A Mobile Application to Support Decision-Making in the Context of Forest Fires

Igor Pimentel Gusmão Fragôso de Souza[1], **José Italo Alves da Silva**[1], **Mycaell de Oliveira Carneiro**[1], **Tiago Brasileiro Araujo**[1], **Jose Gomes Lopes Filho**[1]

[1]Instituto Federal da Paraíba
Monteiro – PB – Brazil

{igor.gusmao,jose.italo,oliveira.mycaell}@academico.ifpb.edu.br

{tiago.brasileiro,jose.filho}@ifpb.edu.br

Abstract. *The increasing number of forest fires in Brazil, allied to the difficulty of fire fighting in vegetation areas, becomes a motivation to apply technological resources to support the fire fighting in forest areas. Therefore, this work proposes the development of software able to collect data from different data sources and provide useful information to fire brigades, supporting the strategic planning as well as assisting the firefighters involved in fire fighting.*

Resumo. *O crescente número de incêndios florestais no Brasil, aliado à dificuldade de combate a incêndios em áreas de vegetação, torna-se uma motivação para aplicação de recursos tecnológicos de apoio ao combate a incêndios em áreas florestais. Portanto, este trabalho propõe o desenvolvimento de um software capaz de coletar dados de diferentes fontes de dados e fornecer informações úteis aos bombeiros, auxiliando o planejamento estratégico, bem como os bombeiros envolvidos diretamente no combate às chamas.*

1. Introduction

According to data from the *Programa de Queimadas*[1] of the *Instituto Nacional de Pesquisas Espaciais* (INPE), the number of fires in Brazil in 2020 increased by 12.73% compared to 2019. Also according to data from the *Programa de Queimadas*, this year the number of fire outbreaks in Brazil has already surpassed 180,000 between the months of January and November. Moreover, the *Laboratório de Aplicações de Satélites Ambientais*[2] (LASA) asserts that the Pantanal region lost 28% of its forest due to fires, which represents an area of 4.2 million hectares. In this sense, it is important to emphasize that fires generate not only environmental impacts, but also economic impacts for the country and the region where they occurred.

Fire fighting in vegetation areas is hard and complicated, requiring technique, expertise, and planning from the part of the firefighters involved. Moreover, commonly is a scenario that requires dozens of firefighters and different kinds of flame-fighting resources. Therefore, the task of fighting forest fires presents different difficulties, such as the recognition of the affected area (presence of water sources, relief, and nearby roads),

[1]https://queimadas.dgi.inpe.br/queimadas/portal (Accessed in 04 of December of 2021)
[2]https://lasa.ufrj.br/

strategic planning to fight fires, and the deployment of personnel and equipment (cars, trucks, and flame-fighting items) [Komalapati et al. 2021].

On the other hand, even we live in a technological society, most part of the fire brigades in Brazil does not have any kind of software that supports firefighters. This scenario reinforces the need for technological means that help decision-making by the fire brigades, in an agile and efficient manner [Çolak and Sunar 2020]. For this reason, the present work proposes the development of software[3] able to collect data from different data sources and provide those data in a clear way to the fire brigades, supporting the strategic planning as well as assisting the firefighters involved in fire fighting.

2. Theoretical Foundation

According to the works [da Silva et al. 2018, Caetano 2021], the impacts caused by fires in forest areas cause irreparable damage not only to the environment but also to the country's economy. Therefore, with the increasing number of fires throughout Brazil, combined with the limitations of contingent and equipment in fire brigades, becomes necessary the application of approaches that assist the decision-making and action planning to combat the forest fires. Among these approaches, the application of technology (software and sensors) emerges as one of the most promising [Çolak and Sunar 2020].

Although technological tools have been applied to combat and prevent forest fires, especially through the use of satellite images [da Silva et al. 2018] or support software [Çolak and Sunar 2020], there is a lack of approaches able to centralize a large number of information in portable devices such as cellphones and tablets [Komalapati et al. 2021]. To the best of our knowledge, none of the fire brigades in Brazil apply software similar to the one proposed in this work. For this reason, [Vargas-Cuentas and Roman-Gonzalez 2021, Çolak and Sunar 2020] highlight the importance of applying complementary data to support the planning and actions related to fire fighting. Thus, the development of a mobile application able to provide useful information to firefighters before, during, and after the fire-fighting, allows financial gains (in the sense of equipment and staff management), environmental (preservation of fauna and flora), and politics (better management and allocation of public resources).

3. Research Methodology

The architecture of the proposed software is divided into two components: back-end and front-end. The back-end is responsible for collecting the information provided by different sources, storing the data and sending the useful information to the mobile application. The front-end is represented by the mobile application, where the users (i.e., the firefighters) can access the information provided by the back-end to support the fire fighting.

