitioning from reactive to proactive responses, and facilitating continuous improvement through organizational learning. Risk management entails proactively addressing decisions that individuals or organizations may encounter in the future, and monitoring and providing feedback to improve future decisions. Although it is known that there are problems in the operationalization of risk management, its integration and adoption are promoted in the decision-making process in WFM (Thompson et al., 2016).

Pacheco et al. (2015) highlight the importance of integration between risk management and DSS development to facilitate and improve the quality of decisions under uncertainty and to ensure harmonious fire management in an uncertain environment. Calkin et al. (2011) reviewed three risk-based decision support tools developed for WFM in the US, while similar risk-based approaches have been developed in other countries (Chuvieco et al., 2010). There is a need to consider a wide variety of approaches, including enhanced communication with communities for risk- based approaches (Dombeck et al., 2004). Calkin et al. (2011) emphasize that resources and opportunities are provided to develop risk-based decision support systems and that managers should develop their skills to use them.

Leveraging technologies such as automated resource monitoring and machine learning algorithms can help bridge the gaps between monitoring, learning, and data-driven decision making in WFM (Plucinski, 2019). Thompson et al. (2019) state that to take full advantage of its analytical potential, organizations need to accelerate cultural shifts that develop a stronger appreciation for data-driven decision

processes and develop informed skeptics who effectively balance both reasoning and analysis in decision making. Marques et al. (2017) state that the Pareto frontier, a posteriori multi-criteria decision method, can be used to support the integration of wildfire risk into multi-purpose forest management planning contexts.

The main purpose of this study is to explore how the development of the CBIFM's understanding of how local people participate in forest fire management and its evolution across different situations and regions. The study also aims to assess the progression of the decision-making processes regarding this issue.

2. Materials and methods

In this study, a systematic literature review was conducted based on the subject and research objectives. Systematic reviews are specified as a rigorous and transparent form of literature review that involve identifying, synthesizing, and evaluating all available quantitative and/or qualitative evidence to produce a robust, empirically derived answer to a focused research question (Mallett et al., 2012). This research method was chosen because it is compatible with the purposes of this study, which is to explore the latest knowledge of the principles of participation and volunteering in WFM. The systematic review guide written by Okoli (2015) was adapted for this study. Considering these guidelines, the systematic review was carried out in three stages, including (i) research questions, (ii) search strategy, and (iii) data.

2.1. Research questions

The research questions were chosen by considering the local people's participation in fire management, fire management at the intersections of wildlife and urban life, and the role of private forest owners in fire management. In this context, the research questions are as follows:

- How has the progress developed regarding local community participation in wildfire and forest fire management?
- What are the prospects for the future development of local community involvement in wildfire management?
- What solutions arise from the involvement of private forest owners in fire management?
- What fire management practices are employed in the wildland–urban interface areas and what roles do the local people play in these areas?
- How does local community participation in the wildfires contribute to the decision-making process?

2.2. Search strategy

The search string was determined in four areas, according to the research topic and purpose: Wildfire, Participation, Management and Local people. In the Wildfire domain, the "Wildfire" and "Forest fire" keywords were included, while in the participation domain, the "Participation" and "Volunteering" keywords were included. In the Local people domain, the "Local people" and "WUI" keywords were included. In the management domain, only the "Management" and "Decision making"

keywords were added to the study string. The search string was created by combining four domains—Wildfire, Participation, Management and Local people—using 'AND' in databases. Searches conducted using these keywords were made by scanning the "Abstracts" in databases. Certain pilot trials were conducted before the search string was completed, and as a result, the relevance of this search string was reached. The search sequence used in this study is as follows: (Wildfire OR Forest fire) AND (Participation OR Volunteering) AND (Management OR Decision making) AND (Local people OR WUI)

In this study, the Web of Science and EBSCO databases were chosen as search platforms to access the relevant literature. As examining the reference sections or feature-related parts allows for a "backward search" of other relevant articles, while certain resources, such as Google Scholar and the ISI Citation Index, allow a "forward search" to find all cited articles that authors may find particularly relevant (Okoli, 2015), a "hand search" was employed to access the relevant literature, as well as the relevant databases in the study. Searches were made between 7 July 2022 and 20 July 2022 in order to access suitable studies for the subject.

