

Wildfire communication from municipalities to communities in Portugal: An exploratory analysis

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Abstract

Enhancing preparedness that enables people and communities to effectively anticipate, respond to, and recover from the impacts of a wildfire requires interactive communication. The purpose of this research is to understand how municipalities are communicating with communities regarding wildfires. Municipalities represent the lowest level of governance in Portugal and their responsibility for wildfire risk communication is fixed by law. In addition, this paper evaluates the influence of experience with extreme wildfires on communication processes. An online questionnaire was sent to 275 Portugal mainland municipalities (the official number of municipalities is 278, but three municipalities were not considered because they are entirely urban areas without wildland). One hundred and one municipalities participated in the survey (37% response rate). The survey identified the predominant use of one-way communication, lack of continuity of communication activities, and lack of purpose and content of the awareness-raising activities. The main difficulty municipalities encountered was the lack of interest from several target groups, which was mainly

due to them continuing to use ineffective communication and not engaging citizens in the process. Considering the contact between municipalities and their citizens, a more interactive role in the wildfire communication process by using two-way communication exchanges is advocated to enhance preparedness and avoid casualties and losses.

Keywords: *Risk communication, emergency communication, post-fire communication, Portugal, wildfire*

In 2017, Portugal experienced its most tragic wildfire season ever recorded with 117 fatalities, 116 civilians and one firefighter. Sixty-six of these were in a single event, the Pedrógão Grande fire (San-Miguel-Ayanz et al., 2020). This event with a rate of spread of 15.2 kilometres per hour and a maximum calculated intensity of about 60,000 kilowatts per metre (kWm^{-1} ; Comissão Técnica Independente [CTI], 2017) reached a Category 6 in the fire classification by Tedim et al. (2018). About 1,108 buildings burned (Viegas et al., 2017). Four months later, seven complex wildfires broke out, reaching extreme intensity values (e.g., $100,000 \text{ kWm}^{-1}$ at the Sertão fire), killing 51 people and affecting 1,712 buildings and 768 businesses (Ribeiro et al., 2020). In both fires, the high number of casualties mainly occurred when people were trying to escape by car without knowing where to go or if that was the best decision. This may have been associated with a lack of information about the characteristics of extreme wildfire behaviour (Tedim, Leone et al., 2020) and the preparedness of people to cope with such events (Johnston et al., 2019; Mackie et al., 2013; McLennan, 2014; McLennan et al., 2011, 2015). This observation highlights the importance of developing and implementing effective, targeted wildfire preparedness strategies.

Preparedness can be defined as the “knowledge and capacities developed by governments... organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters” (United Nations Office for Disaster Risk Reduction [UNDRR], 2016, p. 21). Preparedness should not be grounded in bits of information transferred from the sender to the recipient and disseminated in a unidirectional or generalist manner (Paton et al., 2008).

It requires the development of interpersonal relationships between community members and between them and the fire agencies' personnel who manage the risk communication programmes to enhance awareness and change behaviours through information exchange that takes into account local context, knowledge, values, people's needs, and specific local barriers (McCaffrey, 2015; Paton, Tedim et al., 2012). These aspects, however, may not be considered in organizational risk communication. The latter is often driven by the so-called knowledge deficit model (Arneson et al., 2017; Simis et al., 2016); agencies assume that public reticence to prepare can be ameliorated by giving them more information. While information is important, it is only one facet of the preparedness process. Others aspects include, for example, how people impose meaning on their risk and interpret their needs, with these processes then determining the information people need to make preparedness and response plans and decisions (Paton, 2022). These issues make it important to understand the information exchange process occurring between agency and community stakeholders.

Information exchange, where both sender and recipient interact in order to develop a common frame to enable locally-meaningful understanding of the wildfire problem and how to cope with it, is labelled as wildfire communication. It is a complex continuous task that should be based on an interactive process that develops the ability of the recipients to interpret and use information to formulate their responses (Paton, 2008). It should take into account the local context and provide timely, accurate, and useful information in a reliable and honest manner to diverse stakeholders. This introduces a need for those responsible for wildfire communication to build trust and credibility in a reciprocal information exchange process (Paton & Irons, 2016; Paton, Tedim et al., 2012; Rohrmann, 1992, 1998; Steelman & McCaffrey, 2013). It is also important to consider the various risk management stages in which tailored reciprocal information exchange processes are required.

Specific reciprocal wildfire communication and information exchange should be developed to cover stages occurring before, during, and after the wildfire. Each of these stages differ regarding their respective contents and goals. Before a fire outbreak, information exchange must: i) enhance risk perception and facilitate risk reduction by helping citizens avoid negligent behaviours to decrease the number of unwanted fire ignitions, informing about the legislation requirements related to fuel management in the forests and creation of a defensible space around

the houses, and enhancing citizens' preparedness to cope with wildfires of different intensities and avoid casualties, including preparedness to evacuate; and ii) keep the community informed on fire weather and fire danger ratings when any fire will likely be fast-moving and difficult or even impossible to control (Covello, 1992; Hampel, 2006; Sellnow et al., 2009). In Portugal, there is information about the fire weather index available on the Portuguese Institute for Sea and Atmosphere website (Instituto Português do Mar e da Atmosfera; IPMA) which is available at the municipal scale to all citizens, but it is not an early wildfire warning.

After a wildfire outbreak, emergency management includes a significant and important communication component for communities (Fearn-Banks, 2016; Lin et al., 2016; Reynolds & Seeger, 2005; Sellnow & Seeger, 2021), namely early warning to support people to take actions related to evacuation or to staying and defending their assets (Whittaker et al., 2017; Wilkinson et al., 2016). Post-fire communication is developed after the extinction of the fire. It is important for a good recovery (Madianou et al., 2015; Yeo et al., 2020), including for issues of social justice in accessing recovery and resilience funding programmes. Communication before, during, and after a wildfire should be considered distinct processes with different scopes of intervention, but in a continuous and integrated way (Reynolds & Seeger, 2005; Seeger, 2006).

