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Stakeholders' participation in decreasing wildfire risk in the context of natural resource management in the Podpoľanie region of Slovakia

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Abstract

Key Message As the number and extent of wildfires are increasing due to climate change and human impacts, the demand for effective risk reduction strategies is growing. Due to limited resources or management capabilities in Slovakia, appropriate multistakeholder participation could help decrease the risk of wildfires while continuing to implement the principles of sustainable forest management. Thus, we recommend improving relationships with responsible stakeholders and increasing their knowledge.

Context Although the frequency of wildfires has declined in Slovakia, the total burned area per year and the average burned area per fire have increased rapidly, mainly due to traditional land management and increasing numbers of natural disasters resulting from climate change.

Aim The objective of this study is to assess the participation and management of stakeholders in the region of Podpoľanie, which is the region of Slovakia that is most prone to wildfires. In particular, this study investigates the questions of who is accountable, in what networks, and with regard to what issues with the goal of enhancing efforts to combat wildfires.

Methods This single-country case study features an exploratory sequential mixed-methods design. While stakeholders' participation was explored via face-to-face interviews and interest-influence matrices, stakeholders' prioritization was assessed via an online survey and the quantitative mapping of stakeholders' involvement, power, interest, and knowledge.

Results We separately identified primary stakeholders (e.g., fire departments and state-owned forest enterprises) and secondary stakeholders (e.g., municipalities and community members). Tasks related to efforts to combat wildfires were largely in compliance with legal regulations and other mandates. Nonetheless, some stakeholders (e.g., governmental organizations involved in nature protection or nonstate forest owners and the associated enterprises) lacked the knowledge, experience, or responsibility necessary to perform these tasks.

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This article is part of the topical collection on "Socio-ecological conflicts in forest management: risks of (not) adapting ?"

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Conclusion These stakeholders should be informed and monitored closely to achieve outcomes that can benefit a variety of stakeholders. We recommend a plan that involves improving the relationships among primary and secondary stakeholders, increasing their knowledge, and promoting effective participation to decrease the risk of wildfires in the region.

Keywords Participation, Stakeholder analysis, Wildfire risk management

1 Introduction

European forests and the forestry value chain play important strategic roles in efforts to mitigate and adapt to climate change. However, the rapid rate of climate change may overwhelm the natural ability of forest ecosystems to adapt because the frequency and severity of climate and weather extremes lead to unprecedented events, such as wildfires. As wildfires depend on many factors (e.g., climate, vegetation, topography, forest management practices, and the socioeconomic context), responding to these events correctly and in in a timely manner is difficult (Abatzoglou and Williams 2016; Harvey 2016; Moritz et al. 2014; Tedim et al. 2016). For instance, complex social-ecological systems complicate effective landscape-level fuel treatment planning and implementation, especially in protected areas (e.g., Thompson et al. 2017; Lecina-Diaz et al. 2023). Additionally, the increasing probability and severity of wildfires threaten the resources available to firefighters and the corresponding management capabilities (Reed et al. 2009; Tedim et al. 2016). The effort to combat wildfires under these conditions requires not only up-to-date technologies and firefighting resources but also the expertise and assistance of various stakeholders. Accordingly, multistakeholder participation could help decrease the risk associated with natural resource management and mitigate potential conflicts among stakeholders (Grimble et al. 1995; Stringer et al. 2006; Reed 2008).

Stakeholder participation is defined as a situation in which individuals or groups choose to play an active role in making decisions that affect them (in sensu Freeman 1984). A range of activities could be viewed as participation (e.g., Arnstein 1969; Fung 2006; Dietz and Stern 2008). For the purposes of comparison, Dietz and Stern (2008:14) characterized stakeholder participation in terms of five dimensions: the stakeholders, the timing of participation, the involvement of stakeholders, the power or influence of stakeholders, and the goal of participation. The success of such participation in efforts to combat wildfires is determined by stakeholders. Thus, some doubts have been raised regarding the benefits of participation with regard to the quality of decisions, the implementation process, political manipulation, and the exacerbation of conflicts (Luyet et al. 2012; Maier et al. 2014). In this respect, it is important to address challenges associated not only with stakeholders' participation but also with the management of these stakeholders, particularly by answering the questions of who is accountable, in what networks, and for what issues; addressing these issues can help improve communication and coordination in efforts to combat wildfires (e.g., Reed et al. 2009; Champ et al. 2012; Johansson and Lidskog 2020). Prioritizing stakeholders is especially important because limitations in terms of the time and resources needed to combat wildfires strongly influence stakeholder management. As such, successful stakeholder management could improve natural resource management and even reduce potential conflicts among stakeholders (Reed 2008). In other words, the coordination of stakeholders across three phases of efforts to combat wildfires is crucial with regard to achieving the desired outcome—for instance, mitigating the risk of wildfires. To date, studies on wildfire (risk) management have focused mainly on the environmental effects of such fires without taking into account stakeholder participation in wildfire (risk) management. As only a few studies have focused on stakeholder participation in this context (e.g., Ryan and Hamin 2008; Pereira et al. 2014; Kosoe et al. 2015; Lecina-Diaz et al. 2023), a knowledge gap regarding stakeholder participation and its management in efforts to combat wildfires persists.