Specific inclusion criteria were established in this review to identify the relevant literature. As the principle of participation in forestry was discussed in detail at the Rio conference, studies made before 1992 were not included in this study (The Rio Conventions, 2017). Table 1 presents the inclusion criteria applied in this review.

2.3. Data

In this study, a total of 61 records were accessed before the criteria for the relevant subject was applied. Figure 2 shows the data definition flowchart based on the PRISMA 2020 guidelines (Page et al., 2021). As shown in Figure 2, the search result was processed through identification, screening, and inclusion. In this study, a total of 20 academic papers were included as a data set for data extraction, analysis, and synthesis.

The information categories extracted from the studies selected for content analysis are as follows:
- Whether the WUI was mentioned;
- Contribution to the decision-making process;
- Forestry type (public or private);
- Main suggestion to mitigate wildfire hazards risk;
- Main obstacle for participatory wildfire management;
- Research method of the study;
- Whether the prescribed burning was mentioned.

If there was no information about the sections in the information category in the selected studies, "None" was written in the category section to state that the information was not included.

Table 1. Inclusion criteria for studies

Categories	Inclusion criteria
Language	English
Publication year	Not earlier than 1992
Availability	Full text available
Source type	Published publications
Subject/Content	Related to topic of Wildfire management
Context	Participation
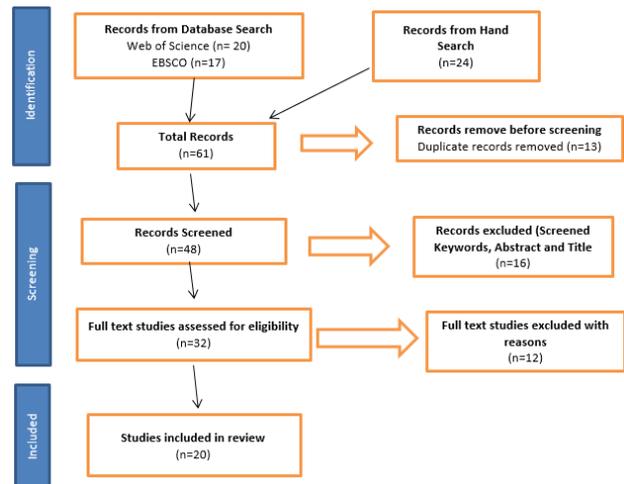
Figure 2. PRISMA diagram documenting study selection.

3. Results

A total of 20 records were found suitable for the study. Table 2 shows the percentage distribution of the records deemed suitable for the research according to the created titles.

3.1. Fire policy and participation

Aguilar and Montiel (2011) state that one of the main weaknesses in wildfire management is the lack of meaningful stakeholder participation. The articles relevant to this topic examine the problems encountered in fire policy regarding the functioning of the participation principle and their proposed solutions. It has been determined that conscious citizen participation in policy making is beneficial to management. Table 3 shows the data from a selection of studies on community participation in fire policy.

Whereas Marta-Costa et al. (2016) discuss this situation in the Portuguese locale, Aguilar and Montiel (2011) offer a broader perspective by including every country in Southern Europe in the discussion. Marta-Costa et al. explain the difficulties caused by the heterogeneous structure of the participating groups and assert that a homogeneous community participation will be more effective. Aguilar and Montiel, on the other hand, describe fire as an ancient method used by locals involved forest fire management and mention the benefits of this method.

3.2. Fuel management

The results of the studies focusing on fuel management (Table 4) indicate that the concept of the zero-burn area is essential and that fuel management can reduce the risk of wildfire. According to Ferster et al. (2013), improving forest fuel management is important for reducing the threat of wildfire in local communities. In order to provide this benefit, studies were carried out on people both living in the region and those with forest assets.

Table 2. Distribution of records by related titles

Studies	Number	Ratio (%)
Hazard mitigation	6	30
Traditional fire knowledge	5	25
Fuel management	2	10
Resource management	5	25
Fire policy and participation	2	10

Table 3. Data from the included records on fire policy and participation

Studies	Mentioned WUI	Contribution to decision making process	Forestry type	Suggestion to mitigate hazards risk	Obstacle for participatory wildfire management	Research method	Mentioned Prescribed burning
Aguilar and Montiel (2011)	None	Understanding different interests	Public and Private	Using fire (Prescribed burning, suppression of fire)	Political process	Literature review	Yes
Marta-Costa et al. (2016)	None	Providing different perceptions that complement the political and economic approaches to specific problems with the participation of the local people.	Public and Private	Public awareness, Social acceptance of hazards, Constituting responsibility for public	Inadequate education policy for the people of the region.	Survey method and Workshop	None