Since the back-end receives streaming data from external data sources and the application also constantly consumes the stored data, the RealTime Database from Firebase is applied. In this sense, a Python algorithm connects to the external data sources, processes the data in terms of standardizing and cleaning, and stores the data at RealTime Database. Regarding the front-end (i.e., the mobile application), the framework React Native is applied, which allows the development of applications for Android and IOS

[3]https://github.com/DataLab-IFPB/IncendioFlorestal-Mobile/

platforms using the same source code in JavaScript and TypeScript languages. The React Redux toolkit manages the information exchange between back-end and front-end, since it is commonly used to allow and control requests between components. The architecture and all the selected technologies and frameworks were chosen in the sense of achieving efficiency, security, and availability to the proposed software.

4. Results

As a result of this work, a mobile application to support fire brigades was developed. To this end, the proposed mobile application works in the sense of providing to the firefighters an access point of information regarding weather, geolocation of fires, relief, and aspects of the places where the fires are located (such as roads, water sources, and buildings).

At the back-end, two algorithms are constantly running to receive information about fires and weather conditions in a real-time way. To collect information about the fires, the API FIRMS[4] was applied. FIRMS is a NASA project which provides the records of fires that were captured by satellites around the world. Among this data, in this work, the following information is collected and stored: geolocation of the fire (latitude and longitude), the timestamp when the fire was identified, and brightness of the fire (high brightness implies intense fire spots, while low brightness implies small fire spots). Regarding the weather data, the Weather API was applied. This API provides weather conditions for a particular location in an informed timestamp. Therefore, the Weather API[5] was applied to collect weather data, such as wind speed, temperature, humidity, and precipitation chances, for the current location of the user as well as for each of the fire spots collected from FIRMS. Notice that, from the data of both APIs, it is possible to get real-time data and support the firefighters with useful information regarding the location of the fires and their weather conditions. Beyond the data being helpful to firefighters during fire fighting, it also can be used as historical data, guiding the fire brigade planning throughout the year.

From the data collected by the back-end component, the front-end works in the sense of showing the information in a user-friendly interface. To this end, as a first step, the user should log in to the application with the credentials, which enhances the security of the application and avoid non-accredited users accessing the application. After that, the user will see a map will all the collected fire spots plotted over this map. Since this project has focused on Paraíba state, only the fire spots located in this region will appear. However, this project can be extended to provide information related to all country and benefit other fire brigades.

As illustrated in Figure 1, the user can switch for different styles of map views: terrain map (relief), satellite, road map, and hybrid (with roads and terrain information). Furthermore, the mobile application shows the exact location of all the detected fire spots, assisting the firefighter to understand the neighborhood aspects (such as near roads, mountains, buildings, or water sources), which can support or hamper the fire fighting. In cases where the FIRMS may not report the fire, the application allow the user to manually add the fire spot on the map. For this reason, there are two different colors of fire spots: red (registered by FIRMS) and yellow (registered by users). Pressing in the fire spot icon, it is possible to visualize additional information regarding this particular fire spot, such as

[4]https://firms.modaps.eosdis.nasa.gov/

[5]https://www.weatherapi.com/

name of the city, weather condition and timestamp when the fire started. In cases where the user add the fire spot, also appears the register of the user as additional information. Regarding the weather condition for the location of the user, on the top of screen, there is a black bar with four climate metrics helpful to the firefighters: wind speed, temperature, humidity, and precipitation chances. Hence, it is important to highlight the importance of this mobile application in terms of providing useful and current information to the firefighters through their smartphones, even during the challenging task of fire fighting.

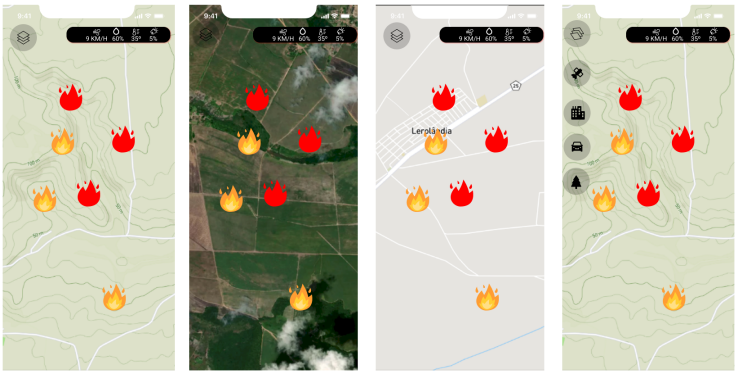

Figure 1. The main screen of the proposed application, with the multiple styles of the map and the fire geolocations.

5. Conclusion

Based on the stated challenges related to the fire fighting task allied to the lack of resources and equipment at the fire brigades, the present work proposes the development of software able to collect data from different data sources and provide those data via smartphones to the fire brigades. The developed software is currently in beta tests phase, the feedback was encouraging and the future steps are related to performing technical adjusts on the software and extending the project to other fire brigades. This work was funded by the Institutional Program Chamada Interconecta IFPB - Nº 02/2021.

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