In the National Plan of Defense of Forest Against Fires (established in 2006, Resolution of the Ministers Council no. 65/2006 and now expired), an annual National Awareness Plan of Defense of Forest Against Fires was foreseen, but it was only in 2017 that the first one appeared. It defined the following main objectives:

- i) Change attitudes, reduce risk behaviours and the number of ignitions;
- ii) Disseminate rules and good practices in forest and protected areas when crossing, visiting, and using them;
- iii) Disseminate restrictions in force during periods of high fire risk;
- iv) Increase knowledge of greater fire danger situations;
- v) Enhance citizens' relationship with forests;
- vi) Raise awareness on prevention and self-protection measures;
- vii) Contribute to the reduction of risky behaviour and to the compliance with legal norms in the practice of burning for pasture renewal; and

- viii) Raise awareness of the environmental, social, and economic value of forests.

In these annual plans, which were published only in 2017, 2018, and 2019, the enhancement of preparedness was not a priority. The municipalities, through the Technical Forestry or Municipal Civil Protection staff, are among the actors with responsibilities in the implementation of these measures. Considering the responsibilities attributed by the current legislative body (e.g., Decree-law no. 82/2021, Sistema de Gestão Integrada de Fogos Rurais no Território Continental, in Portuguese; Integrated Rural Fires Management System of Portugal Mainland, in English) to municipalities for awareness raising campaigns, the purpose of this research is to evaluate and characterize how Portuguese municipalities communicate with communities regarding wildfire risk and emergency phases and to identify whether and how recent experience with extreme wildfires events (EWE, i.e., pyro convective events that exceed the control capacity and are characterized by high intensity, high rate of spread, prolific or massive spotting activity; Tedim et al., 2018; Tedim, Leone et al., 2020) influences the municipalities' communication processes and information exchanges. The research questions are the following:

- i) Do the ways in which municipalities communicate with communities in Portugal promote information exchange required to reduce wildfire risk and enhance preparedness?
- ii) How does the recent experience of past extreme wildfire events influence and improve the risk communication process developed by the municipalities?

This research does not include the post-wildfire communication that is related to the return to normality and the start of recovery and restoration processes, which requires another type of approach not only centred in the municipalities.

Materials and Methods

The literature review did not identify survey tools that could be used to assess wildfire communication from municipalities (the lowest level of local government in Portugal) to communities. Thus, we constructed an ad hoc questionnaire based on existing scientific knowledge and adapted to the Portuguese wildfire and cultural context. The questionnaire is composed of 10 open-ended questions and 11 closed-ended questions (see Appendix 1). Simple language was used as suggested by two members of the technical staff of two municipalities

who reviewed and validated the questionnaire, which may additionally be used to assess wildfire communication from other fire agencies to citizens.

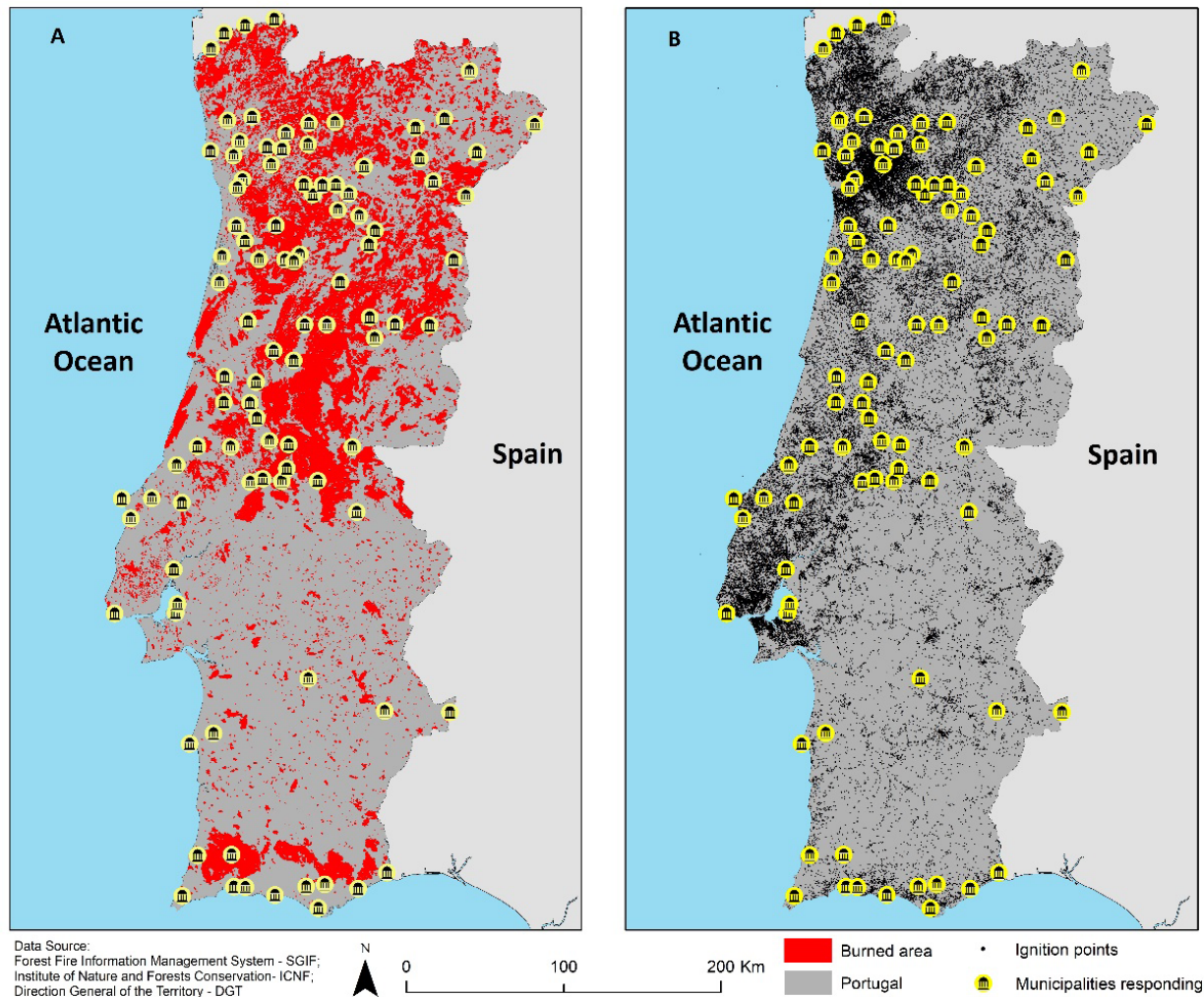
Between November 2020 and April 2021, the survey was conducted by transmitting via email the link for the online questionnaire to 275 out of the 278 municipalities existing in mainland Portugal. Municipalities are administrative units, divided into sub-administrative units, called *freguesias* (parishes). Each municipality and each *freguesia* have their own council; the *freguesias*' council responsibilities are rather reduced compared to the municipality. The municipalities of Porto, Lisbon, and São João da Madeira were excluded because they are urban areas without wildlands and therefore there are no wildfires.