Table 4. Data from the included records on fuel management

Studies	Mentioned WUI	Contribution to decision making process	Forestry type	Suggestion to mitigate hazards risk	Obstacle for participatory wildfire management	Research method	Mentioned Prescribed burning
Santos et al. (2021)	None	Willingness to Accept (WTA) variability for fuel loads enable to take decisions	Private	Informing the design of more cost-effective policies to reduce wildfire hazard and risk through fuel management by owners	Small share of benefits for forest owners	Face-to-face survey	None
Ferster et al. (2013)	Yes	Providing people with the ability to gather information about forest structure from the ground and from a human perspective	Public and Private	Public participation in scientific	Funding, time, and availability of personnel	The Forest Fuels Measurement Application, Paper-based questionnaire	None

While Santos et al. (2021) conducted a study to increase the willingness of forest owners in fuel management and enable more cost-effective policies, Ferster et al. (2013) collected information to facilitate fuel management by using both local people and forest owners. Through the participants' responses to the questionnaires, Ferster et al. (2013) also assessed the relevance of the participants' demographics and experience to their awareness, knowledge, and planned behavior when encountering wildfires.

3.3. Hazard mitigation

The solutions to minimizing the risk of wildfire and reducing the hazards caused by these fires are described in this section. Extensive studies were carried out in WUI areas to find solutions to the loss of life and property caused by fires, and the involvement of the local people in fire management was determined the most important element when attempting to solve these problems (Bihari and Ryan, 2012; Ghasemi et al., 2020). In future studies, it is strongly recommended that the people of the region, together with the managers, work with a common consciousness and that the risk awareness of the people of the region be increased by the managers (McGee, 2011; Reams et al., 2005; Tedim et al., 2016). Table 5 shows data from existing articles on hazard mitigation.

While Fischer et al. (2016a) state that socio-ecological pathology, which is one of the most important factors that creates the risk of fire, is ignored and mention the necessity of making political breakthroughs in this regard, Tedim et al. (2016) point out the necessity of applying the risk reduction approach to the whole region, not only to selected or privileged parts of the region, from a holistic perspective. McGee's (2011) perspective differs from other studies in that wildfire reduction programs that involve local residents build community resilience and improve relationships between residents and government agencies. On the other hand, Ghasemi et al. (2020) highlight that the concept of trust plays an important role in perceived action effectiveness and risk beliefs among local people. Bihari and Ryan (2012) state that social capital is one of the key factors facilitating risk reduction. Moreover, they highlight the role of experience with wildfires and place attachment in positively influencing social capital and the adoption of preparedness measures. Unlike other studies, Reams et al. (2005) also reveal program managers' perceptions of what their most effective programs are for creating defensible space.

Table 5. Data from the included records on hazard mitigation

References	Mentioned WUI	Contribution to decision making process	Forestry type	Suggestion to mitigate hazards risk	Obstacle for participatory wildfire management	Research method	Mentioned Prescribed burning
Reams et al. (2005)	Yes	Systematically examining the current situation and local efforts	Public and Private	Developing effective programs for risk awareness and local people education	Insufficient program funding and negative public attitudes	Survey method	None
Bihari and Ryan (2012)	Yes	Wildfire preparedness of local community	Public and Private	To increase positive relationship between social capital and wildfire preparedness	To promote prevention among new residents who have not experienced a devastating wildfire before	Survey method	Yes
Ghasemi et al. (2020)	Yes	Trust, past experience, and home attachment factors to better predict homeowners' decisions.	Public and Private	To increase perceived wildfire risk for building resilience to the threat of wildfire	Homeowners' lack of wildfire experience	Survey method and ArcGIS	None
McGee (2011)	None	Communication between neighbors and between neighbors and government agencies	Public and Private	To increase participation by strengthening the relations of state institutions with the people of the region	Existing shortcomings in the forest fire risk reduction policy	Case studies	None
Tedim et al. (2016)	None	Understanding the relationships between human systems and fire	Public and Private	Comprehensive effort to economically reduce fire hazard on a territorial scale	Problems in political acceptance of active participation and deficient collaboration among stakeholders	SWOT analyses	None
Fischer et al. (2016)	None	An understanding of the complex interplay between social and ecological conditions and processes.	Public and Private	A fire-adapted governance system that brings together a wide variety of human actors in social networks and planning processes that encourage complex thinking about the future	Inadequacies in the policy aimed at ensuring participation	Network analyses	Yes

3.4. Resource management

Academic studies are carried out to develop the understanding of prevention rather than extinguishing in fire management by ensuring the effective use of resources. In this context, the application of the principle of participation in resource management in forest fire management, along with a set of proposed solutions, is presented to the reader under this title. Table 6 shows data taken from articles on resource management.

