# Citizen Engagement in wildfire management: needs, challenges, methods and framework

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**ABSTRACT**

With climate change, the frequency and spread of wildfires have intensified globally, bearing disastrous impacts on wildlife, the economy, and human well-being. Efforts on broad fronts are required, including proactive public participation. However, studies related to citizen engagement in the context of wildfire management remain limited. Therefore, there is a need for further studies in this area. This paper reports on ongoing work conducted in the context of an H2020 project called SILVANUS. The study investigates the methods, practices, needs and challenges related to citizen engagement in wildfire management. The authors have developed a tentative citizen engagement framework, and preliminary results related to citizens' needs and challenges are presented. The study identifies relevant topics, training contents, and methods that can be used for public engagement in wildfire management. The paper contributes towards designing future engagement modalities, technologies and training materials related to wildfire management and potentially even other crises.

**Keywords**

Citizen engagement, wildfires, forest fires, SILVANUS, disaster, communication

## INTRODUCTION

With nearly a third of the total land area of the Earth being covered by forests (FAO, 2020), forests form a vital global resource with financial, political, and socio-cultural implications. As an example of the economic role of forests, in Sweden, with a population of around 10 million, the forestry industry supports 200 000 jobs, with SEK 200 billion per year contributing to Sweden's economy. Worldwide the numbers become even more significant where forests, as reported by FAO, "provide more than 86 million green jobs and support the livelihood of many more". The socio-cultural aspects have also been increasingly acknowledged, where the positive impacts on human well-being and health and the role of forests as a key cultural heritage have been highlighted.

According to the European Forest Fire Report of 2022, wildfires have occurred more frequently in almost all EU

countries and elsewhere in the world in the last few years (MacCarthy et al.,2022). They have had disastrous effects on wildlife, economics and people (San-Miguel-Ayanz, 2022). The devastation can include ecosystem and biodiversity loss, forest destruction, impact on human well-being and health, soil degradation, economic losses and air contamination. These directly affect civilians in urban areas and the countryside. Research in different countries shows that involving populations living in hazardous areas and various groups of citizens in different stages of wildfire management helps to deal with disasters at early stages and either prevent them altogether or diminish the detrimental effect on many spheres (e.g., Xanthopoulos et al., 2022; Eckerberg & Buizer, 2017). Furthermore, citizens can become a significant additional resource in frequently occurring crises by lending their know-how, protecting property, helping in evacuation, joining voluntary forces and even by contributing to the restoration of the affected areas after the disaster (e.g., Copes-Gerbitz et al., 2022; Durkin et al., 2020; Gorriz-Mifsud et al., 2019).

Engagement with the citizens in emergency management and crisis is not always easy and may be affected by local conditions, legal regulations, way of life, lack of motivation and unclear division of tasks (Yousefi Mojir, 2018; Pilemalm & Yousefi Mojir, 2020). Therefore, the purposes and ways of their participation could be more apparent, and what works effectively in some areas may not be acceptable in others. Creating a disaster-resilient community has been discussed earlier, generally in different crises. However, in specific cases of wildfire, there is still a need for further investigations both on a more general, but also on local levels (Xanthopoulos et al., 2022; Copes-Gerbitz et al., 2022; Tedim et al., 2020; Singh & Kaushik, 2020; McGee, 2011; Gorriz-Misfud et al., 2019). Therefore, there is a need to investigate how to involve citizens in wildfire prevention and management and the methods and channels that can be used or developed for this purpose. More investigation is also needed to identify citizens' needs and challenges in the specific context of wildfires.

## STUDY OBJECTIVES

The subject of our study is citizen engagement in the prevention and management of wildfires. The study aims to provide a comprehensive understanding of citizen engagement in the wildfire management process and identify challenges, needs and areas for improvement. The ultimate goal is to enhance the effectiveness of the engagement process, leading to more efficient and effective prevention, response and recovery of wildfires. The objective of this paper is twofold. *Firstly*, identify the various modalities and essential aspects of citizen engagement to create a framework for wildfire management. *Secondly*, to present the preliminary results concerning the citizens' needs, challenges and engagement methods directly impacting citizen engagement development. We have used the theory of communication effects as the theoretical basis for this study when investigating citizen engagement and applied different methods to contribute to citizen engagement and participation.