Within this context, the goal of this case study, which focuses on Slovakia and employs a mixed-methods design, is to assess stakeholder participation and the corresponding management across three phases of efforts to combat wildfires: (phase A) prevention and preparedness (e.g., issues pertaining to preparation and prevention before the fire), (phase B) fire detection and intervention (e.g., issues related to fire detection and intervention safety), and (phase C) forest restoration after the fire. More precisely, this study aims to address the following questions:

(1) Who is accountable in efforts to combat wildfires, and what dimensions characterize stakeholders' participation in such efforts?
(2) How do key stakeholders perceive their relationships, what types of actors work well together in efforts to combat wildfires, and what levels of knowledge do these actors exhibit with regard to wildfire risk in the context of natural resource management?

2 Methodological approach

2.1 Characteristics of the study area

Changes in climate, land use, and land management have contributed to the occurrence and impact of wildfires across Europe (Fernandez-Anez et al. 2021). Wildfires are normally addressed through fire suppression. While the frequency of wildfires in Slovakia has decreased since the 1990s, the total burned area per year and the average burned area per fire have been increasing, mainly due to increasing numbers of natural disasters resulting from climate change or issues pertaining to land management (Tuček and Majlingová 2009; Majlingová et al. 2022). Currently, the regions most affected by wildfire are located in western and central-northern Slovakia: the *Záhorie* area, the *Low and High Tatra Mountains* area, and the *Podpoľanie* region (Fig. 1). In particular, the *Podpoľanie* region demonstrates how climate change (e.g., prolonged periods of drought and frequent natural disasters), alongside traditional land management (e.g., the deliberate burning of agricultural and grassland areas close to forests), drives the occurrence of wildfires. In the past, many areas in this region have been deforested and replaced by community meadows, pastures, and fields. Traditional land management has largely been preserved due to the lack of any collectivization of agricultural land in the 1950s. In addition, the region is characterized by rural settlements and traditional land management, and it has been identified as a bearer of significant values pertaining to traditional folk culture in Slovakia (Slámová et al. 2016). At present, the *Poľana Biosphere Reserve* is located in this region; thus, the chosen region entails complex social-ecological systems in which nature and society interact.

The *Podpoľanie* region is part of the area featuring West Carpathian flora (Carpaticum occidentale); in addition, it contains the perimeter of the area featuring Precarpathian flora (Praecarpaticum) and contains the district of the Slovak Central Mountains. To the north of the region lie the Poľana mountains, which feature a volcanic structure that exhibits the best-preserved features of the original volcanic morphostructure. This region has always been rich in forests, and even today, the forest coverage accounts for approximately 45% of the area under study. However, the original species composition of the region has been altered in many places by intensive human activity. The most widespread forests are beech and fir-beech forests mixed with Norway spruce, while oak-hornbeam forests dominate the valley bottoms. Beech stands are dominant on the more-or-less open southern slopes. The entire southern part of the *Podpoľanie* region exhibits a warmer climate; therefore, some characteristic xerothermophilic species are present in this part. Generally, the region is characterized by an abundance of animal species as well as both thermophilic and mountain species. For instance, 174 species of birds and 56 species of mammals have been identified. Part of this region is subject to varying nature protection efforts (Fig. 2). The highest positions associated with the protected natural area are covered by the original mountain spruce forest, which is surrounded by a narrow belt of spruce-beech-fir forests. This area represents the southernmost occurrence of native spruce forests in the Western Carpathians (CHKO 2015). Approximately, 76% of the forested area is under state forest management (Fig. 3). Nonstate forest owners and the associated enterprises manage approximately one-quarter of the study area and are mostly members of national or regional associations of forest owners.

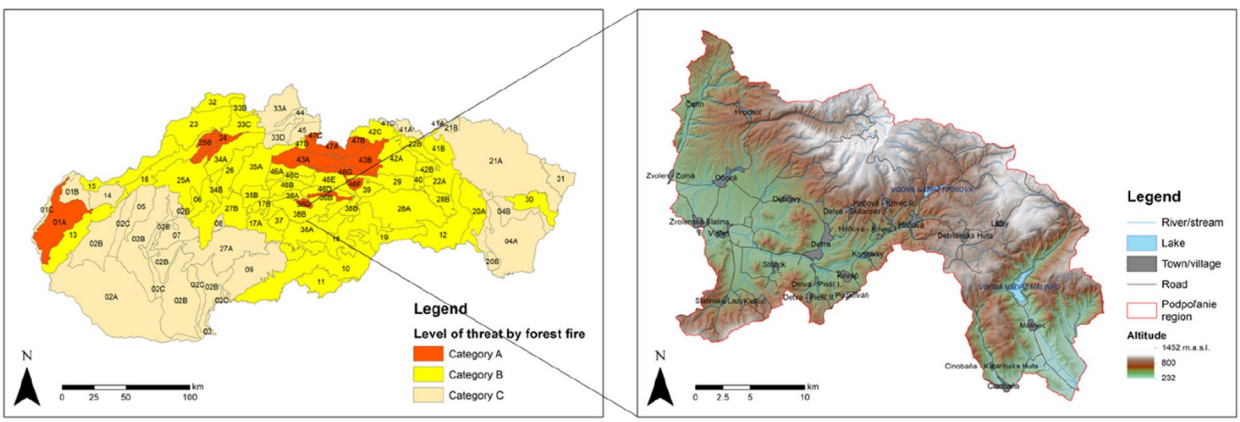

Fig. 1 The most vulnerable areas in Slovakia according to the degree of fire susceptibility (from category A—red/maximum to category C—light yellow/minimum) and localization of the *Podpoľanie* region

