Wildfire Education: A Review Across the Globe

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Abstract Recent projections suggest that wildfires will occur more often and with higher intensity due to the changing climate. In this context, it is vital to educate the population to be ready and prepared to deal with these events. This book chapter reviews the state of the art of educational materials on wildfires worldwide that are available online. A total of 225 references on the matter were retrieved. The materials are from all five continents, involving 36 countries and written in 23 languages. Most of them are from regions with a Mediterranean climate with fire-prone ecosystems in which, for the last decades, wildfires have negatively affected the population. Regarding the target audience, most materials retrieved focused on the general public (about 48%), followed by students from various age groups (around 40%). Written documents, websites, and videos are the most frequent materials for the general public. As for students, a greater variability of pedagogical materials is available, ranging from mobile phone applications and digital and experimental activities to slides for classes and reading materials. The remaining materials focus on the rural population and firefighters' training. Most references present the main concepts and ecological aspects of fire, along with safety and prevention measures. However, few discuss climate change, recovery, and socio-economic or health concerns. This gap should be addressed in the future wildfire educational materials to better prepare and inform society.

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1 Introduction

Predicting the future of the planet under the influence of climate change is among the most pressing issues of our time, along with understanding its impacts on our civilization (McNutt, 2013). Furthermore, climate change might increase the challenges linked to environmental, social, and economic changes (Keenan, 2015), such as the recurrence and intensity of large wildfires, the escalation of people migration, and the loss of biodiversity. These risks and impacts will manifest globally, as few cultures and territories will escape their influences in coming decades, whether in cities in the developed world or resource-dependent subsistence economies (Adger et al., 2013; Plana et al., 2021). Adapting to climate change requires understanding the role of climate on the ecosystem, industries, and communities. This requires multiple forms of knowledge and new approaches to management decisions in various sectors, including forest management (Keenan, 2015).

In what concerns wildfires, more extreme and frequent events are among the challenges posed by climate change, as seen in recent decades worldwide (Amatulli et al., 2013; IPCC, 2022). Also, IPCC (2022) reflects on the increase in the fire season, particularly in the Mediterranean climate. In recent years, catastrophic wildfires occurred worldwide, affecting particularly the life and safety of thousands of people (fatalities, injuries, and evacuation from their homes), putting in plain sight the need for a more aware and educated society to face this risk (Fernandez-Anez et al., 2021; Grant & Runkle, 2022; Molina-Terrén et al., 2019).

Education plays a key role in the prevention and preparedness for wildfires (Colaço et al., 2018; Pardellas et al., 2018). Education influences how responsible institutions and individuals deal with certain issues related to various risks and make long-term changes. In addition, in many cases, education works well with the public and prevents emergencies before they happen (Knox, 2018). Wildfire education efforts encompass various methods, including public service announcements, distributing brochures, and making presentations, which are intended to prevent and/or mitigate negative fire consequences (Prestemon et al., 2010). Simultaneously, several pedagogical campaigns focusing on students and teachers or inhabitants in risk areas occur in different countries (Colaço, 2017). However, in the face of this new reality, where extreme fire events surprised communities and different authorities like Forest Services or Civil Protection Agencies (Portugal 2017, Greece 2018, Chile 2018, USA 2017, Australia 2018), the need for more information and education became very clear.

Considering this pressing demand to inform and educate the population about the need to adapt and prepare for wildfires, especially in the context of climate change, the present book chapter aims to review the wildfire educational materials state of the art

worldwide. Additionally, limitations and suggestions for future wildfire educational content are made.

2 Materials and Methods

Online searches were conducted to find and select the wildfire and forest materials to be included and analyzed in this review. The searches took place between July and September 2022. The keywords "forest", "fire", "wildfire", "educational", "didactical", "pyrology", "forest fire guide", "guide", "manual", and "handbook" were typed into Google's search engine (social networks posts were not included in this study). The previous terms were associated in multiple ways to maximize the number of retrieved results (e.g., "forest" + "wildfire" + "handbook"; or "forest fire" + "educational" + "guide"). Following a snowball literature search type method, in which previous results inform the next searches (Lecy & Beatty, 2012), more results were found from new web links and bibliographic references.

