







'Portugal Without Fires', A Data Visualization System to Help Analyze Forest Fire Data in Portugal

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Abstract. The year 2017 was relatively tragic concerning the fires in Portugal. The scourge that settled in the country and the loss of countless human lives were engraved in the Portuguese memory. Due to extraordinary weather conditions and a lack of powerful means to immediately respond to the tragedy, more than a hundred citizens lost their lives in forest fires, some of them in severe conditions, in the middle of the forest and without a chance of escape, burned in cars as they fled. This paper presents the development of an integrated visualization system, exploring data acquired over the period of last ten years of Portuguese Forest Fires. The data was extracted from multiples of official public sources and formats, analyzed and classified accordingly. Advanced graphics and data-intense processing techniques provide distinct outputs, results, and correlations on acquired sources. This project contributes to innovative data analysis and reports perception, and it is intended to fit the expectation and needs of forest fires experts in crisis scenarios, representing an add-value for transformative co-decision.

Keywords: Data visualization · Data analytics · Big data · Wildfires
Interaction · Co-decision

1 Introduction

Decision making in environments characterized by the uncertainty and unpredictability of several variables is a very demanding task. If, on the one hand, this decision can be hampered by the lack of data, on the other hand, if the data exist, the ability to process and handle it and to get the expected answers, in a timely and efficient manner, also requires considerable effort and expertise. Interactive data visualization facilitates this process by allowing users to navigate, select, and display data via an easy-to-use interface [1]. Indeed, being vast and dynamic data sets, most of the times dispersed in multiple sources and formats, collecting, interpreting and analyzing it, requires time and complex processes. The capacity to quick and easy visualize such data, extract useful knowledge and information timely, represents a critical service of enormous interest and usefulness in contexts where rapid and agile decisions are required.

Scenarios of natural disasters or accidents are examples of such cases. Near real-time continuous multidimensional data analysis, discover and explore existing correlations and predicting results, are effective services that must be supported. According to experts on wildfires, the uncertainty caused by (i) the quantity and types of involved resources (persons, technicians, vehicles) and (ii) the amount, variance and variety of influencing data (time, humidity, temperature, wind, orography), the existing and used integrated strategies of experts, communications and information systems are not sufficient to support timely and right decisions.

This work intends to develop a set of novelty services for data processing and useful visualization, applied to Portuguese forest fires events, of the last ten years. It intends to contribute to demonstrate that collecting and processing scattered heterogeneous data, using advanced analysis and processing mechanisms such as Big Data, exploitable with advanced visualization data-intense graphics libraries, provides operational near-real-time context-aware information for simulation, monitoring, management and assessment of fire risk and impact scale. The ability to make timely decisions based on available data is crucial to disaster management [2]. It is thus critical to investigate and establish connections of different order among the acquired data, to promote awareness of its correlated information, as exploring large collections of data becomes increasingly difficult as the volume grows [3].

The project presented here also aims to enable the public, in general, to become aware of and establish interconnections between the various fire incidents occurred in Portugal, understanding bonds of causality, through an interface that is desired to be functional and useful for civil protection authorities.

2 Background and Related Work

Wildfire is a global problem that put forward several studies and developments for analysis, prevention, detection, and reacting against these kinds of problems. Existent technologies and solutions like satellite-based systems, embedded integrated systems, sensors networks, high processing data capacity, give us almost near real-time data from fires and climatic conditions [4, 5]. Since 2007, the Council for Scientific and Industrial Research (CSIR) developed the Advanced Fire Information System (AFIS) that provides almost in real-time information for the prevention, monitoring, management and assessment of wildfire as a risk or hazard to society on a local, regional and global scale, as well as Europe, that works towards the European Forest Fire Information System (EFFIS), a Global Wildfire Information System (GWIS) [6]. Among others, both initiatives show that this still is a severe problem.

Portuguese scenario is characterized by scattered data in distinct formats and multiple sources and not integrated information systems (IPMA [7], ICNF [8], POR-DATA [9], APA [10], MAI [11]). Collect and analyze this data is not easy, as our ability to generate information now far exceeds our capacity to understand it [12]. The existence of integrated processes and visual systems to display correlated information is essential to support quick and efficient responses, as visual displays provide the highest bandwidth channel from the computer to the human [13].