## STUDY SETTING - SILVANUS PROJECT

To reduce wildfire occurrences, there is a great need for improved information, risk mitigation, and other preventative efforts (fire management, forest restoration, regulatory frameworks). These issues are being addressed in a large EU-funded multidisciplinary, international project called SILVANUS, which comprises 49 partner organisations from 18 countries with more than 200 members. The project's main objective is to create a climate-resilient forest management platform to prevent and combat forest fires. Due to the key role played by humans in causing, managing or having to live with the consequences of forest wildfires, a few central aspects of the project are to raise awareness about the risks and causes of wildfires, to engage citizens in sound practices to prevent or manage fires and lead to a shift in attitudes and improved knowledge, and practices. This part of the project is called the Citizen Engagement Programme (CEP).

In this paper, the focus is placed on some of the activities and studies conducted in developing the SILVANUS CEP.

## BACKGROUND AND THEORETICAL FRAMEWORK

The definition of citizen engagement in the literature varies from the redistribution of power between authorities and citizens' involvement in decision-making processes and participation in governance. We have chosen one that emphasises the communication between the involved actors. Citizen engagement "is an interactive two-way process that encourages participation, exchange of ideas and flow of conversation between the citizens and the government. It reflects a willingness on the part of the government to share information and make citizens a partner in decision making." (Singh and Kaushik, 2020, p. 50) This simplified definition identifies two communicators, consisting of many organisations and individuals, as stated later in the text.

We have retrieved 68 articles from WoS related to citizen engagement in wildfire management published over the last 20 years. Our search has shown that much research on citizen engagement in the wildfire management process

is done in countries where wildfires happen more often, and such engagement is vital for diminishing the harm to people but also to nature, e.g., US, Canada, Australia, and the Mediterranean region of Europe. Other countries publish much less but produce instructions and other public documents for citizens (e.g., https://www.krisinformation.se/en/hazards-and-risks/gras--och-skogsbrand). Here we present only the main findings of the content analysis of this body of work.

The concept of citizens is far from uniform and their motivation as well as information and communication needs, are understood differently. Examples are communities and groups, e.g., smaller communities, bigger municipalities or regional centres (Copes-Gerbitz et al., 2022), social-political movements coming together in local geopolitical actions (Leguia-Cruz et al., 2021), communities of practice, such as volunteer groups, (Robinson et al., 2018), neighbourhoods (McGee, 2011). Citizens' engagement will need political support from all levels of policy-makers for their involvement in the actual decision-making process (Gazzard et al., 2020), knowledge of standard operational procedures for different actions, especially in the suppression stage (Blanchi & Whittaker, 2018), information on fire preparedness and public safety (Miller et al., 2020), and trust building between professionals, decision-makers and community (Eckerberg & Buizer, 2017; Olsen & Sharp, 2013). Citizens may also be perceived as individuals, e.g., land owners, houses, forests, other private property, and farmers (Durkin et al., 2020; Eriksen and Prior, 2011; Robinson et al., 2018), and residents (Penman et al., 2013). They need information about self-protection measures, infrastructure safety, information channels for alarm information and instructions about evacuation (Blanchi & Whittaker, 2018; Strahan et al., 2018) as well as economic support for protecting their property and understanding of how to apply for it (Miller et al., 2020). However, the most interesting is the proactive locals organising themselves into volunteer groups (Gorriz-Mifsud et al., 2019), which need information on conducting engagement activities (Otero et al., 2018) and interaction with forest wardens, firefighters, other responders (e.g., Madsen et al., 2018). Thus, the overall spectre of organisations and the range of citizen bodies engaging in communication for the purpose of wildfire management is complex and varied in both cases.

The Australian Institute for Disaster Management has developed one for any emergency management in general (Fig. 1) related to the context and purpose of community engagement, such as information, consultation, participation, collaboration, and empowerment.