Before transmitting the questionnaire, the 275 municipalities were contacted by phone to explain the goal of the research and obtain the email address of the technical staff to be contacted (often a member of the Technical Forestry Department or Civil Protection Department). Due to the initial low response rate (4%), unresponsive municipalities were re-contacted by phone as many as four times. The containment measures related to the COVID-19 pandemic may partially explain the difficulties and delay in replying to the questionnaire by municipalities. Thus, 101 responses (37% of the municipalities) were obtained, covering the most wildfire-hazardous regions of Portugal (see Figure 1). The response rate is acceptable; email response rates are commonly 25% to 30% without follow-up and reinforcements (Yun & Trumbg, 2006), and municipalities are not obligated to reply to questionnaires sent by universities or research institutions. For the survey analysis, we used basic descriptive statistics. Some quotes are presented to show the explanations of the respondents and support our interpretations.

To evaluate whether previous experience of extreme wildfires increases a municipality's focus on wildfire communication, the 101 responding municipalities were split into two groups: those with experience of extreme wildfire (27 municipalities) and those with no recent experience (74 municipalities). Responding municipalities affected by extreme wildfires were identified by taking into account the occurrence of wildfires and the area affected by them for the years 2013, 2016, 2017, 2018, and 2019, in which events with extreme characteristics were recorded. Differences in responses between the two groups were evaluated by comparing the following parameters: meetings in the *freguesias*' councils, door-to-door actions, interest in the programmes "Safe Village"

Figure 1

Location of the Municipalities that Replied to the Questionnaire in Relation to the Burned Area (A) and Ignitions Points (B) in the Period 2001 to 2019



Note. The density of replies is higher in Central, North, and Algarve Regions, heavily affected by extreme wildfires in the most recent times.

and “Safe People” (created by the Resolution of Minister Council no 157-A/2017 to enhance the safety of people in case of a wildfire), self-protection actions, and search for information by municipality staff.

Results

Wildfire Risk Communication: Type and Source of Information and Target Groups

Only 74 municipalities replied correctly to the question: “What information is provided to the municipality for fire risk awareness to the communities?” The most frequent information used by municipalities to support their actions in communication to citizens is related to: i) wildfire risk, mentioned in 45 (60.8%) of the replies; ii) fire weather warnings, considered in 26 (35.1%) replies; iii) how to use fire when burning agricultural and forestry residues (7 mentions, 9.5%); iv) self-protection measures (3

mentions, 4.0%); v) information about the official national campaign “Portugal Calls” (3 mentions, 4.0%); vi) special alerts (3 mentions, 4.0%); and vii) information on the national programmes “Safe Village” and “Safe People” (2 mentions, 2.7%).

The main source of wildfire information (Table S1) is the National Authority of Emergency and Civil Protection (ANEPC); 83 out of 101 municipalities declared that they directly receive information from that organization, 17 municipalities (16.9%) based their action solely on the information sent by this same source, and 53 municipalities (52.5%) declared that they receive information from other institutions (e.g. the Institute for Nature Conservation and Forests [Instituto da Conservação da Natureza e das Florestas; ICNF], IPMA, firefighters, Municipal Civil Protection Service [the Department of the municipality that directly receives the information from ANEPC], and the Agency for Integrated

Management of Rural Fires [Agência para a Gestão Integrada de Fogos Rurais; AGIF]). In 55 municipalities (54.5%), the technical staff looked for other information beyond that officially received, mainly using the websites of the public agencies already mentioned. Only one of the respondents directly contacted experts from a research institution.

Most of the respondents (91, 90.1%) expressed satisfaction with the information received for awareness-raising actions, and only 10% would like to have more material (e.g., videos, presentations, pamphlets, and posters, also in English to be used for tourists) and more data and knowledge on fire behaviour. One municipality suggested creating a video “which clearly exemplifies the behaviour that citizens should adopt in order to minimize the impact of fires. In this same movie, it should be important to see fire behaviour according to driving factors (fuel load and type, weather conditions, topography among others)” (Municipality A).

One of the respondents would like to receive better training on how to correctly and safely behave in case of a wildfire, but recognized difficulties in the implementation of the information because of ageing and low income of the population. A respondent from Municipality B highlighted that: “There is a lack of information on self-protection, and what is worse is how to do it in territories with ageing population, with people without economic capacity and who live in the middle of the forest. A lot of things are missing, especially the integrated vision that is so important in inland territories”.

The main target groups for awareness-raising campaigns are the general public (mentioned by 95 municipalities, 94.1%), school age children (69, 68.3%), farmers (64, 64.3%), and landowners and wood producers (63, 62.4%). Hunters (29, 28.7%) and shepherds (29, 28.7%), followed by emigrants (16, 15.9%) and tourists (14, 13.9%), are rarely considered priority groups.