Among the studies under this title, while Ni'mah et al. (2018) describe what kind of contributions will be made in the fight against wildfires by increasing ecotourism activities, Dube (2013) differs from other studies in their mention of building trust and respectability among communities by granting a legal right to incineration for land use needs. While Patrão (2014) reveals the legal framework of forest fire management in Portugal on the subject, in Nyongesa and Vacik's (2018, 2019) studies, which were conducted locally in Kenya, the researchers offer recommendations for further policy options that consider forest health, productivity, and socio-economic values for improving people's livelihoods, in addition to collecting data on local people's perceptions and traditional ecological knowledge.

3.5. Traditional fire knowledge

Many studies have concluded that the search for a solution to forest fires requires a new method that goes beyond face-to-face firefighting. In countries with fire-prone ecosystems, they have recognized the need to engage with the different perspectives of prescribed burning and the practices of local communities. Further, a number of studies have mentioned that burning traditions are indispensable to their livelihoods, regional administration, and cultural expression. For these reasons, in some countries, indigenous peoples are key partners in developing fire policies and responses (Mistry et al., 2019; Welch and Coimbra Jr., 2021). In this study, the author discusses the fire experiences of local people and their knowledge of firefighting, which has developed accordingly in WFM under the perspective of participation. Table 7 shows data from articles on traditional fire knowledge.

While Welch and Coimbra Jr. (2021) also discuss the burning actions of the local people at the center of human rights, Lineal and Laituri (2013) touch upon the concept of trust, stating that the complex framework of inter-agency cooperation is essential for effective information sharing and communication. Further, Devisscher et al. (2019) and Mistry et al. (2019) mention the development of bottom-up strategies focused on merging TFK (Traditional Fire Knowledge) and SEK (Scientific Ecological Knowledge). Devisscher et al. (2019) conducted their studies in Bolivia, while Mistry et al. (2019) conducted their studies in Brazil. Khatun et al.'s (2017) study is a participatory REDD+ project effort that combines forest management efforts with a fire management plan, which differs from other studies in that regard.

Table 6. Data from the included records on resource management

References	Mentioned WUI	Contribution to decision making process	Forestry type	Suggestion to mitigate hazards risk	Obstacle for participatory wildfire management	Research method	Mentioned Prescribed burning
Ni'mah et al. (2018)	None	Providing information about local wisdom in fighting wildfires	Public	Developing an ecotourism management approach for the region	MPA (Masyarakat Peduli Api) membership is voluntary and has no direct financial benefits	Literature review, Expert determination, SWOT analyses	Yes
Nyongesa and Vacik (2019)	None	Implementing O&C (Objectives and Criteria) assessments reduces the knowledge gap between decision makers	Public	Improvement of community livelihoods	Participants have difficulty expressing their preferences regarding management strategies, the importance of objectives, and criteria	Expert determination, Focus group discussion, AHP	Yes
Nyongesa and Vacik (2018)	None	Understanding local people's perceptions and traditional ecological knowledge	Public	Ecotourism, Prescribed burning	Financial, educational, equipment, and motivational deficiencies	Focus group discussion and Survey method	Yes
Patrão (2014)	None	Revealing the incompatibility between the legislative framework and the perspective of decision makers in the intervention of burning areas	Public and Private	Implementation of collaborative wildfire management framework with local communities	System stuck in a top-down management approach	Literature review	None
Dube (2013)	None	Understanding the social behaviors that trigger fires and incorporating them into fire management	Public	Prescribed burning, Fuel management, Motivating the active participation of communities and building the necessary administrative skills	A top-down fire management approach that tends to put out fires, State-centered, excluding local communities	Systematic Literature review	Yes