**Figure 1. Community engagement model for emergency management (Australian Institute for Disaster Resilience, 2013, p. 6)**

This model sets contexts and purposes for citizen engagement, identifying the actions of engaged citizens and organisations. However, it does not explain how to capture citizens' attention, change their perception of wildfires, or understand their role in preventing and managing them. We regard citizen involvement in decision-making and

participation in activities as a change our citizen engagement programme needs to achieve. Thus, the citizen engagement programme is a tool to make a difference and cause changes in people's behaviour mainly through informing, persuasion, and education.

We have added media effects theory to this model, suggesting that audiences can acquire knowledge, attitudes, emotional responses and change behaviour through interactions with media (Bandura, 2001; Potter, 2012) as a conceptual foundation for developing a citizen engagement approach. Therefore, we have treated entire citizen engagement as a result of bidirectional communicative activities helping to attract and engage citizens and their organisations in managing wildfires and data exchange with them and professional organisations during different phases of the fire management process. Table 1 below summarises a simplified model of communication measures concerning the wildfire management phases and communication effects extracted from the literature review.

**Table 1. Simplified model of communication effects concerning wildfire management stages**

| Type of Activity | Prevention | Response | Recovery | Local authority/services |
|---|---|---|---|---|
| ***Awareness*** | | | | |
| *Inform* | Instruct how to control negligent fires through personal and community information channels. | Plan for escape.<br>Display alarm signs.<br>Mark evacuation routes.<br>Send timely warnings. | Provide guidelines for recovery. | Improve informing policies. |
| *Educate* | Create supportive learning environments.<br>Conduct regular courses and training. | Training for suppression.<br>Implement the concept of "coexisting with fire". | Organise ludic and educational activities in nature.<br>Training for rapid restoration of private lands and forests. | Develop competencies of people. |
| ***Attitudes (cultural values)*** | | | | |
| *Raise engagement* | Community building.<br>Democratic participatory planning procedures. | Build a network of volunteer firefighters.<br>System for coordination of interventions. | Raise interest in wild nature.<br>Collaborative planning of restoration activities. | Planning voluntary work. |
| *Promote safe practices* | Establish preventative behaviour.<br>Transforming land use into safer modes. | Infrastructure safety.<br>Train and hands-on exercises in protecting health and property during a fire. | Creating fire-safe landscapes. | Support for returning inhabitants. |
| ***Behaviour*** | | | | |
| *Assist effective fire management* | Self-protection measures.<br>Protection of property. | Assist with safe escape.<br>Coordination of volunteer and professional actions. | Post-fire best practices.<br>Long-term interaction with citizens for trust-building in restoration activities. | Include citizen responses in policies. |
| *Actions* | Reporting hazards.<br>Preventing risky behaviour.<br>Involvement in prescribed fires. | Assistance to responders in firefighting or evacuation.<br>Involvement in auxiliary extinction activities. | Be a tool for data collection.<br>Manage firewood economically. | Action guidelines and instructions. |

Simplified effects that should be produced are marked on horizontal lines of Table 1 as "raising awareness",

"changing attitude" (including cultural values) and "changing behaviour" of citizens. These effects are interpreted in the context of wildfire management. Thus, the columns with the "Type of activity" (far left column) should produce the desired effect, which includes the activities of informing and educating to raising awareness, increasing intent to engage and use safe practices for changing attitudes, organising assistance and involvement in specific actions for the effect of changing behaviour. Three middle columns mark three stages of wildfire management with examples of actions (e.g., community building, promotion of fire prevention) within specific activities. These examples have been derived from a literature review on citizens' engagement in fire management, presented partly in this paper's earlier part. The far-right column lists what should be done by local authorities and service providers to ensure the success of each activity. The last column shows that local authorities, professional and educational organisations and many more are engaged with and responsible for citizens and their organisations. This model is used as a base for developing the SILVANUS Citizen Engagement framework presented later in this paper.