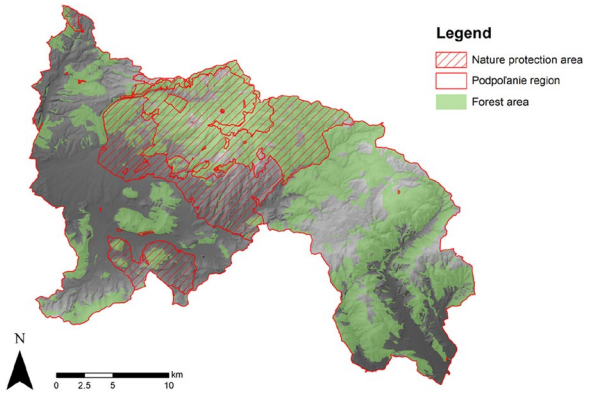

Fig. 2 Location of nature protected areas in the *Podpoľanie* region

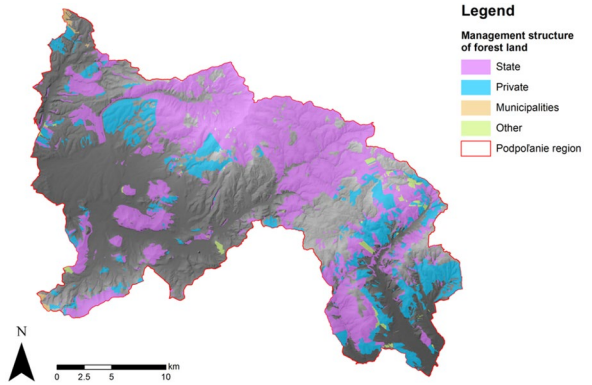

Fig. 3 Forest management structure in the *Podpoľanie* region

2.2 Stakeholder analysis

The definitions of stakeholders and their identification provided in the literature have varied (Mitchell and Lee 2019). According to stakeholder theory—a theory of organizational management that emerged in the field of strategic management—the most well-known definition of a stakeholder focuses on either an individual or a group that has a valid interest in the activities and outcomes of the firm and on whom the firm relies to achieve its goals (Freeman 1984). The [… *executives manage stakeholders, and the manner in which those stakeholders are managed influences the value a business firm creates (or destroys)*] (Freeman et al. 2018: 3). While stakeholder theory originally focused on the questions of who is the most important stakeholder and what that stakeholder's interests are (e.g., Friedman and Mildes 2004, 2006; Prell et al. 2007), the focus of such research has recently shifted toward the task of analyzing stakeholder relationships (Freeman et al. 2018). The resulting stakeholder analysis has been used widely in various fields, including natural resource (risk) management (Friedman and Miles 2006; Prell et al. 2009; Freeman et al. 2010; Rowe and Frewer 2013; Bendtsen et al. 2021).

According to Reed et al. (2009), both normative and instrumental approaches to stakeholder analysis have been proposed. As natural resource management often addresses conflicting interests among stakeholders, as these actors use the same resources (e.g., using forests for different purposes), it is crucial to understand and contribute—through stakeholder analysis (normative approach)—to the search for consensus (i.e., by promoting learning among stakeholders regarding the situation at hand) (Röling and Jiggins 1997; Rist et al. 2006). In this respect, key stakeholder participation has been described as "a democratic right to participate in environmental decision-making" (Reed 2008: 419). In contrast, using stakeholder analysis (an instrumental approach), it is possible to identify, explain, and manage stakeholders with the goal of achieving a desired outcome. Stakeholder analysis can thus allow data to be obtained from a broader range of sources, thereby providing a knowledge base that can support the development of plans and actions related to natural resource management (Olsson et al. 2004).

2.2.1 Dimensions of stakeholder participation

The first step in stakeholder analysis—the identification of stakeholders—involves determining relevant stakeholders and their systematic representation in an analysis. Such classification is essential both to improve explanations of value creation generally and to mitigate conflicts associated with natural resource (risk) management in particular. The identification of stakeholders ranges from passive consultation (e.g., two-way exchange of information) to active involvement when stakeholders influence the determination of who is included in the analysis (Reed et al. 2009; Rowe and Frewer 2013). With regard to value creation—the task of ensuring effective stakeholder participation in efforts to combat wildfires—it is crucial to be aware of key stakeholders and their classification, for instance, in terms of stakeholders' attributes such as interest or knowledge (e.g., Mitchell et al. 1997; Mitchell and Lee 2019). Thus, the aim of the second step in the process of stakeholder analysis—the categorization of stakeholders—is to sort the stakeholders relevant to the analysis in either a top-down or bottom-up manner. While in the former case, the researchers sort stakeholders into predefined categories, and in the latter case, this task could be accomplished by the stakeholders themselves (Reed et al. 2009).

In this study, passive consultation (e.g., semistructured interviews) and analytical consultation (top-down), particularly through interest-influence matrices, were used due to the explorative character of the case study.

To identify suitable informants for face-to-face interviews, the "snowball sampling" approach was used, which started with one person who appointed other people to respond (Schnell et al. 2008). This manner of selecting of stakeholders within the geographical boundaries of the *Podpoľanie* region is not random but rather deliberate. Although representativeness is a critical criterion in this context, due to limitations in terms of financial resources, the selection process resulted in nine semistructured interviews with relevant informants from the forestry, firefighting, or nature protection sectors. The focus of these face-to-face interviews was on stakeholder participation in the three phases of efforts to combat wildfires (in sensu Dietz and Sterm 2008) (Table 1).