Table 7. Data from the included records on traditional fire knowledge

References	Mentioned WUI	Contribution to decision making process	Forestry type	Suggestion to mitigate hazards risk	Obstacle for participatory wildfire management	Research method	Mentioned Prescribed burning
Welch and Coimbra Jr. (2021)	None	Taking benefit indigenous fire knowledge system	Private	Traditional burning practices	Structural challenges and opposing viewpoints on traditional burning activities	Case study	Yes
Lineal and Laituri (2013)	None	Gaining information from local people about their traditional fire experiences and their interest from forest	Public and Private	Cessation of agricultural occupation of forest lands and uncontrolled agricultural burn	Lack of trust of local people to institutions	Case study	Yes
Devisscher et al. (2019)	None	Obtaining local people's different forms of information about wildfires	Public and Private	Bottom-up strategies combining TFK (Traditional Fire Knowledge) and SEK (Scientific Ecological Knowledge), a more participatory fire risk management system	Weak integration of Traditional Fire Knowledge (TFK) into contemporary risk strategies	Case study, interview, Focus group discussion	Yes
Khatun et al. (2017)	None	Gathering detailed information on local livelihoods and village policies	Public	Increasing staff and resources, raising awareness and training	Hegemony of stronger stakeholders	Semi-structured interview	Yes
Mistry et al. (2019)	None	Indigenous and traditional perspectives and practices of fire management	Public and Private	Bridging local, technical and scientific understandings of fire and its governance	Focusing on firefighting techniques	Literature review	Yes

4. Discussion

When reviewing the previous studies, there is a clear need for a new understanding of wildfires instead of the extinguishing firefight paradigm (McGee, 2011; Nyongesa and Vacik, 2019). Hence, the necessity of adopting a bottom-up WFM approach with the participation of local stakeholders in fire management is explained as an important breakthrough in every study reviewed (Dube, 2013; Patrão, 2014). Among these stakeholders, it is stated that the community that suffers the most from forest fires is the local people living in the region who own the forests, and it is emphasized that these groups should play an active role in forest fire management (Lineal and Laituri, 2013; Welch and Coimbra Jr., 2021).

The political problems related to the participation of local communities regarding fire management are discussed (Aguilar and Montiel, 2011; Marta-Costa et al., 2016). In order for participation to be truly effective, it is stated that an education policy and awareness of the importance of knowledge are necessary for the studies under this heading. However, Marta Costa et al. (2016) assert that the revival of old and wise yet abandoned fire practices, which have traditionally been in the hands of rural communities, should also be included in these policies. When the studies under this title are reviewed, the literature could not be enriched by examining the legal rights of the people living in the fire areas. This situation is important for the policies created or considered regarding fire management.

A significant legal study on the subject recently took place in Turkey, where state forestry is widespread. The understanding of participation, which is based on the fact that protecting the forest is a civic duty, was changed in 2018 with the introduction of law no. 7139. As of this year, the fire-extinguishing obligation of the people living in the fire area was changed on a voluntary basis. In this way, not only do people living in the region become obliged participants, but also those who wish to participate as volunteers. However, this situation causes problems in the implementation of the principle of participation in the fight against wildfires. First of all, the Regional Directorates of Forestry, which have a fire-extinguishing obligation, face the problem of not being able to recruit sufficient personnel. In addition, the fact that those willing to participate in the fire fight on a voluntary basis represent a heterogeneous mass from various backgrounds, often outside the region, creates adaptation issues (Ok et al., 2018).

Under another title, "Fuel Management", two studies are discussed. These studies are aimed at collecting information about the region for fuel management. While Santos et al. (2021) collected economy-based information to understand the willingness of forest owners to pay for fuel management, Ferster et al. (2013) aimed to measure forest fuel data by enabling the people living in the region to take an active role in management. The fact that the studies under this title mainly focus on information collection is seen as a shortcoming as the result of the involvement of the local population in the removal of substances from the field for fuel management remains underexplored. For example, there is a gap within the scope of the participation principle concerning the benefits that grazing activities will bring to

fuel management and what kind of problems this practice brings (Tolunay and Özmiş, 2022).