Characteristics of the Wildfire Communication Process

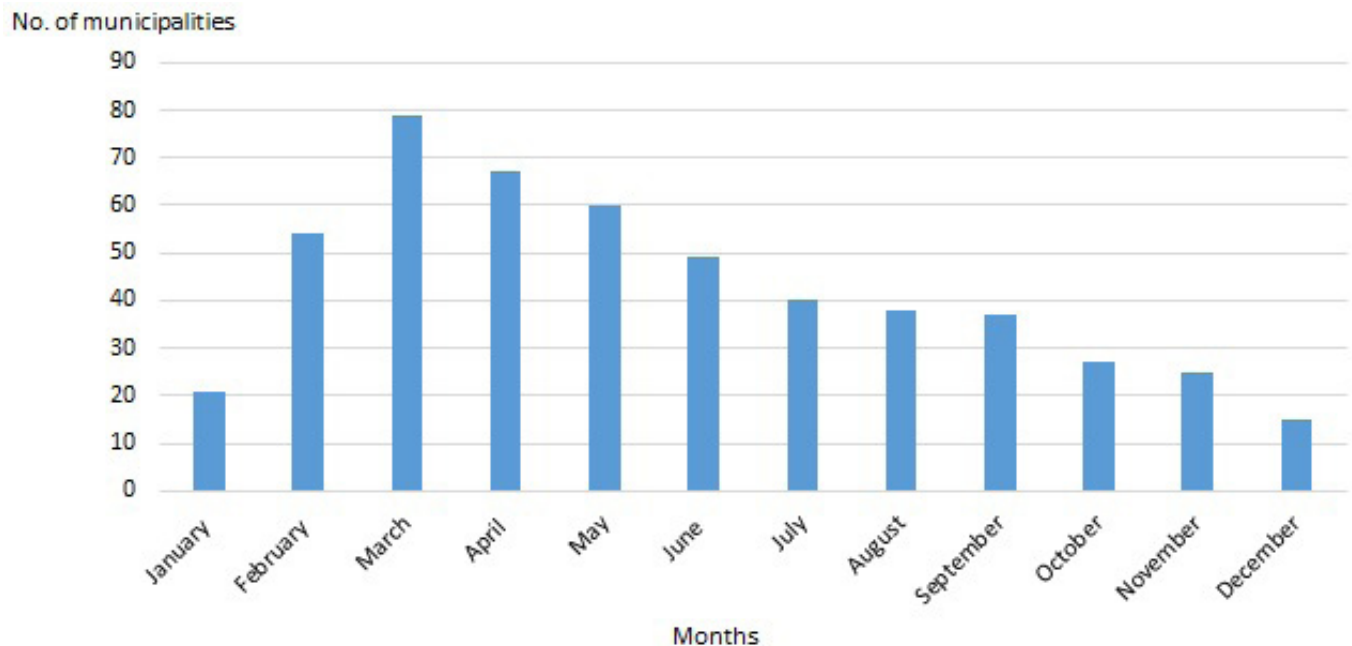
Communication channels. Respondents predominantly reported the use of passive means to disseminate information and create wildfire awareness (see Table 1). The most common method of communication used by the municipalities was the Municipal Council website (94 mentions, 93.1%) (Table 1). The use of local radio (mentioned 50 times, 49.5%) to disseminate wildfire information is worth noting as local radio stations are usually considered outclassed by other more modern forms of communication such as social media. Similar

to meteorological warnings, radio stations are among the preferred communication channels used in risk communication. In rural areas where people are older, the radio may still have an important role in disseminating information. The use of municipality social media accounts (mainly Facebook) was less important (mentioned in 23 responses, 22.8%).

Table 1
Communication Channels Used by Municipalities to Disseminate Information

Channel	No. of Municipalities	%
Website of the municipal council	94	93.1
Face-to-face or phone contact with the Technical Forestry Department/Civil Protection Department	86	85.1
Posters	69	68.3
Local media (radio and press)	50	49.5
Meetings at the freguesias' council	31	30.6
Emails	28	27.7
Municipality social networks (Facebook, Twitter)	23	22.7
Flyers	19	18.8
Talks in social centres, cafés, fairs, churches, and markets	19	18.8
Door-to-door actions	12	11.8
Meetings at schools	12	11.8
Implementation of the programmes “Safe Village” and “Safe People”	5	4.9
Awareness actions on special dates (e.g., World Arbor Day)	3	2.9
Reading warnings in churches	3	2.9
Simulation and training	2	1.9
SMS	1	0.9

Municipalities implemented diverse face-to-face actions like meetings at the freguesias' council, attending fairs and markets, door-to-door actions, demonstrations, and drills. However, the most frequently mentioned was the interaction (face-to-face or by phone) of citizens with the Forestry or Civil Protection technical staff in the municipality's council (mentioned by 84 municipalities, 83.2%), when citizens needed permission to burn or clear fields or clarification on rules and procedures. Municipalities implemented different types of initiatives using different channels to disseminate information to communities. About 33.7% of municipalities implemented four different ways of communicating, while 23.8% used three. Only 17.8% of the municipalities carried out five

Figure 2*Number of Municipalities that Implemented Activities of Awareness-raising by Month*

or six different actions, whereas 24.7% carried out just one or two actions.

Communication content. Most of the information disseminated by the municipalities is related to fuel management and vegetation clearing actions around houses and settlements (mentioned by 47 municipalities; 46.5%) and the use of fire (mentioned by 46 municipalities, 45.6%) (Table S2). The compliance with the current legislation in force was mentioned by 21 municipalities (20.7%), followed by self-protection measures (17 municipalities; 16.8%). The restrictions of the use of fire during summer or on days with very high risk was mentioned by 10 municipalities (9.9%). Seven (6.9%) municipalities disseminated information about forest preservation and another seven about daily fire risk.

Frequency of awareness-raising actions. Awareness-raising actions are mostly seasonal, as only 11 municipalities (10.9%) developed activities throughout the year (Figure 2). Most commonly, municipalities (30, 29.7%) implemented actions mainly in March, April, and May (i.e., before summer). Just 4.0% of the municipalities developed communication activities only in one month of the year, generally April or May. In 8.9% of the cases, it is less than once a year, which means that some municipalities do not implement these kinds of actions every year. About 15.0% of the municipalities explicitly stated that communication frequency is irregular, as they only develop actions when a warning or alert is issued to

the community, when the high level of fire risk requires it, or when there is a request to do so. These actions can address the same target groups, but not necessarily the same group of people (e.g., same students in different school years).

Collaboration between municipalities and other agencies related with fire. Most of the municipalities (85; 84.2%) develop awareness-raising campaigns in collaboration with other organizations (Table S3). The most frequently mentioned agency is National Guard (79 municipalities, 78.2%), followed by firefighters' voluntary teams (mentioned by 32 municipalities, 31.7%); forestry associations and ICNF were mentioned 10 times each (10.0%). The high number of collaborations with the National Guard is explained by its institutional task and commitment to raising citizens' awareness established by the legal framework (previously the decree-law no. 124/2006 and currently the decree-law no. 82/2021).