Content analysis (Mayring 2015) was used to explore the face-to-face interviews. Most notably, stakeholder categories were created and grouped in a top-down manner into categories such as government agencies and departments, civil society organizations and community members, businesses, and industry, academia, and research (in sensu Göbels et al. 2017). The level of stakeholder involvement in the three phases of efforts to combat wildfires ranged from situations in which stakeholders were informed or consulted to participation in actual decision-making in three phases of efforts to combat wildfires (in sensu Rowe and Frewer 2013). Furthermore, stakeholders' "interest" in and "influence" over three phases of efforts to combat wildfires were determined (in sensu Reed et al. 2009; Skarlatidou et al. 2019). Interest refers to the stakeholder's level of concern regarding outcomes, and influence emphasizes the stakeholder's level of power. During this qualitative phase, the informants had no active involvement in the construction of the interest-influence matrix. More precisely, the researchers examined the levels of "interest" and "influence" exhibited by stakeholders across three phases of efforts to combat wildfires on a Likert scale (low, medium, high). This step was supported by Microsoft Excel software.

2.2.2 Stakeholder relationships

During the final step of stakeholder analysis, the relationships among stakeholders were investigated using more technical (e.g., social network analysis) or qualitative methods (e.g., actor-linkage matrices and mapping techniques) (e.g., Biggs and Matsaert 1999; Reed 2008; Geneletti 2010). In this study, mapping techniques (e.g., power-interest, power-involvement, and power-knowledge matrices) were used to obtain a deeper understanding of stakeholder relationships, thereby identifying what actors work well together as well as those with knowledge (in sensu Roeder 2013). Power was used to measure stakeholders' overall level of authority in various phases of efforts to combat wildfires. More precisely, this term referred to the stakeholder's capacity to influence the outcome. Interest referred to the stakeholder's level of concern regarding the outcome of efforts to combat wildfires. Knowledge was defined in terms of stakeholders' skill in, understanding of, or education about certain issues as a result of experience or study. Involvement referred to the degree to which stakeholders participated actively in the various phases of efforts to combat wildfires.

With regard to the online survey, a database with 122 stakeholders in efforts to combat wildfires was created in light of the geographical boundaries of the *Podpoľanie* region and the results of the qualitative phase. This approach guaranteed that the recognized category of key stakeholders was represented in the target group (Table 2). Specifically, it has been viewed as important to include all (but not excessively many) relevant stakeholders when conducting stakeholder analysis (Bendtsen et al. 2021). The aim of the online survey featuring open-ended questions was to investigate stakeholders in terms of their attributes to obtain a deeper understanding of their relationships—including by identifying individuals who work well together and those with knowledge (in sensu Roeder 2013) (Table 3). Stakeholders' perceptions of the attributes (e.g., power, interests, involvement, and knowledge) were measured on a Likert

Table 1 Dimensions of participation

Characteristics of dimensions of participation		Examples
Stakeholders	Who is participating?	Government agencies and departments, civil society and community members, public, businesses and industry, education and research
Timing of participation	When and at what points is participating?	Prevention and preparedness (phase A), fire detection and intervention (phase B), forest restoration after the wildfire (phase C)
Level of involvement	At what level is participating in phases A, B, and C?	Information, consultation, collaboration, co-decision
Goal or interests	What level of interests exists in phases A, B, and C?	High interests, medium interests, low interests, no interests
Extent of power or influence	What level of influence exists in phases A, B, and C?	High influence, medium influence, low influence, no influence

Table 2 Characteristics of stakeholder groups in the *Podpoľanie* region

Groups of stakeholders	Target group	Respondents	Position			Education		Age			
			Director	Manager/owner	Specialist/other	Higher	Secondary	−40	40–49	50–59	60 +
Government agencies and departments (forestry)	5	0	-	-	-	-	-	-	-	-	-
Government agencies and departments (firefighting)	2	1	-	1	-	1	-	-	1	-	-
Government agencies and departments (nature protection)	3	2	-	-	2	2	-	-	-	2	-
Government agencies and departments (municipality)	13	3	1	1	1	2	1	-	1	2	-
Civil society org. and community members (forestry)	9	0		-	-	-	-	-	-	-	-
Civil society org. and community members (firefighting)	12	6	4	-	2	2	4	2	-	4	-
Civil society org. and community members (other)	21	0	0	-	-	-	-	-	-	-	-
Businesses in public ownership (state-owned forest enterprise and its branches)	5	3	1	1	1	3	-	1	-	1	1
Businesses in private ownership (nonstate forest owners and the associated enterprises)	52	9	-	7	2	5	4	3	1	3	2
Total	122	24									

scale (low, medium, high) across three phases of efforts to combat wildfires. The evaluation of the results of the online survey (including 24 completed questionnaires) was performed by constructing power-interest, power-involvement, and power-knowledge matrices (in sensu Roeder 2013). The dots in simple two-by-two matrices represent the frequency of identical answers by specific stakeholder groups. The grids were used to explain relationships among the stakeholders and to prioritize the involvement of stakeholders in the three phases of efforts to combat wildfires (e.g., Durham et al. 2014; Vogler et al. 2017). This step was supported by Microsoft Excel.