The search was aimed at finding literature for all possible audiences: schoolchildren, students, firefighters, technicians, as well as general public. In order to get more accurate results on a global scale, the searches were conducted in the following 21 languages, as they were the ones the authors were able to read: Bulgarian; Czech; English; Estonian; Finnish; French; German; Greek; Icelandic; Italian; Kazakh; Latvian; Mongolian; Polish; Portuguese; Roman; Russian; Spanish; Swedish; Turkish, and Ukrainian. Additionally, Catalan, and Galician references were also included although the languages were not explicitly searched, totaling 23 languages.

Next, a document analysis was used to examine the general content of the educational material retrieved. This is a systematic procedure applied in the review or evaluation of documents, such as institutional programs. As a research method, document analysis is applicable to produce detailed depictions of a single program or policy (Bowen, 2009), which constitutes an adequate approach for this study. The characterization of the content was done according to the information given in Table 1, which was developed to structure the document analysis. This characterization did not address the quality of the documents, it only describes the subjects presented in the materials.

Next, the results of the content analysis process are shown. The main trends identified are described, and the knowledge gaps are highlighted in the discussion. Finally, based on the analysis results, suggestions on the way forward for forest and wildfire education are made.

Table 1 Topics examined in the document analysis performed in the review process

Topics analyzed	Categories
Country	Country for which the content was developed
Target audience	• General public • Firefighters • Students[a] – Pre-school (ages from 4 to 5) – Elementary school (ages from 6 to 10) – Middle school (ages from 11 to 16) – High school (ages from 17 to 18) – K-12 (ages from 4 and 18) – College (over 18) • Rural population
Material format	• Written documents • Video • Website • Activities • Slides • Book (written documents with an International Standard Book Number-ISBN) • Phone application (APP)
Subjects	• Climate change • Ecological aspects of wildland fires • Economic concerns • Fire effects • Fire management • Fire mitigation • Fire prevention • Fire regimes • Fire risk • Fire safety • Fire triangle • Health concerns • History of humans and fire • Legislation/policy • Main fire concepts • Recover • Response • Social concerns • Uncontrolled fire versus controlled fire

[a] Since school names and structure change according to the local educational system, the age range considered in this study is indicated

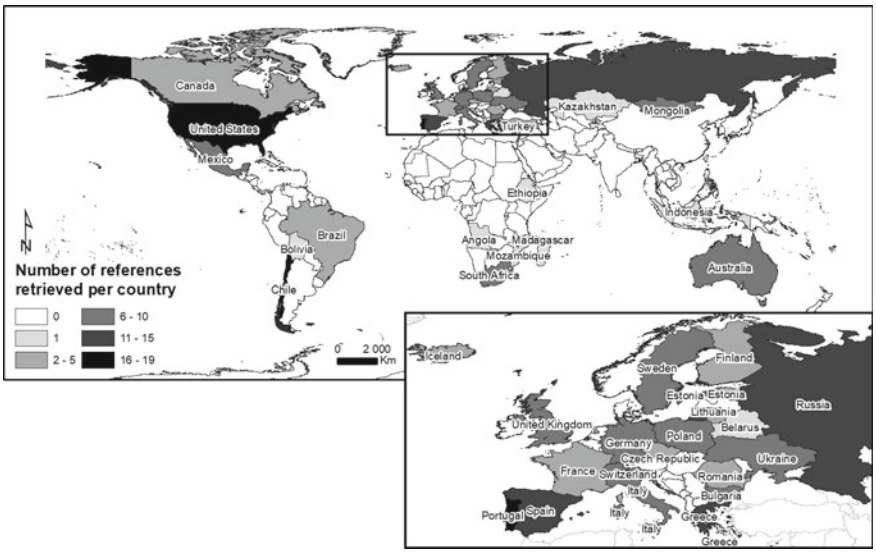

Fig. 1 Number of references retrieved per country. Searches were conducted on Google between July and September 2022

3 Results

After three months of online search using multiple associations of the established keywords, a total of 225 references on wildfire education were retrieved from the five continents.[1] Figure 1 shows the number of references found per country.

Materials were found from 36 different countries, as well as two references that dealt with global wildfire issues. Then, the target audience for each of the materials was analyzed. Some of them were focused on specific groups, such as the firefighters and rural population, while others targeted broader audiences. Figure 2 shows the distribution of the retrieved references according to their target audiences.

Most of the information and educational materials found were targeted at the general public (about 48%), followed by students from various age groups (around 40%). The other more specific target groups accounted for around 11% of the total. Some materials were intended for more than one group, such as firefighters and the general public. As for the format of the educational references, there were multiple mediums and sets of materials. Figure 3 shows the distribution of the total retrieved content format and its associations.