Difficulties faced by municipalities in the communication process. Almost all the municipalities (97%) face constraints in developing awareness-raising campaigns. The most frequent ones are the lack of human and financial resources and the difficulty to adapt the campaigns to the local characteristics (Table S4). Other problems are related to the lack of interest from citizens, attributable to people's mindset and age but also to the content of the actions and messages as quoted by Municipality C:

“There is a profound lack of interest in the information that is transmitted. The information that is transmitted is always the same related with the use of fire and the rules for cleaning the fuel management strips. Paired with the lack of fuel management, the interest of the authorities is only related with the increase of revenue from fines. The repetitive information year after year, the the fact that when there are fires the fighting forces are not always able to respond to all the needs, makes it very difficult to transmit information even when it is of real interest to people. They are completely discredited”.

Involvement of municipalities in emergency communication. During wildfires, in addition to the communication between operatives on the ground, there is a need to communicate with the population, to help them to cope and decide what to do (e.g., to stay and defend or to evacuate) to minimize impacts and avoid the occurrence of disasters. However, only 42.5% of the municipalities stated that there were communications with the population during past wildfires.

Regarding the content of communication, only three municipalities mentioned issuing early warnings (2.9%). Another three municipalities (2.9%) declared not having experienced fires with high intensity, thus, they did not need to communicate with the population during a fire; one municipality (0.9%) did not know how to communicate about how to cope with an intense wildfire.

During wildfires, the freguesias’ presidents have very active roles in communicating with citizens and responding to the needs of the population (Table 2). Social networks were mentioned 16 times (37.2%) and the website of the municipal council was mentioned 8 times (18.6%). Other municipalities highlighted the

Table 2
Channels of Communication During a Wildfire

Channels	Number of responses	%
Freguesia’s president	20	46.5
Social networks	16	37.2
Website of the municipal council	8	18.6
Face-to-face contacts	7	16.2
Local radio	6	13.9
Security officer from the programmes “Safe Village” and “Safe People”	5	11.6
Volunteers	1	2.3
Directive Body of Common Lands	1	2.3
Local actors	1	2.3
App	1	2.3
SMS	1	2.3

use of local radio stations and direct contact with the population to attend to their needs, followed by the Local Safety Officer (a citizen living in a village that joined the “Safe Village” and “Safe People” programmes who has the mission to transmit warnings to the population, organize the evacuation of the village if needed, and raise awareness among the population), the volunteer firefighters, local associations, and the Common Lands Directive Body. The use of apps and SMS to share information during wildfires was also mentioned.

Wildfire communication for tourists. All the 101 municipalities have tourist activity, but only 64 of them reported concerns for tourists’ wildfire risk awareness (63.4%). Of these, only 30 (29.7%) mentioned actions specifically directed to this target group.

The main actions specifically developed for tourists are: i) dissemination of posters and leaflets in different languages namely in the tourist offices; ii) awareness-raising actions to tourist offices, B&B, and rural farm accommodations to provide them knowledge to inform tourists about the safety measures to be taken in case of a wildfire; iii) prohibiting entering wilderness areas on high fire danger days; iv) patrolling in places of concentrated tourism; v) trail maintenance (cleaning and signposting); and vi) contact with campers who usually concentrate on the forest perimeter, to advise the non-use of fire on high fire danger days (Table 3). Some municipalities with a low presence of tourist activities did not conduct fire prevention and preparation activities directed specifically to tourists. In these cases, the municipalities arguably consider such activity not strictly necessary, so they disregard it.

Whereas 64 municipalities (63.4%) demonstrated concern about the safety of tourists before wildfires occur,

Table 3
Number of Municipalities by the Type of Communication Action Targeted to Tourists

Type of Action	Number	%
Multilingual posters and leaflets	12	40.0
Raising the awareness of tourism agents	7	23.3
Prohibition of activities in wilderness on high fire danger days	5	16.6
Patrolling in places of concentrated tourism	3	10.0
Trail maintenance (cleaning and signposting)	3	10.0
Contact with campers	2	6.6

Note. Percentages refer to the subsample (n = 30) of municipalities who reported communicating to tourists.

more municipalities (88, 87.1%) were concerned about the safety of tourists during a wildfire. The remaining 13 (12.9%) expressed no concerns or assumed that tourists' safety could not be ensured during a wildfire due to local reasons such as the lack of a strategy focused on tourists, lack of attention on this issue, and absence of tourists within some municipalities. In one case it was stated that the "security of the tourists must always be considered before the fire" (Municipality B). During a wildfire, the main actions reported were the evacuation of tourists and the prohibition of activities such as approaching the fire to take selfies and parking of cars on roads near the fire event.

The influence of past wildfire experience on communication activities. In this section, the sample is split into two groups: a) municipalities with extreme wildfires experience ($n = 27$) concentrated in the centre region of Portugal, and b) municipalities without it ($n = 74$).

No relevant differences between the two groups were found (Table 4), although the programmes "Safe Village" and "Safe People" and the implementation of self-protection actions exhibit slightly higher values in the group with past experience of extreme wildfire events (EWEs). Both likely represent a reaction to the 2017 wildfire disasters, which left Portuguese society shocked at the deadly consequences.

The technician staff in both groups (59% and 54%, respectively) conducted a high number of searches for information. This can be considered a good indicator of a growing awareness of the need for wildfire-related information. Similarly, the programmes "Safe Villages" and "Safe People" seem more appreciated (the value of the ratio between groups is 2.75) by municipalities that have already experienced EWEs and thus put high expectations on the programmes of adaptation and mitigation to avoid future losses. In any case, the low number of municipalities concerned with the programmes

indicates that they have a scarce appeal (arguably for lack of funding, human resources, and interest from the local communities).

Discussion

Wildfire Communication from Municipalities to Communities in the Portuguese Legal Framework

The use of the term communication is very limited in Portuguese hazards legislation. The decree-law no. 2/2019 establishes that, independently of the type of hazard, communication is the act of informing the National Authority of Emergency and Civil Protection about the imminence of occurrence of a process or phenomenon with potential to create damage, by the institutions that make observations, measurement, and continuous assessment of hazards as well as the act of dissemination of early warnings. It is not a way to improve wildfire knowledge, understand people's needs, enhance citizens' skills, reinforce pro-active practices, or overall to enhance awareness-raising activities.