3 Results

3.1 Dimensions of stakeholder participation

3.1.1 Primary stakeholders in efforts to combat wildfires

Based on the results of this mapping process, specifically with regard to the interest-influence matrices, the key stakeholders were isolated across all phases of efforts to combat wildfires (Fig. 4): state and nonstate forest owners and the associated enterprises (business and industry), the Fire and Rescue Service of the SR under the jurisdiction of the Ministry of Interior of the SR (governmental agencies and departments), and volunteer fire brigades (civil society organizations and community members). The key position and high power of *forest owners and the associated enterprises* resulted from their ownership rights and their obligations to comply with the relevant laws (Fig. 4). While these stakeholders exhibited high levels of legal responsibility, they were simultaneously interested in protecting their property. Thus, the state-owned forest enterprise was active during phase A not only due to existing laws (e.g., developing organizational maps for rescue purposes, conducting patrolling activities, providing training in fire prevention, and organizing specific firefighting resources) but also on its own initiative (e.g., supporting forest pedagogy and public awareness activities). These stakeholders also provided information, performed consultation, and engaged in close collaboration with local fire departments or volunteer fire brigades (e.g., by developing a platform for mapping the spatial distribution of water bodies, road networks and warehouses storing firefighting tools, participating in joint drills). The state-owned forest enterprise actively participated in phase B, specifically before or during the intervention (e.g., by participating in the wildfire intervention until the local fire department arrived or helping the local fire department navigate the forest). Participation in phase C was largely in compliance with relevant laws, which, for instance, required the reforestation of the deforested area within at most 2 years or 3 years in protected areas. In this respect, mainly nonstate forest owners and the associated enterprises could apply for state aid schemes aimed at supporting the restoration of forests damaged by wildfires or other natural disasters (e.g., support for sustainable forest management, soil erosion prevention, biological diversity support, and attempts to improve water management in forests). Often, nonstate forest owners' associations merely provided information and consultation activities for their members.

The patterns that characterized the distribution of stakeholder attributes (i.e., the highest interest and influence in phases A and B) indicated that *fire departments* represented their primary stakeholders (Fig. 4). In this highly structured context, their key position and power were law based. During phase A, these stakeholders reported (e.g., regarding the time of increased danger), provided (e.g., in terms of guidelines or joint drills), or controlled the implementation of methodological guidelines pertaining to (wild)fire protection in forest enterprises and municipalities. In the past, a useful fire protection camera system was installed; however, due to corruption in the context of procurement, expensive maintenance, or a lack of links to local fire departments, this system was terminated after 1 year of use. Their goal of phase B was to implement supervision and promote efforts to combat wildfires. As part of this intervention, local fire departments were often assisted by the regional branch of state-owned forest enterprise and volunteer fire brigade. In this context, room for improvement in terms of information exchange or collaboration was observed, such as by educating professional firefighters regarding how to use maps and providing technical support concerning how to export the data (e.g., exporting maps from forest management information systems into the navigation system GINA or facilitating general coordination among various applications related to the task of mapping water bodies or road networks). The involvement of national and local fire departments in phase C was largely informative and usually provided only information to support fire investigations.

The primary stakeholders who exhibited a high level of interest and a rather moderate level of influence in efforts to combat fires were *volunteer fire brigade***s**. By law, larger municipalities were required to establish a fire brigade; however, the members of such a brigade were usually individual volunteers who were highly interested in protecting their community and property. Their involvement in phase A consisted of providing information, consulting with community members, or organizing joint drills with local fire departments and forest enterprises. However, their main position in phase B was to join forces with local fire departments during the intervention and to participate in efforts to combat wildfires (Fig. 4). Often, their participation was shaped by a lack of (or only inadequate) techniques and technologies (which could, e.g.,

Table 3 Attributes of stakeholders

Characteristics of stakeholder's attributes		Examples
Power	What is the stakeholder level of authority in phases A, B, and C?	High, medium, low, no authority
Interests	What is the stakeholder level of concern regarding the phases A, B, and C outcome?	High, medium, low, no interests
Involvement	What is the stakeholder level of active involvement in the phases A, B, and C?	High, medium, low, no involvement
Knowledge	What is the stakeholder level of phases A, B, and C — specific knowledge?	High, medium, low, no knowledge

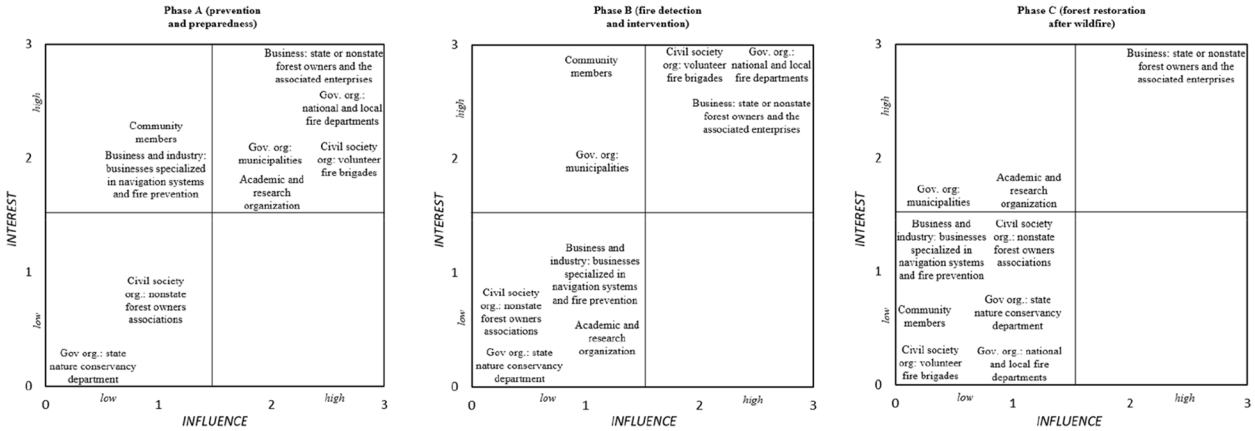

Fig. 4 Stakeholders mapping result showing stakeholders grouped by their levels of interest (*y*-axis) and influence (*x*-axis) in phase A (prevention and preparedness), in phase B (fire detection and intervention), and phase C (forest restoration after the wildfire)

hinder effective efforts to combat wildfires in large areas that had been disturbed and harmed by bark beetles) and a decreasing number of volunteers. Due to the increasing risk of wildfires and the limited (financial) resources available during phase B, a call was made for overall change in phase A.