Most of the educational content is presented exclusively in a document written form (about 44%), usually through a wildfire guide or manual. Websites are also a common mean to share educational content (about 30% of the references). More

[1] Spreedsheet with all references available here: https://tinyurl.com/WildfireEducation.

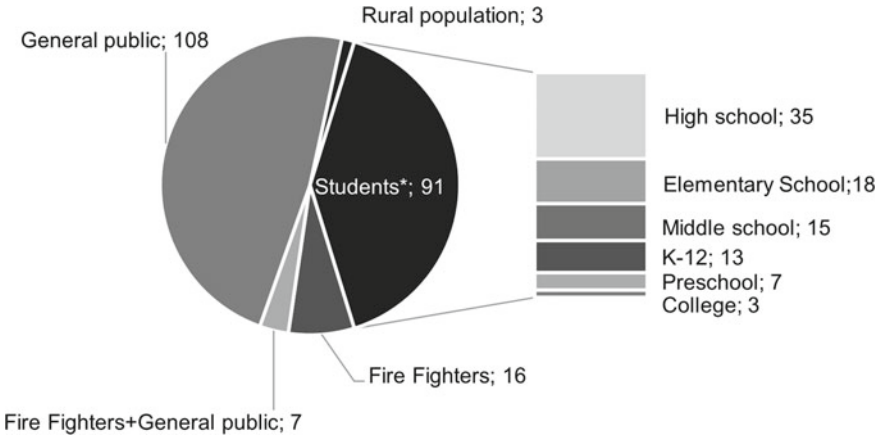

Fig. 2 Distribution of the total retrieved materials according to their target audience. *Students: Pre-school (ages from 4 to 5); Elementary school (ages from 6 to 10); Middle school (ages from 11 to 16); High school (ages from 17 to 18); K-12 (ages from 4 and 18); and College (over 18)

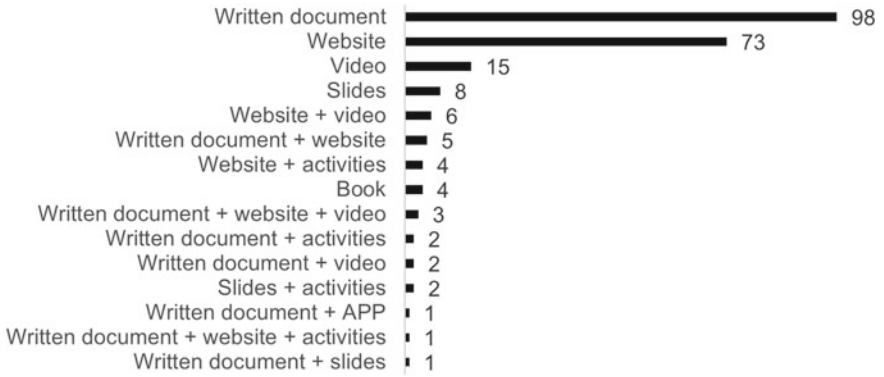

Fig. 3 Distribution of the formats in which the educational materials are provided

modern means of information sharing, such as phone applications, were not retrieved often.

Regarding the topics addressed per reference, it was possible to analyze the content of 218 materials, as a few of them were paid or not fully available online. Most of them encompassed multiple issues varying from the basics of fire chemistry up to fire safety and policy issues. Table 2 gives the percentage of educational materials that addressed each of the topics.

Most materials cared to describe the main concepts and ecological aspects surrounding wildfire occurrences. Fire safety, prevention, and risk were also among the most addressed topics. Issues related to climate change and socio-economic matters had the least focus among the retrieved materials. Finally, it was possible to

Table 2 Topics addressed by the retrieved didactical materials

Topics	% of references (%)
Main concepts	65
Ecological aspects of wildland fires	56
Fire safety	55
Fire prevention	53
Fire risk	53
Fire management	46
Fire regimes	38
Response	32
Fire triangle	28
Fire effects	26
Fire mitigation	22
Uncontrolled fire versus controlled fire	21
Legislation/policy	17
Climate change	16
Recover	14
History of humans and fire	12
Economic concerns	10
Social concerns	9
Health concerns	7

determine the date of 216 references that were made available. It was observed that they were all released between 2000 and 2022 (Fig. 4).

It should be highlighted that most of them (around 83%) were developed in the last ten years. Moreover, it is possible to note that after 2017, a year with major wildfires in places such as Portugal and California, the number of materials released shows an increasing trend.