In the current National Plan of Integrated Rural Fire Management 20-30 (PNGIFR 20-30; Resolution of Ministers Council no 45-A/2020), which reflects the official wildfire management policy until 2030, general guidelines for communication are presented without a clear implementation plan (NB: a plan is in preparation). In a context where EWEs are expected to be more frequent and intense, maximizing the importance of stronger and more interactive communication to improve citizens' awareness and preparedness should be a first priority in PNGIFR 20-30.

Weaknesses in Wildfire Communication from Municipalities to Communities

The dominance of passive means of communication.

The activities developed by the municipalities are not aligned with the current scientific knowledge (Cole & Murphy, 2014; Cooper et al., 2020; Johnston & Taylor, 2018; Spialek et al., 2021), because they are still mainly based on dissemination of information using passive methods (e.g., flyers), without engaging citizens and understanding the social context. Passive and unidirectional communication is dominant because it is easier and requires little engagement with citizens' difficulties and needs. Even in the activities that imply some interaction, such as door-to-door contact, the attitude of the municipalities' staff is more oriented toward disseminating information and explaining legal commitments to people, with minimal effort

Table 4
Influence of Experience of EWEs on Wildfire Risk Communication

Selected item	a) Experience of EWEs ($n = 27$)	b) No experience of EWEs ($n = 74$)	a/b
Meetings in the freguesia's council	33% (9)	31% (23)	1.06
Door-to-door actions	15% (4)	18% (13)	0.83
"Safe Village" and "Safe People" programmes	11% (3)	4% (3)	2.75
Self-protection actions	22% (6)	15% (11)	1.47
Technician search for information	59% (16)	54% (40)	1.09

focused on understanding people's needs, difficulties, and capabilities for wildfire risk reduction and safety enhancement. Hence, it will be necessary to improve the current model of municipalities' communication to citizens in two domains: i) improving the content of the messages to enhance citizens' preparedness to cope with wildfires (e.g., to stay at home and defend it or to evacuate safely), and ii) adopting more interactive communication processes to engage communities. Moving beyond the current model is crucial to prepare people to avoid casualties because many of the rural communities' inhabitants want to protect their properties and prefer to stay and defend them.

Difficulties faced by municipalities: The perceived lack of interest of the citizens. The municipalities that participated in this research have different practices and experiences with awareness-raising campaigns, which can be explained by differences in the local fire regimes, wildfire causes, and how the wildfire problem is approached by the municipalities' political and technical bodies. For instance, the programmes "Safe Village" and "Safe People" are implemented in only 56 of the municipalities participating in our research, and even then with distinctive expression and development. In addition, the lack of human and financial resources clearly limits the number and type of awareness-raising actions that several municipalities can carry out.

The municipalities perceived a lack of interest from the citizens in the communication process before wildfire outbreaks, explained firstly by the repetitive content of the messages, which are quite often "about the use of fire and the rules for cleaning the fuel management strips, and fines, that people already know" (quote from Municipality A). Secondly, municipalities do not respond to the real needs of citizens and do not offer adequate assistance when a fire occurs. These issues reflect a failure to understand the dynamics of people's relationship with wildfire risk. In addition to the constraints on people's interest introduced above, risk research has identified several factors that affect people's engagement in preparedness programmes and which are inappropriately dismissed by civic authorities as indicators of community complacency. Factors that can limit motivation to engage in preparedness include unrealistic optimism, risk compensation, negative outcome expectancy, social disengagement, anxiety, denial, over-confidence, and distrust (Paton, 2022). Strategies to overcome these factors are documented and available to support communication strategies based on community engagement and development principles

(Paton, 2022). It is also important that communication strategies are locally meaningful.

A good and expert communicator changes attitudes and behaviours by helping people understand the threat, make decisions, and take actions; a communicator should pay attention to the local dynamics and does not give generic and decontextualized information (Marsen, 2020). However, the procedures remain dictated by a top-down approach that gives little opportunity and support to municipalities in adaptive management. This approach is reductive as wildfires should be seen as complex socio-ecological processes (Essen et al., 2022; Tedim, McCaffrey et al., 2020) which represent a wicked problem influenced by multiple, dynamic, and complex contexts that require a holistic and integrated view to select the best communication practices. Communication must be adapted to each context, because the information required to address needs vary from place to place (Cooper et al., 2020; Mileti & Sorensen, 1990; Paton et al., 2014; Seeger, 2006; Steelman & McCaffrey, 2013; Venette, 2007).

Research using Community Engagement Theory (CET) in Portugal (Paton, Frandsen et al., 2012; Paton, Tedim et al., 2012) provides an empirically supported framework for developing community-engagement based communication strategies in Portugal. Importantly, an evaluation of a CET-based community development approach has demonstrated its ability to significantly increase levels of wildfire preparedness (Paton, 2022; Paton et al., 2017). The strategies used included:

- community members developing risk profiles to develop tailored, localized risk management strategies that empowered community members and built trust;
- building on community strengths;
- community meetings to formulate preparedness strategies and to plan their implementation, including regular opportunities for feedback and programme refinement to enhance place attachment;
- community participation and collective efficacy; and
- circulating stories of successes in other communities to bolster positive outcome expectancy (Paton, 2022).

Lack of continuity of communication activities. In the actions developed by the municipalities a marked seasonality, irregularity, and a lack of continuity are observed, in contrast with the exigency of prevention which should be a continuous and evolutionary process. The initiative to enhance preparedness of citizens should not be reduced to occasional actions. The same can be said in relation to people's safety, emergency behaviour, and evacuation procedures which demand deep

knowledge, continuous training, and drills to develop capabilities and promptness.

Communication during an emergency. During an emergency there is a huge information need that is crucial for the success of suppression activities, focused on hard and fast actions for reducing and containing damage, but also to support citizens in making the best decisions to cope with a wildfire. The most critical role of communication to communities is thus to quickly respond with accurate and timely information, including providing people with real-time information on fire behaviour (e.g., precise location, intensity, size, and direction of spread), therefore making them aware of the type of fire that could be expected and the level of threat it may present to people and assets.

