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Abstract Information

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Abstract Title

Wildfire Evacuation - a case study of an isolated village in Portugal

Abstract Topic:

Human Behavior/Evacuation Modelling

Presentation Summary - Published in Program

This work is focused on the numerical simulation of a wildfire propagation, that was carried out to prepare an evacuation exercise in an isolated village. This village has only one road in and out and is located in central Portugal, which is one of the most vulnerable areas to wildfires in Portugal. The main goal of this evacuation exercise is to gather critical evacuation data, in particular clearance time data. The evacuation exercise was done in conjunction with wildfire propagation numerical simulation to get an idea of different scenarios of wildfire, the direction of fire spread, the time available before the fire reaches the community, and critical danger zones. The wildfire simulation was done using the Wildfire Analyst (Tecnosylva) package.

The results from this study show that the timing of an evacuation in case of wildfires is of great importance. Other challenges may rise in case of wildfire, for instance, the lack of rescue teams to help with the evacuation, which can increase the evacuation time. That being said, the advantages of shelter-in-place come to the surface in certain scenarios, as an evacuation may pose higher risks to lives.

Learning Objectives

The presentation will be focused on the following objectives:

- Estimation of the risk of evacuation;
- Prediction of the behavior and profile of the individuals involved;
- Study the impact of three scenarios as emergency plans for communities: evacuation, shelter-in-refuge and/or shelter-in-home (or partial combinations), providing guidance on circumstances that favor evacuation and those that do not.

Body of Abstract

**Abstract -
Introduction/Methodology/Conclusion**

Wildland fires have been recognized as a crucial field for research by the International Association for Fire Safety Science (IAFSS) agenda 2030 for a fire-safe world [1]. Over the past decades, an increasing number of severe wildfires have occurred due to climate change and global warming, each one breaking records after the other, even in areas normally not exposed to high wildfire risk, for example, the Nordic countries [1]. Wildland-urban interface (WUI) communities are defined as places "where humans and their development meet or intermix with wildland fuel" [2], which are the most vulnerable to wildfires, given their proximity. Moreover, other risks usually exist in WUI residencies, such as i) insufficient transportation infrastructures that don't develop enough in comparison to urban development, and ii) increase in population. For instance, many WUI communities are accessible by only one road, which can cause difficulties during evacuation [3]. Multiple fatalities occurring during wildfires have been reported as the consequence of difficulties during evacuations due to the inadequacy of rural roads. The inadequacy of the rural roads can cause congestion and trap the evacuees (e.g., Pedrogão Grande, Portugal, 2017). Moreover, delayed evacuation trigger alarms or delays in evacuation advice implementation are other problems that can cause locals to stay until the last minute and face hazardous situations [4].

Rodrigues et al. [5] investigated the causes of death in wildfires in 2017 in Portugal. In this research, the relation between several factors (such as age, location of death, the distance between the location of death and the residence location, as well as the decision to flee or evacuate), and the causes of death were investigated. Victims of such incidents are categorized into three groups: i) individuals who realized the threat to their life and had enough time to take protective measures but failed to choose appropriate protective strategies; ii) individuals who did not realize the real threats to their lives and iii) individuals who were physically unable to protect their lives. The analysis of data shows a very important fact: on average, 65% of the victims were people who fled or evacuated without orders or information from authorities but were killed during the process. This clearly demonstrates the importance that an effective, planned, and in-time evacuation may have in these incidents. In case of a wildfire, the unorganized evacuation will cost lives.

Beyki et al. [6] investigated the works done in the field of evacuation and evacuation modeling under the threat of wildfire. It was shown that evacuation data on people's behavior and decision-making, which are crucial for designing an evacuation model, are very scarce in cases of wildfires. Most of the available models used data from other disasters such as hurricanes, which cannot be applied to wildfires. Some research on evacuation strategies specific to wildfires has been done over the past few years, but most of them are for cases that occurred in the US. These evacuation strategies are not necessarily applicable to Europe.

This work is focused on the numerical simulation of a wildfire propagation, that was carried out to prepare an evacuation exercise in an isolated village. This village has only one road in and out and is located in central Portugal, which is one of the most vulnerable areas to wildfires in Portugal. The main goal of this evacuation exercise is to gather critical evacuation

data, in particular clearance time data (i.e. the time residents net to evacuate out of the danger zone and reach their destination). The evacuation exercise was done in conjunction with wildfire propagation numerical simulation to get an idea of different scenarios of wildfire, the direction of fire spread, the time available before the fire reaches the community, and critical danger zones. The wildfire simulation was done using the Wildfire Analyst (Tecnosylva) software package.

The village under study is Cabanões with an area of 25.13 km², with a total of 25 houses and 9 permanent residents. The evacuation exercise was carried out with 26 participants (9 local and 17 invited) and 75% of the participants were more than 65 years old. The drill was not a complete evacuation from the area and was directed to a shelter appointed inside the village area. The evacuation was done on foot from residencies to the shelter, with a number of incapables that needed help from rescue teams that would increase the time of evacuation. An air shot from the village is shown in Figure 1.

Figure 1. The village of Cabanões

In addition, the time considered for this drill was the minimum possible, meaning that the participants would leave their residence as soon as they received the evacuation order, without accounting for the time of required preparations before leaving the residence. The timeline data from the drill showed that it would take 5 minutes to inform all the residents of the evacuation order, 15 minutes to gather around at the designated meeting point, and 38 minutes to reach the designated shelter, which sums up to a total of 58 minutes. Figure 2 illustrates a part of the evacuation exercise.

Figure 2. Evacuation Exercise

Wildfire propagation simulations were also performed for different scenarios around the village area to get information about the time that is available to take protective measures. It was shown that in the best situations (i.e. very unfavorable conditions for fire intensity and progression, that is, with no wind and high humidity) there will be only 12 hours available before the fire travels 5km in a straight line, which is approximately two towns away from the village, to reach there. The simulations were done in reverse mode, which shows how much time is required for the fire to reach a specific point. To clarify, it will take the fire 12 hours to reach the village, if it starts from any point on the outer line of the contour presented in Fig.3.

Figure 3. Wildfire Simulation in reverse mode

The results from this study show that the timing of an evacuation in case of wildfires is of great importance. In case of a severe wildfire, the fire's rate of spread will be much faster that could travel the 5km in simulation in less than half of that time (less than 6 hours). Other challenges may rise in case of wildfire, for instance, the lack of rescue teams to help with the evacuation, which can increase the evacuation time. That being said, the

advantages of shelter-in-place come to the surface in certain scenarios, as an evacuation may pose higher risks to lives.

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