## METHODOLOGY

We have administered online surveys to investigate stakeholder experience about citizen engagement in the wildfires and related citizens' needs to collect data on a range of topics, including the extent to which stakeholders believe citizens are engaged in crisis response efforts, their experience about that, the factors that influence citizen engagement, and the strengths and weaknesses of current citizen engagement initiatives, and the related citizens' need and challenges.

We are also using focus groups, interviews and observations to investigate the modalities for engagement and citizen needs and challenges to be involved in the prevention, response and recovery of wildfire. In the context of investigating citizen engagement and requirements in wildfire prevention, response and recovery, focus groups can be an effective way to gather information about the citizens' challenges and needs, for example, what technology features and services are most important to citizens, how they currently use technology in their daily lives to receive information, and what their expectations and concerns are for future way of receiving information. Therefore, we are conducting various focus groups involving relevant stakeholders (e.g., firefighters, crisis management authorities, authorities working with forest and forest industries, and citizens). To involve citizens, we use the SILVANUS network of partners who have access to local communities in rural areas near forests, municipalities, and volunteers.

Observation and field study are used to understand citizens' experiences and challenges during crisis events and to identify the various engagement methods in prevention, response and recovery efforts. So far, we have carried only a short study trip to Gargano Park in Italy, where we met with local firefighters. However, we have conducted surveys of our stakeholders, organised interviews with partners responsible for citizen engagement in the pilots, produced a study protocol providing a question pool of about 50 questions and used the theory of mass media communication. The protocol is used for focus groups and interviews with citizens and citizen group representatives, and we carried out preliminary focus groups with them. The data collected consists mainly of recordings and transcripts as well as field notes from one field trip made by two members of our team and survey data from 49 participants in our surveys and the materials found on the websites. We have conducted a content analysis of the materials using the codes prompted by the simplified model of communication effects that we have presented in table 1.

## RESULTS

### A holistic citizen engagement framework

The SILVANUS CEP framework was developed based on the above findings, as presented in Figure 2. At the model's core are various channels and different modalities of citizen engagement. Here, modalities refer to the various methods, approaches, and tools used to involve citizens in related activities, learning instances, and even potential decision-making processes, policy development, and the definition of public services. Levels of engagement vary depending on the purpose, target groups, channels and modalities and typically range over: *inform*, *consult*, *involve*, *collaborate*, and *empower*. Different tools and engagement modalities were considered in relation to: target groups (e.g., those living in forest areas, tourists, school children), goals (e.g., promote safe behaviour, learn about current habits, inform about fire danger), levels of engagement (inform, consult, involve, etc.), time (both in terms of the time of the engagement taking place but also the time required for the planned engagement activity), and opportunity available and subsequently, various modalities and channels were identified as useful. These ranged from social media and mass media to public events, participatory engagement activities, and social campaigns, as well as a dedicated App that is being developed within the project specifically for the purposes of citizen engagement. The social media primarily used are Twitter and LinkedIn,

with additional material being published on YouTube. Various mass media channels (including press releases and publication in newspapers, as well as related reportage and news features in radio and tv programs) are used for broad outreach. Further citizen engagement modalities and activities were identified to be utilised in raising awareness about forest wildfire, fire risks, fire prevention and management, and post-fire restoration in a more interactive and involved way. Some examples include (but are not limited to) the following:

- **Festivals and Fairs** allow citizens to engage through interactive exhibits, demonstrations, and hands-on activities related to wildfire prevention and management. For example, a booth can be set up with information on how citizens can prevent wildfires. Materials can be distributed to educate people about the dangers of wildfires and how to protect their homes and communities.
- **Popular scientific conferences** provide a platform for scientists and experts to present the latest research and knowledge about wildfires and wildfire prevention to citizens. In addition, participants can attend lectures, panel discussions, and workshops to learn about best practices and strategies for preventing and managing wildfires.
- **Laddering events** bring together citizens from diverse backgrounds and provide a forum for open discussion and dialogue about wildfire prevention and management. Participants can share their experiences, knowledge, and perspectives to develop a shared understanding of the issue and identify collective solutions.
- **Hackathons** engage citizens in developing innovative and technological solutions to wildfire prevention and management. Participants can work in teams to create digital tools, applications, or other solutions that help citizens prevent and respond to wildfires.
- **Open space events** provide an open forum for citizens to engage in discussions and idea-sharing related to wildfire prevention and management. Participants can explore different topics related to wildfire prevention, such as sustainable forestry, emergency preparedness, and post-fire restoration.