During a wildfire, people try desperately to obtain information from official and/or informal sources including family, friends, community members, computer applications, and websites. The experience of the tragic 2017 wildfires shows that communication failed completely; many people were caught off guard by fires with unprecedented characteristics and tried by themselves to cope in the best possible way. We advocate that municipalities should make accurate information available to their citizens; messages must be easily understood by the public, and this entails using everyday language and distributing information through multiple communication channels (Taylor et al., 2007). However, attention should also be paid to remove the barriers at individual, community, and agency levels that affect the communication process (Bharosa et al., 2009). A cost-effective approach to doing so involves using dedicated social media strategies (Irons & Paton, 2017; Paton & Irons, 2016). These authors used a Facebook-based strategy to support wildfire recovery. The key element in the effectiveness of this approach rested on developing a social media resource specifically for the affected community and it having a dedicated leader. Key outcomes were the development of reciprocal communication within the community and between the community and civic response agencies and the development of social exchange processes that enable the emergence of social support relationships, sense of community, and better mapping of recovery plans and resources to community needs (Irons & Paton, 2017). This section identified several issues with prevailing communication practices and identified the existence of evidence-supported (from Portuguese research) strategies that could be adopted by the municipalities.

Limitations and Implications of the Research

The main limitation of this exploratory research is related to the number of responses and the purposive reduction of open-ended questions to maximize survey completion. Several explanations provided by open-ended questions would have been interesting but were not obtained and we made the decision not to follow-up with further contact to obtain additional explanations due to recruitment difficulties. These were mainly related to the fact that the questionnaire was proposed by a research institution rather than the state. At the same time though, the questionnaire was validated as a research tool and can therefore confidently be applied to evaluate the wildfire communication process in other contexts.

The communication process for communities is currently based on a top-down approach and needs to be better adapted using a bottom-up approach that more comprehensively addresses needs, capacities, and barriers of local communities. The results of this research and the discussions on the individual points make it clear that the complex reality of managing wildfire cannot be limited to the action of extinguishing the flames. In the complex social and ecological reality in which they occur, many collateral aspects play a relevant role in contributing to the efficiency of the system. Communication is undoubtedly among these aspects, and this paper highlights how, in the context of Portugal, it currently makes limited contributions to the final result and is clearly in need of modifications and changes in both content and process.

Conclusion

This paper presents the first research on wildfire communication from municipalities to communities in Portugal. The research findings show that the communication process from local government to communities does not currently promote information exchange to reduce wildfire risk and enhance preparedness. Communication is scarcely associated with wildfire risk reduction, emergency management, or post-fire recovery; consequently, it has only a modest role in the general effort to contain and control not only the number of ignitions and burned areas, but also the casualties, losses, and damage caused by the wildfires that regularly disrupt the country.

The differentiated pattern of responses to the questionnaire reveals a high heterogeneity of understanding wildfire risk communication goals and procedures by the municipalities and suggests that wildfire communication

activities with citizens have not been prioritized by municipalities in Portugal. Instead, communications that promote wildfire risk awareness and enhance preparedness are very limited in Portugal, therefore requiring attention and consequent improvements.

Our research findings highlight an evident lack of strategy to transform available information into a communication tool for the defence against wildfires of territories and their inhabitants. Wildfire risk communication for communities is rare, incoherent, and basically ineffectual at creating a generalized awareness of wildfire risk in individual citizens and across communities. There is a marked seasonality, irregularity, and lack of continuity in the communication developed by municipalities, in contrast with the exigency of prevention and preparedness. The municipalities mainly try to follow the procedures dictated by ANEPC and ICNF to ensure timely compliance with the legal framework. The current top-down suppression centred policy based on static regulations does not favour the engagement of municipalities in ways that go beyond the current procedures, because they have no authority or voice in the policy-making process. However, as has been demonstrated, many municipalities have the perception that the information they receive is insufficient, with staff seeking more information on their own, mainly from the websites of the most important Portuguese institutions.

Despite an increasingly complex and uncertain environment, the interaction of municipalities with academic experts to improve knowledge and practices seems limited. As a result, Portugal remains unprepared to face the challenge of increasingly frequent extreme wildfire. There are clear opportunities for collaboration between research institutions and municipalities to co-produce actionable information and effective communication processes.

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Appendices

Appendix 1

Questionnaire

1. Identification of the municipality
2. What information is provided to the municipality for fire risk awareness to the communities?
 - 2.1. Who provides this information?
 - 2.2. How does it reach the municipality?
 - a) Sent directly by IPMA
 - b) Sent directly by ANEPC
 - c) Sent directly by ICNF
 - d) The technician searches directly on the IPMA site
 - e) The technician searches directly on the ANEPC site
 - f) The technician searches directly on the ICNF site
 - g) Other
3. What type of awareness-raising actions does the municipality develop?
4. Who are the awareness and education actions aimed at?
 - a) Farmers
 - b) Hunters
 - c) Shepherds
 - d) School population
 - e) Tourists
 - f) Forest owners and producers
 - g) General Population
 - h) Emigrants
 - i) Other
5. At what time of the year are the actions carried out?

a) January	e) May	i) September
b) February	f) June	j) October
c) March	g) July	k) November
d) April	h) August	l) December
6. How often do you organise awareness raising activities for the same group in a year?
 - a) Less than once a year
 - b) Once a year
 - c) Twice a year
 - d) 3 times a year
 - e) 4 times a year
 - f) Other
7. Which channels do you usually use to disseminate information?
 - a) Local radio
 - b) Distribution of flyers via the post office
 - c) City Council Website
 - d) Display of posters
 - e) Door-to-door interaction with the population
 - f) Interaction with the population in Technical Forestry Office / Civil Protection Office)
 - g) Other