There are six studies under the title of "Hazard Mitigation". In all studies, it is emphasized that a collaborative approach should be adopted with local communities in order to minimize the destruction caused by fires. Fischer et al. (2016a) point out that even with a clear understanding of wildfire pathology and possible solutions, governance and management systems will evolve gradually and in flawed ways. Similarly, Tedim et al. (2016) state that new ways of governance are needed in a situation where, from a passive expectation in fire management, local communities gradually become autonomous actors of bottom-up initiatives in terms of prevention, preparedness, and rapid suppression. Fischer et al. (2016a) also explained that although we have a good understanding of fire pathology, there may be resistance to changes in and the development of future systems. Reams et al. (2005), on the other hand, assert that minimizing the risk of fire is the most important solution proposal. However, in today's world, a management approach toward the least fire risk understanding is insufficient for hazard mitigation. Unlike other studies, Ghasemi et al. (2020) focus on issues that increase community engagement in hazard mitigation. In this context, Ghasemi et al. (2020) conclude that the concepts of home attachment, past experience, and trust for fire institutions are key concepts. Similarly, Bihari and Ryan (2012) state that the concepts of place attachment and past experience increase the interest of the local people in the issue of hazard mitigation. Also, Mcgee (2011) determined that local people consider past experience, agency involvement and personal and family protection as major reasons to participate in the hazard mitigation process. Further, Bihari and Ryan (2012) explain that the only way to ensure direct public participation in hazard mitigation is through the community planning process. Fischer et al. (2016a) and Mcgee (2011) also mention that the community planning process is the only way to ensure public participation. Studies generally indicate the local community's motivation to work on hazard mitigation. However, the factors that make the people of the region reluctant to participate are not mentioned. The kinds of problems encountered by local people in the wildfire areas while participating in hazard reduction activities due to the lack of trust in public institutions is another topic worthy of discussion.

Another title is "Resource Management", which comprises a total of five studies. Each of the studies agrees on the need to enhance the role of the community in land resource management in rural areas to improve fire management. Furthermore, researchers agree that a method should be established that considers the interests of the local people in resource management for wildfires. Some of the studies discuss the importance of establishing and developing the necessary legal frameworks for resource management (Nyongesa and Vacik, 2018; Dube, 2013; Patrao, 2014). Of these studies, Nyongesa and Vacik (2018) and Dube (2013) advocate the legal right of the local people to incineration for their legitimate land use needs. It is noteworthy that these two studies are located in the African continent (Kenya and Botswana). Patrao (2014), on the other hand, highlights some of the barriers faced by

professionals and other stakeholders in implementing a more collaborative wildfire management framework within the legal framework of wildfire management in Portugal. Nyongesa and Vacik (2019) provide recommendations for fire management policy options that consider the improvement of people's livelihoods as a key requirement in resource management. Ni'mah et al. (2018), on the other hand, recommend increasing community participation in order to prevent the occurrence of wildfires instead of preventing forest fires by increasing ecotourism activities in the region. While several studies have attempted to increase the participation of local people in resource management by focusing on local socio-economic values, it is concluded that this is done without discussing the limits and balance of policies and legal rights on a local, regional, and global scale. In terms of studies, this appears to be a shortcoming.

The "Traditional Fire Knowledge" title comprises a total of five studies. All the studies under this heading emphasize the importance of the benefits of traditional combustion methods. In their work, Devischer et al. (2019) and Welch and Coimbra Jr. (2021) state the necessity of making use of the burning practices of the local people, and have even left this process to the local people in firefighting in some regions. On the other hand, Khatun et al. (2017) also evaluated the damage caused by the carbon emissions resulting from the practices of the region's inhabitants, including practices related to hunting. Lineal and Lauturi (2013) and Mistry et al. (2019) state that natural resource managers should take an active role in developing the personal skills of local people in these fire practices, managing resources, and identifying problems that may hinder the management planning process. While the studies mention that the traditional fire knowledge the local people possess significantly contributes to the development of effective fire-fighting practices, the precise methods are yet to be explored. Hence, it is necessary to conduct detailed research on the evolutionary fire-fighting practices developed by the inhabitants of these regions and to make recommendations based on this.

5. Conclusion

This study discussed the impact of the local people's participation in WFM on the decision-making process. It is obvious that a new paradigm is needed in the fight against wildfires due to the changing ecological and social regimes of people caused by climate change and global warming. Therefore, this study recommends that the IFM method replace direct fire-fighting methods. As IFM combines ecological, political, social, anthropological and legal principles, it has crucial advantages as a fire-fighting method. Another concept under IFM, CBIFM planning, is a participatory approach to fire management that involves local communities, civil society, development organizations, and government officials with the aim to achieve ecological and socio-economic sustainability. Local community participation in WFM is examined under this planning title. This study concluded that this approach is not a choice but a necessity in order to produce fast and effective solutions to the problems caused by wildfires. In terms of cost efficiency, aircraft, helicopter, fuel, and personnel costs in direct firefighting have the potential to be minimized thanks to this approach.