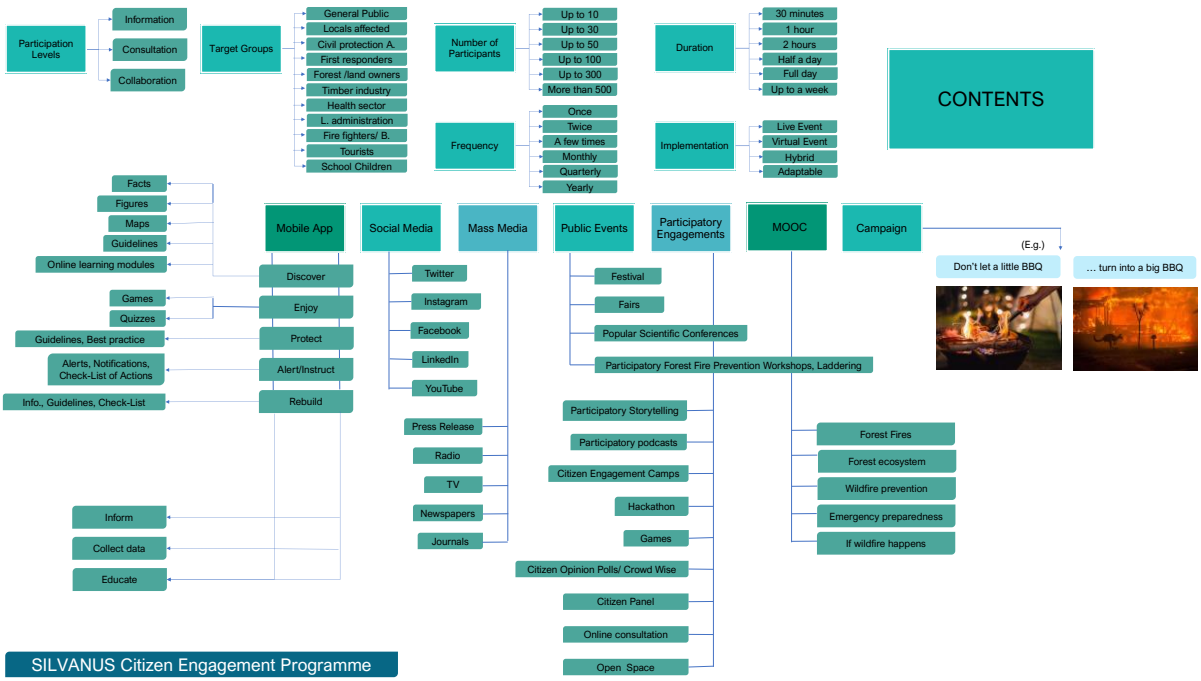


**Figure 2. Citizen engagement framework**

**Engagement methods and citizens' needs and challenges to enable their engagement in wildfire management**

As the citizen engagement programme aims to develop a systematic approach with specific methodologies and relevant tools that address the challenges of communicating fire safety, govern the moves of the population and involve a broad group of European and global citizens in a meaningful activity, it was essential to explore the understanding of users and their needs by the SILVANUS partners and functional requirements for the platform and the tools used for citizen engagement in two surveys.

A questionnaire was sent to all 49 SILVANUS partner organisations. Twenty-seven responses were received after three reminders, two partners responded twice, and their data was integrated into one response; thus, 25 valid responses were examined. Nine partners said they had no citizen engagement activities; six had their own citizen engagement programs. Ten partners do not have citizen engagement programs but have observed citizen engagement elsewhere and presented their observations.