8. In the awareness actions developed by the Municipality, the Parish Councils are collaborating?
- Yes
 - No
- 8.1. Do the Parish Councils develop awareness-raising actions other than those programmed by municipality?
- Yes
 - No
9. What difficulties have you experienced in making the campaigns operational?
- Lack of financial resources
 - Lack of human resources
 - Lack of receptiveness of institutions (e.g. schools; farmers' associations)
 - Lack of receptivity from the residents
 - Difficulty in adapting the campaign to local realities
 - Others
10. Are there other entities involved in the awareness campaigns in the municipality?
- Yes
 - No
- 10.1. If yes, please indicate which ones and how they are articulated?
11. What information do you favour in your awareness-raising actions?
12. In case of fire, do you inform the population about the evolution of the fire so that they can take the appropriate protection measures?
- Yes
 - No
- 12.1. If yes, how do they do it?
13. Do you have all the necessary information to carry out the awareness campaigns?
- Yes
 - No
- 13.1. If you answered no, what kind of information would you like to have?
14. What types of tourism does your municipality offer?
15. If tourism is an important activity in your municipality, is there any attention from the municipality to ensure the safety of tourists in the face of fire risk?
16. In case of fire, how do you communicate with tourists to ensure their safety?

Appendix 2

Supplementary Tables

Table S1

Origin of the Information that Municipalities use to Communicate with Citizens

Information directly received from public agencies	Municipal technicians consult public agencies' websites	Municipal technicians contact research institutions	Number
ANEPC			17
ANEPC; ICNF			16
ANEPC	IPMA		12
ANEPC; ICNF	IPMA		10
	IPMA		5
ANEPC; ICNF	ANEPC; ICNF; IPMA		5
ANEPC; ICNF; IPMA			4
ICNF			4
ANEPC; ICNF	IPMA; ICNF		4
ANEPC	ICNF; IPMA		3
ICNF	IPMA		2
ICNF	ANEPC; ICNF; IPMA		2
ANEPC	ANEPC; IPMA		2
ANEPC; ICNF	ICNF		2
ANEPC; IPMA			1
	ICNF		1
ANEPC; ICNF; Firefighters; Municipal Civil Protection Service	IPMA		1
IPMA	ICNF		1
ANEPC; ICNF	ANEPC; ICNF		1
ANEPC	Municipal Civil Protection Service		1
ANEPC; ICNF; IPMA	ANEPC; ICNF; IPMA		1
ICNF; IPMA	ICNF; IPMA		1
ICNF; AGIF	ICNF		1
ANEPC; IPMA	ANEPC; ICNF; IPMA	University of Lisbon-IST	1
ANEPC; IPMA	IPMA		1
ANEPC	ANEPC; ICNF		1
No valid response			1

Table S2

The Information Transmitted by Municipalities in Risk Communication

Type of information	Number of municipalities which provide the information
Fuel management	47
Fire use	46
Law enforcement and penalties	21
Self-protection measures	17
Restrictions in the critical period	10
Forest preservation	7
Daily fire risk	7
Use of machines	2
Emergence phone number	1
Not valid response	21

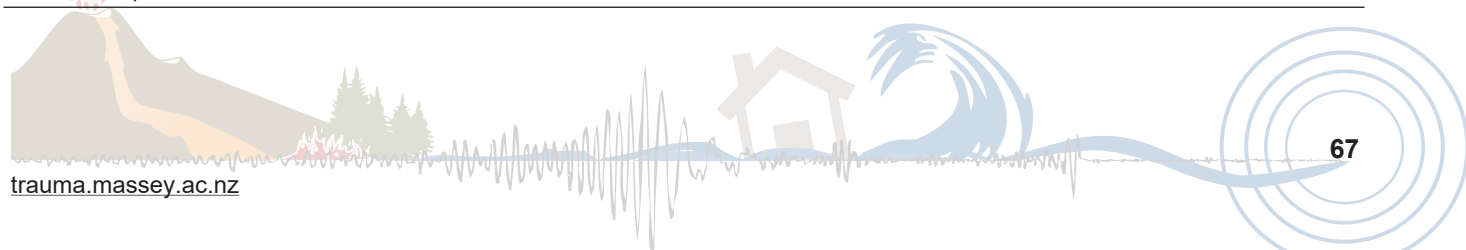


Table S3*Collaboration Profile Between Municipalities and Other Institutions*

Institutions	Number
National Guard	27
National Guard; Firefighters	16
National Guard; Forestry Association	6
National Guard; ICNF; Firefighters	5
National Guard; Public Safety Police; Firefighters	3
National Guard; ANEPC; ICNF	3
National Guard; Firefighters; Forest rangers	3
National Guard; Forestry Association; Forest rangers	3
National Guard; Local organisation	2
National Guard; Public Safety Police	2
National Guard; ANEPC	2
Firefighters	2
National Guard; Municipal police	1
Forestry Association	1
National Guard; Municipal Police; Firefighters	1
National Guard; ANEPC; Public Safety Police; ICNF	1
Public Safety Police, ICNF; Forestry Association	1
National Guard; Firefighters; ICNF; AGIF	1
Local Security Officer	1
National Guard; Firefighters; Forest rangers; ICNF	1
National Guard; ICNF	1
ANEPC	1

Table S4*Difficulties in the Implementation and Success of Wildfire Communication*

Difficulties	Number
Lack of interest of citizens	29
Lack of human resources	14
Lack of human resources; Lack of interest of citizens	11
Lack of financial support; Lack of interest of citizens	5
Lack of financial support; Lack of human resources; Lack of interest of citizens	5
Inadequate information	4
Lack of interest of citizens; Inadequate information	4
Lack of financial support; Lack of receptiveness of the institutions; Lack of interest of citizens	3
Lack of financial support; Lack of human resources	3
Lack of receptiveness of the institutions; Lack of interest of citizens	3
Lack of receptiveness of the institutions	3
Lack of financial support; Lack of human resources; Lack of interest of citizens; Inadequate information	1
Lack of human resources; Lack of interest of citizens; Inadequate information	1
Lack of human resources; Inadequate information	1
Lack of human resources; Lack of time	1
Lack of financial Support	1
Lack of human resources; Lack of investment in awareness-raising	1
Lack of financial support; Lack of receptiveness of the institutions	1
Lack of human resources; Lack of receptiveness of the institutions	1
Lack of financial support; Lack of human resources; Lack of interest of citizens; Inadequate information	1
Redundant and oppressive actions	1
No weaknesses or difficulties	3