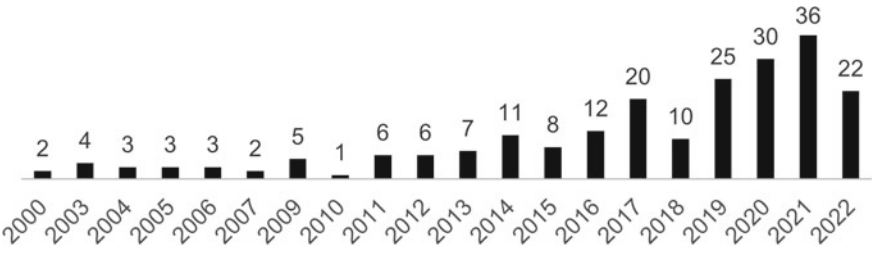

Fig. 4 Distribution of the release year of the wildfire educational materials retrieved

4 Discussion

About 40% of the retrieved educational materials were elaborated in countries that have experienced recent and intense wildfire events, namely the USA, Portugal, Chile, Russia, Spain, and Greece (BBC, 2017; Dixon, 2021; Euronews, 2022; Firstpost, 2017; NIFC, 2022; Voanews, 2022). Also, in terms of the distribution per country, more than 50% of the references are from nations with Mediterranean-climate regions. These regions are present in all five continents (Rundel, 1998). Although they only occur on about 2% of the world's total land area (Dallman, 1998), these climatic regions are major centers of human population (Montenegro et al., 2004) with major economic damages due to wildfires (EM-DAT, 2022). Regarding its global land area distribution, Mediterranean-climate regions are 73% in the Mediterranean Basin, 10% in California; 10% in Southwestern Australia; 4% in Central Chile; and 3% in the Cape region (Rundel, 1998). The content retrieved per country in the search process follows this proportional distribution. This reinforces that these areas have a higher demand for educational materials targeted at their ecosystem reality, as they are fire-prone, and most are densely occupied by infrastructure and human population. In contrast, no references were found for countries like Latvia, which was targeted in this study's search. Perhaps, since the occurrence and area affected by wildfires have decreased in the last decades (GWIS, 2022), despite that the total area of forest land has nearly doubled (Donis et al., 2017), it has not created a demand for educational material on wildfires in Latvia.

As for other regions of Europe, the least information was found in the Nordic and Baltic countries. Among the Scandinavian countries, the largest amount of material was found in Sweden. Considering the dates of the publications from this country, they are likely a response to the wildfires that raged through large parts of Sweden in the summer of 2018 (Krikken et al., 2021). Another interesting fact is the quantity of material found in Central European countries, namely Germany and Switzerland. Nine sets of education materials found in Germany and six in Switzerland contain extensive information on many of the analyzed subjects. This can be explained by the strong forest tradition in these countries and their concern about climate change and wildfires.

As for the target audience, almost half of all found and analyzed references (about 48%) are aimed at the general public. Most of these materials are guides, manuals, websites, and a few videos. They mainly present basic wildfire concepts and focus on wildfire prevention and safety issues related to their community context. As programs that tailor their efforts to tackle local values and interests are more likely to be adopted (Sturtevant & Mccaffrey, 2003), it is interesting to observe that despite having similar information, most of the references tried to contextualize their content to reflect their local reality.

The next large target audience for wildfire educational materials are students (about 40%). Of the materials aimed at students, around 38% are specifically focused on the high school public (17–18 years of age). This can be explained by the larger capacity to address complex problems, their willingness to change the world (e.g.,

climate strike), and also by the benefits related to academic achievement and civic engagement (Ardoin et al., 2018). Furthermore, some of these materials include activities effortlessly integrated into the curricula of many disciplines of this level of education.

Very few references target the rural population. Perhaps, since the searches for this study were conducted online, some materials aimed at this parcel of the population were not retrieved. As this public is not necessarily technological-savvy, likely, educational materials that target them are not presented in a digital form. However, considering that many wildfires worldwide ignite in a rural setting, perhaps more effort should be put into communicating with this parcel of the population through multiple means, as it could potentially directly result in a lower number of fires and lead to better preparedness. In general, the communication means for rural communities are presented in paper brochures or posters, distributed door to door, and professional and popular fairs (Colaço et al., 2018; Pardellas et al., 2018).