SILVANUS partners have identified three types of aims for citizen engagement activities:

- PRACTICAL
  - Fire prevention, warning and forest protection (mentioned by 5 partners)
  - Support first responders with technological innovation, build a network of volunteers supporting firefighting brigades (2)
  - Agricultural production (1)
- EDUCATIONAL
  - Public awareness raising and promotion of fire prevention (mentioned by 4 partners)
  - Developing competence of people, including children (5)
  - Raise interest in wild nature, organise ludic activities (1)
- RESEARCH
  - Collect data, store data, and indicate key problems (3)

There was quite a wide range of organisations representing citizens or organising the engagement activities that SILVANUS partners have named as important for wildfire management (Table 2):

**Table 2. Organisations of citizen engagement in wildfire management**

| Organisations representing citizens | Institutions organising engagement activities |
|---|---|
| Voluntary firefighter associations (7) | Local authorities, police (8) |
| NGOs and associations of organisations (national parks, towns, environmental, cultural, agricultural) (11) | Research institutions (4) |
| Universities and schools (3) | Professional firefighter brigades (3) |
| Private companies (2) | Public administration (3) |
| | Policymakers (2) |
| | Ministry of Interior (1) |

The categories of citizens mentioned by SILVANUS partners were rather numerous but coincided with the ones found in the literature review. The most important processes through which citizen engagement in wildfire management happens, as identified by the partners, are learning and training (mentioned 13 times), voluntary work and involvement in action (mentioned 13 times). The other processes, such as deliberation and consultation, data collection or provision, were mentioned by several partners. However, decision-making was the process mentioned only once.

A parallel study (Majlingova et al., 2022) in the Silvanus project addressed all requirements for the SILVANUS platform and was filled in by relevant stakeholders. The results related to citizens' needs include:

- Citizens should be notified about the fire occurrence in their vicinity.

- Citizens shall be able to notify fire to the fire and rescue service.
- Citizens shall be able to notify forest management services of human negligence.
- Citizens shall be able to report a suspect fire by geo-location, photos, and description.
- Fire and rescue services should be able to ask citizens in the fire vicinity for help by voice call
- Forest management services should be able to contact citizens in the fire vicinity for help by chat or voice call.
- Citizens should be provided with the content on forest fire impact.

### Mobile app and poster-campaign development

Based on the citizen engagement framework (figure 2), developing mobile applications and designing posters and campaigns were chosen as the first set of methods to engage citizens since they can enhance citizen awareness and also enable communication between citizens and emergency response actors.

Based on the preliminary citizens' needs presented above, we are developing a platform along with a Citizen Engagement Mobile App (CEMA) based on real-time poll management and aggregation described in (Balogh, 2016). The platform (called EmerPoll) allows the dynamic collection and aggregation of template-based semi-structured data submitted into information channels using a publish-subscribe messaging paradigm (fig. 3). The platform aims to provide functionalities such as guidance, wildfire news, local information, fire reporting and notification. In addition, during the detection and response phases, the mobile app, with its fire reporting and warning modules, can provide one of the primary communication means between fire responders and citizens.

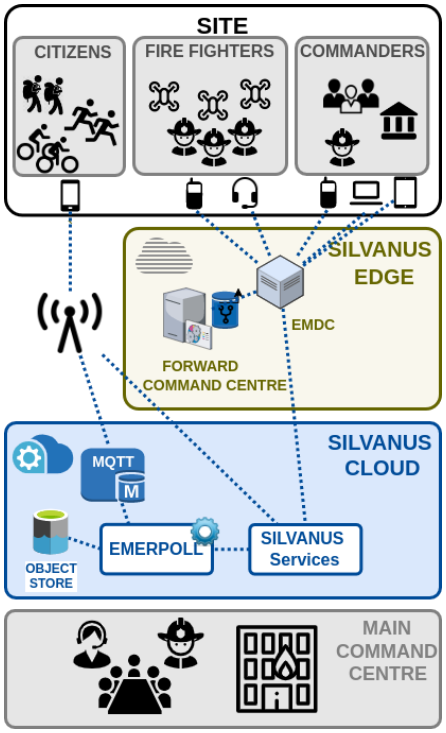


**Figure 3. Simplified block schema of SILVANUS architecture for communication between firefighters, commanders, local authorities, and citizens.**