The patterns exhibited by the distribution (low to zero interest and influence) of the *State Nature Conservancy of SR* under the jurisdiction of the Ministry of Environment of the SR suggested passive or low participation across the three phases of efforts to combat wildfires (Fig. 4). The goal of this stakeholder was justified by the law that emphasized the lack of management, intervention, and restoration in protected areas in general and in the 5th decree protection areas in particular. This situation resulted in some degree of chaos (e.g., the absence of information exchange and cooperation), as recent amendments to nature protection law required interest-influence on the part of this stakeholder in efforts to combat wildfires, especially during phases A and C. This stakeholder, which was potentially a primary stakeholder, especially in protected areas, focused on nature protection over reducing the risk of wildfires.

3.1.2 Secondary stakeholders in efforts to combat wildfires

The *municipalities* were considered to be secondary stakeholders due to their medium level of interest and particular influence in efforts to combat wildfires. The goals of the municipality during phase A focused on fire prevention and preparedness. The fulfillment of these goals involved several levels. For instance, by law, some tasks were transferred from the local fire department to the municipality (e.g., the management of municipal fire protection documentation), and some tasks were performed by the municipality itself (e.g., the creation of conditions conducive to the performance of fire protection tasks by legal entities established by the municipality, such as the fire brigade). The primary goal of their participation in phase A was to provide information to and consult with community members (e.g., through specialized seminars, preventive inspections, monitoring activities in summer months). *Community members (public)* were identified as secondary stakeholders because they exhibited a high level of interest in protecting their community and property. On the other hand, due to traditional land management methods (e.g., the use of fire for land management in spring and autumn), negligence, or, more generally, socioeconomic factors (e.g., the abandonment of agricultural land and unemployment of marginalized groups), these factors could

increase the risk of wildfires. In this respect, the question of whether fuel treatments would be effective about achieving ecological and social objectives was raised by the national fire department. While public influence was rather low in phase A (whether passively through receiving information or consultation or actively through volunteer membership in fire brigades), these stakeholders were considered to be the best source with regard to wildfire detection (Fig. 4).

Additionally, *businesses and industry* specializing in the firefighting sector were secondary stakeholders because they exhibited a high level of interest but only low a level of influence (e.g., by providing navigation systems or equipment), as they participated during phase A only by providing information, consultation, or collaboration. The patterns of the allocation of stakeholder attributes identified *academic and research organizations* as secondary stakeholders in efforts to combat wildfires (Fig. 4). Their involvement focused on providing information (e.g., research associated with wildfires) and consultation (e.g., education and training for future firefighters or foresters). Thus, their main goal in phase A was to prepare graduates for efforts to combat wildfires across all three phases. They also participated through scientific consultation or collaboration with stakeholders outside academia (e.g., by standardizing terminology and statistical monitoring of wildfires in Slovakia, mapping and quantifying wildland fuel, modeling the spread of wildfires, or designing a national wildfire warning system to provide information regarding the dangers of wildfires in real time).

3.2 Stakeholder prioritization

Specifically, in *phase* A (prevention and preparedness), national and local fire departments, volunteer fire brigades, state and nonstate forest owners and the associated enterprises, and municipalities exhibited high levels of authority and knowledge (Fig. 5, top right quadrant). These stakeholders should therefore be managed very carefully. However, some nonstate forest owners and the associated enterprises as well as municipalities and community members were either not involved, not informed or not knowledgeable in this context (Fig. 5, phase A, bottom right quadrants) for various reasons (e.g., the lack of experience, technology, or resources). As these stakeholders exhibited less authority but were nevertheless interested, they should be well informed. The low levels of involvement and knowledge that characterized the state nature conservancy department (Fig. 5, phase A, bottom left quadrants) validated similar results obtained in the qualitative research phase. In summary, as phase A is best served by knowledgeable and informed stakeholders, a high priority in terms of communication (or an increased level of knowledge) should be given not only to the participation of nonstate forest owners and the associated enterprises and the state nature conservancy department but also to the community members, as the most common reasons for the emergency of fires in the region were humans and their careless manipulation of fire.

In *phase B* (fire detection and intervention), the most crucial and knowledgeable stakeholders who must be managed carefully included fire departments and volunteer fire brigades, state and nonstate forest owners and the associated enterprises, and municipalities (Fig. 5, phase B, right upper corners). However, some nonstate forest owners and the associated enterprises and municipalities had authority but were not interested or knowledgeable; alternatively, they passed on responsibility to other stakeholders (Fig. 5, phase B, left upper corners). Therefore, these stakeholders should be monitored and assigned a high priority in terms of communication. A notable example pertains to the position of the state nature conservancy department, some nonstate forest owners and the associated enterprises, or municipalities in the left and right bottom quadrants, as shown in Fig. 5, in Phase B. These stakeholders, who exhibited low authority, should therefore be monitored or informed specifically. On the one hand, they do not have authority with regard to the intervention in phase B; however, they should have the knowledge and resources necessary to extinguish fires during the initial phase (e.g., the organization of specific firefighting resources according to the law). On the other hand, this situation is the cause or result of weak or incoherent legislation as well as, more recently, the notable support provided to ecological management despite the existing legislative amendments pertaining to fire protection. For instance, inadequate forest road work often prolongs the time required for local fire departments to reach a wildfire, thus leading to the uncontrollable spread of the fire; this situation is also exacerbated by degraded or unprocessed biotic calamities, especially in protected areas.