As for the format in which the educational content is presented, most references rely on digital written guides, manuals, handbooks, or websites. This is especially the case when they target the general public. Few materials stimulated the public to interact with their local community and promote active forest and fire management and preparedness. In some cases, communication channels were indicated to engage the population further.

In contrast, a wider variety of means is observed when the target audience is students. This is probably pedagogically adequate, as the younger generations are digitally fluent, competitive, and are considered digital natives. Thus, transmitting knowledge, teaching, or reinforcing skills can use various digital didactic tools, like e-learning platforms, games, intelligent accessories, and instructional videos (Gawlik-Kobylińska et al., 2020). For this parcel of the population, more interactive activities were provided, including complete classroom lesson plans (CIRES, 2022). Even companies in the private forestry sector have developed interactive educational materials aimed at school-age children (Navigator, 2020). Furthermore, classical characters, such as Smokey Bear, appear in materials targeted at almost all age groups (USDA, 2007). The need for a mascot that represents a “cute” and “loved” animal continues to be used in different wildfire prevention campaigns (e.g., Raposa Chama (Portugal) with a fox, Mefitu (Spain) with a wolf or Bookie (South Africa) with a klipspringer).

For this study, the quality of the content provided in each reference was not analyzed. The goal was to map the main concerns and recommendations being conveyed to the various sections of the population. The results indicate a widespread concern about transmitting the basic knowledge regarding wildfire chemistry and physics and providing basic prevention and safety knowledge.

However, not many references tackled issues of a socio-economic nature. This is potentially a shortcoming of the educational references available, as people do not tend to expect to lose a house to wildfire, and showcasing the social benefits of adopting fire prevention measures may be more effective than highlighting only economic advantages (Sturtevant & Mccaffrey, 2003). This is perhaps a changing

reality as recent fires in many parts of the world have caused substantial material losses and many lives were lost. This might push for the development of more educational materials, including socio-economic issues related to wildfire prevention. Furthermore, programs that promote contact between neighbors can aid in developing a sense of community as they work collectively to lessen fuels across ownership boundaries (Lisa Langer & McGee, 2017; Sturtevant & Mccaffrey, 2003). A few community programs consider this, such as FireWise and FireWorks in the United States and FireSmart in Canada.

Finally, considering that most references were made available to the public in the last ten years, it is interesting to note that very few addresses climate change and its consequences for forest and fire management, as well as the history and culture of fire. This can also be considered a notable gap, as adopting principles and practices of sustainable forest management can provide a sound basis for addressing the challenges of climate change (Keenan, 2015), especially in the context of wildfires.

5 Conclusion

This study provided a content overview of the current state of the art of wildfire educational materials from 36 different countries. The diversity and content of the found materials, as well as their ability to satisfy the search for information about wildfire from an educational point of view, were analyzed. It was beyond this study's scope to analyze the content's quality but rather to map the type of information being communicated to the public. The results have shown that wildfire is a concern in all five continents, as fires eventually happen in every country. Nevertheless, more materials are available in developed and highly populated places with fire-prone ecosystems, such as Mediterranean-climate regions, suggesting the need to tailor the educational content to the local culture. Regarding the materials content, the most innovative approaches were targeted at students. Possibly, this is linked to the fact that this parcel of the population is more predisposed to learning and is familiar with more modern technologies. As the content search was conducted online, it is not surprising that the more advanced resources target a younger audience. Still, the general public could also benefit from more information content being available in multiple media. Furthermore, initiatives targeting not only individuals, but the entire community might be more successful, especially regarding fire safety.

Moreover, there was a lack of content regarding wildfire's socio-economic aspects, including health and trauma issues. Furthermore, considering that most references are from recent years, it is surprising that climate change is not one of the most addressed issues, as evidence indicates that it is one of the issues that is affecting fire regimes. As cultural perspectives partly explain the differences in responses across populations to the same environmental risks, and recent research shows that information about climate change does not connect with all cultures and worldviews in the same way, contextualization becomes essential. The development and adaptation of educational

materials on wildfires at the local level become a fundamental step in managing this risk and mitigating its consequences for society.

Finally, the literature suggests that wildfire education efforts appear to have persistence in the population, and some initiatives, such as Smokey Bear, have sensitized generations, which reinforces the importance of investing in the development of didactical/informational materials. In this sense, the present study has provided insights that can inform the development of wildfire educational content that is meaningful both from a broad and general perspective, as well as considering local cultural aspects.

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