The main screen of the module contains a vector map containing general information like routes, paths, and points of interest (fig. 4 left). It also shows a list of information channels to which the user is subscribed. One of the provided information channels is called "Fire Report," to which the exact location of the fire on the map can be submitted. Additional information about the fire, like photos, voice or a short text message, can be amended too (fig. 4 right). By submitting a form to the FireReport channel the report is sent to the EmerPoll system which aggregates the information from all the channel users in real-time. The aggregated data are also displayed in the SILVANUS Dashboard, which may serve as an additional source of information for first responders in order to visualise crowdsourced data. Validated and confirmed information is shared with relevant first responders at the incident site.

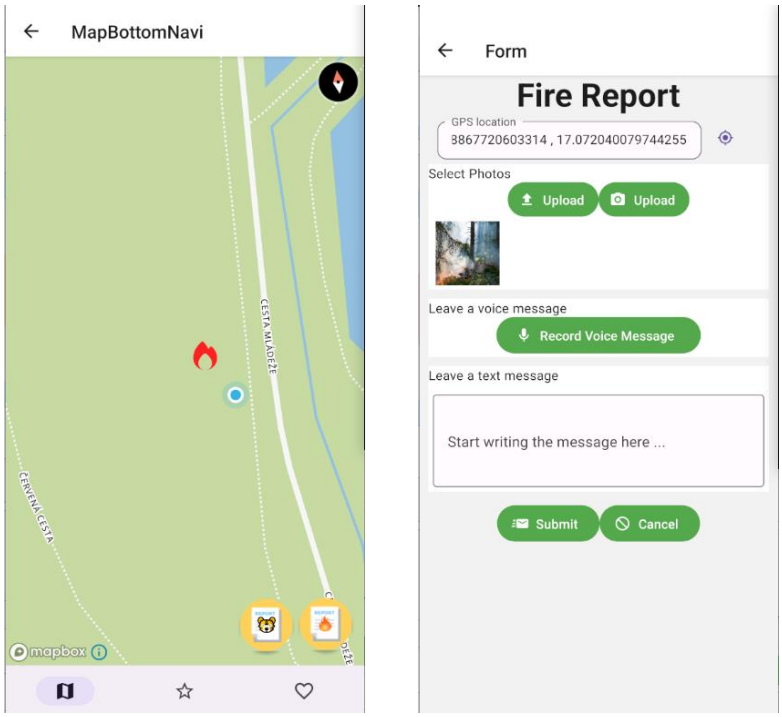


**Figure 4. The screenshots of the first version of the fire reporting and notification module of the SILVANUS mobile app. The left screenshot shows an interactive vector map with icons for reporting fire and dangerous animals. The screenshot on the right shows the fire reporting form.**

The SILVANUS CEMA, in addition to reporting and warning capabilities, provides a way to incorporate information from other SILVANUS user products too (i.e. Guidelines, tips and advice to citizens). For instance, the evacuation routes or a fire spread model prediction can be easily incorporated into the shown map in the CEMA.

The identified challenges and possible walkthroughs related to engaging citizens in wildfire include:

- Acceptance of the SILVANUS mobile app by the general public who are reluctance to install a mobile application is the major challenge due to narrow focus and infrequent use of the app;
- The infrequent appearance of the local citizens in the forest area;
- The reluctance of the mobile app owners to share data;
- False-positive or malicious fire reports;
- Unavailability of internet connection in remote areas.

We try to tackle these challenges by designing specific functionalities by:

- Providing additional, more frequently used channels that are more useful to the general public, making the SILVANUS mobile application more attractive to them. For example, general municipal announcements, activities in the local area, etc.
- The mobile app focuses on specific user groups with a higher probability of occurrences in the forest area, i.e. hikers, runners, cross-country bikers, landowners, foresters, etc. The mobile application allows sharing information using other channels, such as reporting and warning against dangerous animals, information about terrain traversability, etc.
- The shared data should not provide private information about the mobile app owner.
- The operational centre should be able to verify the fire reports by back-call to the reporting user. If the user is unavailable, the operator may choose to ask/call some other SILVANUS app user in the area.
- The user has preloaded data relevant to the current location, updated when reconnected to the Internet.