In *phase C* (forest restoration after wildfire), the key stakeholders that exhibited the highest levels of interest, authority, and knowledge included state and nonstate forest owners and the associated enterprises (Fig. 5, Phase C, left and right upper corners). Remarkably, in the law, fire prevention is not a criterion for the selection of restoration programs. No special requirements have been stipulated regarding forest restoration after a fire in the context of fire protection legislation or practice. Thus, a high priority in terms of communication should be given to these stakeholders. Space for improvement was found with regard to communication activities pertaining to nonstate forest owners and the associated

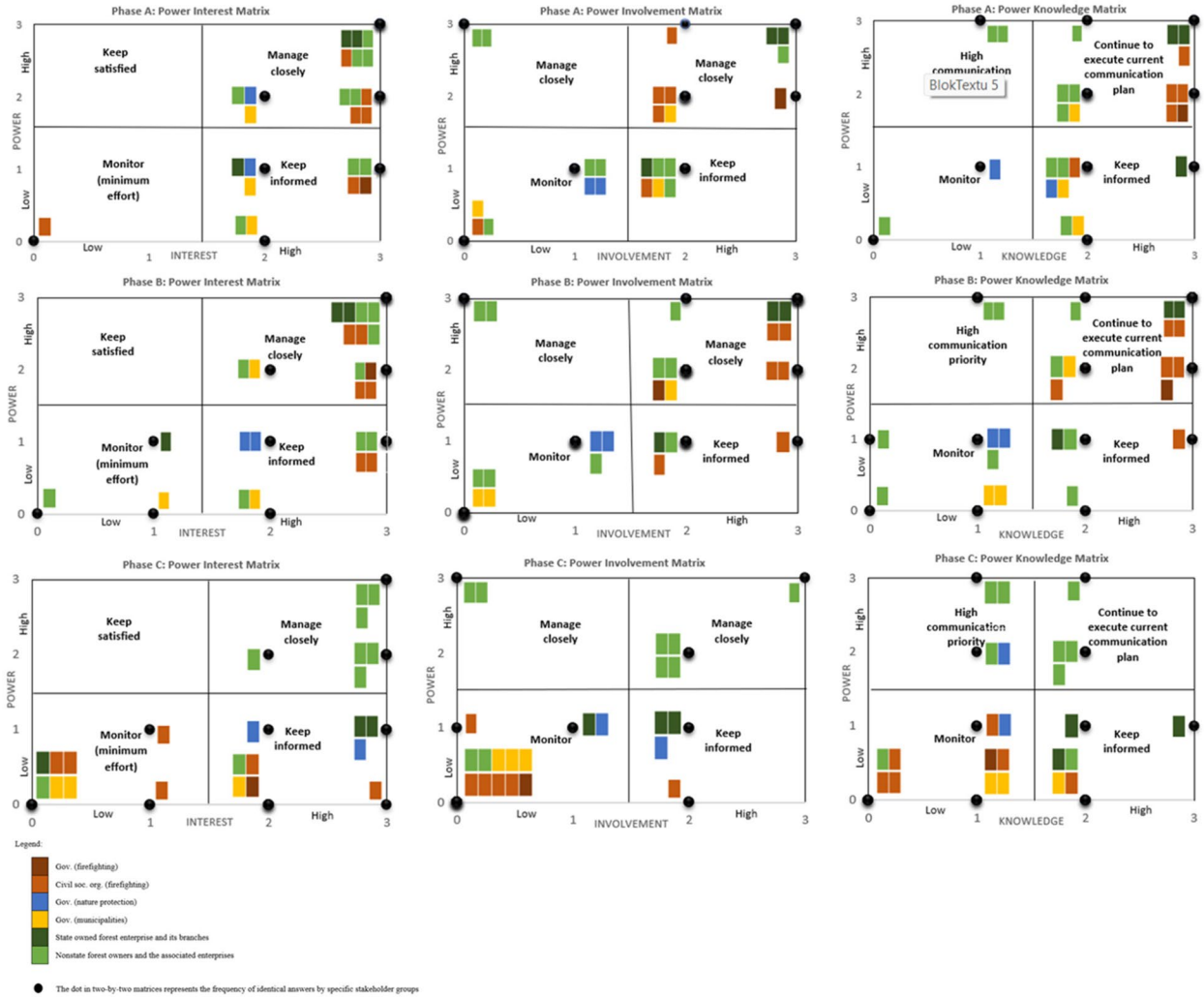

Fig. 5 Prioritizing stakeholders across all phases of efforts to combat wildfires in the *Podpoľanie* region of Slovakia

enterprises (Fig. 5, Phase C, bottom right corner). By law, the nature conservancy department was also involved in forest management activities, particularly in protected areas. However, due to low levels of interest or knowledge concerning fire prevention in restoration activities, this stakeholder must be informed and monitored closely (Fig. 5, Phase C, left bottom corners). Most commonly, other stakeholders (e.g., fire departments and volunteer fire brigades) were involved in phase C only in the context of investigations regarding the causes of a fire. In this respect, these stakeholders should only be monitored (Fig. 5, Phase C, left bottom corners).