Fast diagnosis and early intervention are important factors in neutralizing wildfires. For this reason, people who live in WUI areas or have assets in the region aim to accrue the least damage possible when extinguishing fires in order to protect both their assets and their families. This illuminates how critical the participation of the local community is to ensure early detection and first response. In addition, some indigenous communities living in fire areas have developed some methods to minimize this damage throughout their history. It is thought that these methods will be useful, but in order for these methods to be applied in a controlled manner, they should be carried out together with forestry organizations. In particular, the prescribed burning method is highly beneficial in terms of eliminating fuel loads in the region before fire times. However, if it is not applied in a controlled manner, other fires can emerge, causing further disruptions to social life in the region.

Another issue that needs to be addressed is the expectations of local people from forest areas. In some regions, the people in the region only live their lives intertwined with nature, while in others, the public sees the forest as a source of income. For this reason, decision makers need to measure people's perceptions about the region, and they must take this into account when choosing the most effective method to apply. Furthermore, local people contribute significantly to the data collection process in the region. The collection of local people's perceptions of the region, as well as their knowledge about the region, is also important in establishing the right fire management mechanism.

Further, another issue is to increase local people's knowledge of risk management. This can aid the prevention of fires that may occur due to the attitudes of people in the region, and it also enables them to approach the region with a more protective attitude against external elements. After the training and educational processes, the place attachment of the local people is channeled to fire-fighting. In order for these processes to work beneficially, it is necessary to ensure the trust of the society.

In some regions, local people want to participate in the direct fight against wildfires. However, the fact that they do not have adequate training in the fight against wildfires causes them to endanger their own lives and to interrupt the work of the firefighting teams. The training given to the groups who want to join the fight directly in the region before the wildfire period starts is a part of this study.

Even if the said benefits are obtained with the participation of local people in WFM, it is observed that there are situations that cause disruptions in the functioning of this management. The most important of these problems are the difficulties experienced in creating appropriate policies due to the unique nature of each region and people's distrust of institutions. Besides, the fact that the top-down management approach is still accepted poses another issue. Moreover, the lack of adequate funding, constant change of the people in the touristic areas, and low-risk awareness of the people in some regions, due to a lack of fire experience, are additional problems. Some of the income-generation activities of the people of the region are in conflict with the fire-fighting activities (hunting, agriculture). The negative attitudes of some groups engaged in these activities are also of concern. Furthermore, the lack of active participation of local people in WFM presents an additional challenge for the CBIFM approach.

6. Suggestions

First of all, it is necessary to adopt regional policies instead of centralized policies by accepting that each region has its own characteristics and to provide a more efficient bottom-up management approach. The creation of applications based on information technologies will facilitate the operation of the system in order to collect information from local people about both the region and their firefighting experiences.

After the literature review, it is seen that only a few studies on the direct participation of forest owners in wildfire management. There is a need for more studies on this subject. Further, few studies on the subject have focused on the continents of Australia and Asia, where wildfires are prevalent, and it is recommended that more studies be done in these regions.

The existing studies mention that fire management should be formed by considering the socio-economic values of the people of the region; however, sufficient suggestions are not offered for the creation of fire-related jobs for the people of the region. Business areas such as extinguishing, surveillance, and village guards are beneficial in terms of ensuring the economic development of the people of the region.

WUI interaction is not mentioned in any of the studies on resource management and traditional fire knowledge. In particular, the necessity of studies in which the concepts of resource management and WUI are combined is advocated. Further, there were no suggestions considering the public-civil balance in studies for establishing or improving equipment, organization, etc. There is a need to improve in these subjects for effective wildfire management.

Controlled grazing is not discussed in the studies within the scope of local community participation in wildfire management. It is also known that these practices cannot be implemented successfully due to a lack of trust in the public institutions. Controlled grazing is beneficial in terms of fuel management in wildfire management and is a topic worthy of further investigation.

Studies are carried out in countries where private forestry is intense. In countries like Turkey, where private forestry does not exist, there is a research gap regarding how the participation of local people in wildfire management progresses. In order to facilitate the communication of decision makers with the people of the region, additional training on the subject is also recommended.

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