To design posters and campaigns, we needed to know what topics are essential for raising awareness in citizens about wildfires. Our focus group studies are ongoing now, and we have identified several topics based on expert views, e.g., firefighters and relevant authorities. We still need to complete our study, and the data collection and

analysis are still ongoing; however, we could identify the following topics as examples that can lead to citizen awareness. They are:

- Protecting houses against wildfires
- Barbeque prohibition in or near forests
- Use of the fire extinguisher
- Making a family emergency plan
- Camping safely
- What to do when noticing wildfire
- What to do if you are near a wildfire
- What to do if the fire reached you
- Wildfire causes
- Importance of forest ecosystems
- Evacuation in case of wildfire
- Forest awareness
- Biological diversity and fire protection
- Fire risk maps
- Tips and advice for citizens living next to a forest area
- Tips and advice for citizens in the forest/countryside
- Orientation and pathfinding
- Important phone numbers, websites and social media channels

We have designed several posters regarding these topics, and the evaluation of how they may affect citizen awareness will be studied and presented in the future. Figure 5 shows an example of some posters that can be used for citizen engagement and raising awareness.


**Figure 5. Examples of posters designed for citizen awareness in wildfire management**

There are also challenges to evaluating the effect of the mentioned methods, for example, on citizen awareness and how it might be possible to measure that. It is part of the study, and we are investigating different methods, for example, counting the involved citizens, using QR codes, etc. The result will be published later when the study is done.

Our citizen engagement framework also shows that other modalities, such as workshops and training programs, can enhance citizen awareness and change citizen attitudes and behaviour regarding wildfires. These methods and other methods are under study and development. We are conducting focus groups and observation (field study) to investigate these methods and their related challenges, their effectiveness and how to evaluate their effects on citizens to raise awareness and change citizens' attitudes or behaviour concerning citizen engagement in wildfire management.

In our short field trip to Gargano National Park in Italy, we were in contact with the Park Management Authority, Civil Protection and Arif - Puglia regional agency for irrigation and forestry activities and with the participants of the World Orienteering Competition, who were well aware of the need to protect forests from fires. The observation has proved once again that the citizens are not a homogeneous group and that multiple communication channels need to be engaged to attract them to be actively involved in fire prevention activities, especially in

places as popular among local and international tourists as Puglia's coastal forests.

## CONCLUDING PART

To fulfil the first objective, we have used previous research (Bandura, 2001; Copes-Gerbitz et al., 2022; Durkin et al., 2020; Gorriz-Mifsud et al., 2019; Eckerberg & Buizer, 2017) and our own data and have developed a tentative citizen engagement framework presented in figure 2. To fulfil the study's second objective, we presented preliminary results from our survey study, focus groups and parallel studies in the Silvanus project about the related citizens' needs and challenges, different groups of citizens, and related engagement methods, including designing a mobile app and also posters. This facilitates the design of technologies and training materials appropriate and valuable in wildfire management. We attempt to do this with regard to possible legal, organisational, and ethical concerns, for example, to avoid ambiguities in actors' responsibilities and find formal mechanisms to prevent conflicts and prioritise tasks (Yousefi Mojir, 2018; Pilemalm & Yousefi Mojir, 2020). The result may be applied to other types of crises; however, the communication methods and messages to involve citizen groups may differ.

This study is a work in progress. We are conducting different focus groups, interviews with citizens and field studies in different countries (e.g., Greece, Slovakia, Italy) to extract the more precise citizens' needs and challenges for involvement in wildlife management. We are also identifying the relevant topics for citizens training and developing related engagement methods (e.g., posters, campaigns, workshops) and a mobile app to facilitate communication between citizens and authorities. Furthermore, developing the citizen engagement framework and appropriate methods and evaluating the effectiveness of these methods in citizen engagement will be the focus of this work-in-progress in the future.

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