4 Discussion

Through stakeholder analysis, the participation and management of stakeholders in efforts to combat wildfires, which can contribute to attempts to decrease the risk of wildfire in the context of natural resource management in the *Podpoľanie* region of Slovakia, were assessed. This task required a better understanding of who is included in efforts to combat wildfires, why this is the case, and who should be prioritized in this context (Luyet et al. 2012; Glucker et al. 2013). To mitigate the limitations of stakeholder analysis in general (e.g., Mitchell et al. 1997; Frooman 1999; Reed 2008; Luyet et al. 2012) and nine face-to-face interviews specifically, in this single case study on the Slovakian *Podpoľanie* region, an exploratory sequential mixed-methods design was used (in sensu Creswell and Creswell 2018).

The exploration of the views of informants during the interviews led to the identification of primary stakeholders, including state and nonstate forest owners and the associated enterprises as well as governmental and civil society firefighting organizations that exhibited high levels of interest and influence across the three phases of efforts to combat wildfires. Secondary stakeholders, who

exhibited high or medium levels of interest but low levels of influence in efforts to combat wildfires, included municipalities and community members. Moreover, some stakeholders, such as large municipalities, empowered firefighting organizations in society. In contrast, governmental organizations involved in nature protection had little or no interest in efforts to combat wildfires, although their participation was stipulated by recently adopted legislation. More precisely, while the interests and influence of the majority of primary and secondary stakeholders were shaped by legal obligations and concerns with protecting property and human lives, the interests of nature protection stakeholders were shaped mainly by considerations related to ecological management (e.g., the lack of management, forest road construction, and removal of calamities, especially in protected areas). As competence fragmentation is common in the context of natural resource (risk) management, competencies must be clearly negotiated (Kirchner et al. 2024). Therefore, a certain degree of power combined with a lack of responsibilities leads natural protection stakeholders to be described as "difficult."

The results of the online survey not only validated the prioritization of primary and secondary stakeholders; they also showed that not only fragmented responsibilities but also a lack of knowledge prevented some stakeholders (e.g., nonstate forest owners and the associated enterprises, civil society firefighting organizations, municipalities, and community members) from participating effectively in efforts to combat wildfires. This difficulty has been linked to incoherent legislation, limited financial or human resources, and limited experience in efforts to combat wildfires or forest site-specific knowledge. These "difficult" stakeholders should thus be informed and monitored closely to achieve outcomes that can benefit a variety of stakeholders in efforts to combat wildfires. This need for better knowledge or monitoring has also been highlighted in other studies (e.g., Eckerberg and Buizer 2017; Johansson and Lidskog 2020; Titko and Ristvej 2020). Moreover, the main reasons for such fires included community members and their careless treatment of fires (e.g., unmanaged or even deliberate grass burning in spring and fall); however, they were also considered to be the best sources with regard to detecting wildfires. Accordingly, questions emerged concerning either the possibility of allowing the use of forbidden grass burning or providing education regarding how to burn grass properly. Many advantages of mitigation treatments (e.g., prescribed grass burning or other fuel treatments) have been reported in the literature (McCool et al. 2006; Prestemon et al. 2012; Kalies and Yocom Kent 2016); however, in Slovakia, the implementation of planned treatments continues to face socioeconomic and institutional barriers, as in other European countries (e.g., Tedim et al. 2016).

As a result, more inclusive participation across the three phases of efforts to combat wildfires was necessary, a finding which is in line with the results of previous research (e.g., Madsen et al. 2018; Kirschner et al. 2023; 2024). In particular, calls for reforms in terms of the prevention and preparedness phases through collaboration and shared responsibility among key stakeholders were made, as most existing rules in Slovakia focus mainly on fire suppression. For instance, facilitating interaction among primary stakeholders and nature protection actors could help address the incoherence of relevant legislation and improve coordination across all phases of efforts to combat wildfires, as some positive experiences in local forestry collaboration are already in evidence (e.g., Brodrechtova 2024).

5 Conclusion

Due to ongoing climate change, attempts to decrease or even eliminate wildfire risk requires the more effective integration of relevant stakeholders into natural resource management structures in Slovakia. In this context, tasks related to efforts to combat wildfires were conducted mainly by primary (e.g., fire departments and state-owned forest enterprises) and secondary stakeholders (e.g., municipalities) in compliance with legal regulations and other mandates. Nonetheless, some stakeholders (e.g., governmental organizations involved in nature protection, nonstate forest owners and the associated enterprises, and community members) lacked the responsibility, knowledge, and experience necessary to aid efforts to combat wildfires. This situation could be linked to gaps in disaster management in Slovakia (Titko and Ristvej 2020). For instance, with the exception of duties resulting from existing legislation, no initiatives have been undertaken to improve stakeholders' participation and management with the goal of decreasing wildfire risk in the context of natural resource management. This approach is especially critical, as the financial resources or management capabilities available to firefighters are limited. An action plan that specifies how to engage "difficult" stakeholders could support effective relationships among stakeholders and the corresponding management; in addition, such a plan could raise awareness among community members and enhance their knowledge in the context of efforts to combat wildfires (e.g., McCool et al. 2006; Curnin et al. 2015; Tymstra et al. 2020). More precisely, key stakeholder participation and management could increase local responsibility and decrease the risk of wildfires by taking advantage of the potential offered by local knowledge and experience (e.g., Eckerberg and Buizer 2017; Haynes et al. 2020; Kirschner et al. 2023).

Code availability
Not applicable.

Authors' contributions
YB, conceptualization, formal analysis, investigation, methodology, supervision, writing—original draft, and writing—review and editing. AM, investigation, writing—review and editing, responsible for project administration, and funding (EU Horizon No. 101037247). RS, methodology, responsible for project administration, and funding (APVV-20–0408). The authors read and approved the final manuscript.

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Availability of data and materials
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Declarations

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Competing interests
The authors declare that they have no competing interests.

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