3 Portugal Without Fires

The solution explored in this work represents a responsive data visualization service, following a cloud pattern architecture with (a) a no-relational database (NoSQL) repository to store the multiple structured data (JSON) collected from varied sources [7–11]; (b) an API of REST services to explore the repository; and (c) an interactive visualization graphical system that behaves as an integrated interface to support analysis and perceptions of past and present scenarios, and helps predicting future occurrences.

4 Technical Development

The data was extracted from multiples official public sources and formats, analyzed and classified accordingly, following complex ETL processes and several scripts processing. The application was developed using Processing, MongoDB as a repository and RESTful services in PHP7. The frontend dashboard was developed from the scratch, integrating several existing libraries. Particular emphasis to library ControlP5¹ that lets the user visually filter the information and decide what to see, giving a personal experience while using the application, and library ANI² that offers animations on transactions and information display. This demo represents fires, between 2007 to 2017.

5 Data Visualization

The application was thought to be used by generical public and was produced with a simple and minimalist interface. Usability heuristics, proposed by Jacob Nielsen [14], were highly considered [15]. The application starts with the explicit links to the main sections with direct access to national statistics, an interactive map, meteorological section and an obituary (Fig. 1).



Fig. 1. The visualization's main screen.

¹ <http://www.sojamo.de/libraries/controlP5/>.

² <http://www.looksgood.de/libraries/Ani/>.

After filtering, a second graphic offers a visual comparison of the results for selected criteria. At the same time, the map on the left of the screen changes the color of the districts. If the user crosses over the district area on the map, the graphical information about the burned area appears (Fig. 2).

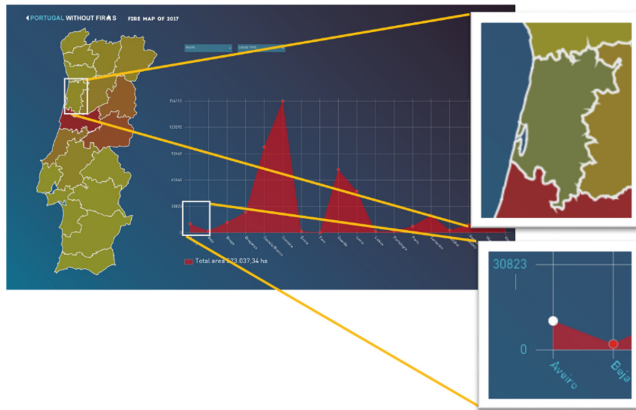


Fig. 2. Data visualization frontend. By selecting districts on the left, fire information appears on the right side.

To have a detailed perspective about a region is possible to click on and jump to another screen with more detailed data of the municipalities in the selected district. It is possible to analyze the causes of fire and check the areas of Portugal with more damage.

2017 was a dramatic year in Portugal [16]. To demonstrate this impact, we created a screen that shows the number of deaths of civilians and operational professionals by the fires (Fig. 3).

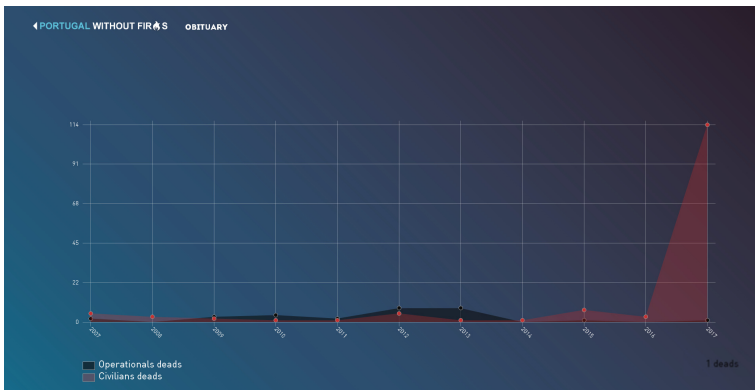


Fig. 3. Obituary section on data visualization frontend.

Because the project involved the research of different sources of information, in the proposed visualization system we collect graphically, and through a timeline, different information that, when combined, provide a perception of the problem and indicates the possible associated causes. Figure 4 represents the comparison of the total burned area with the number of occurrences. Having these results, it was possible to associate the number of active firefighters in each period.

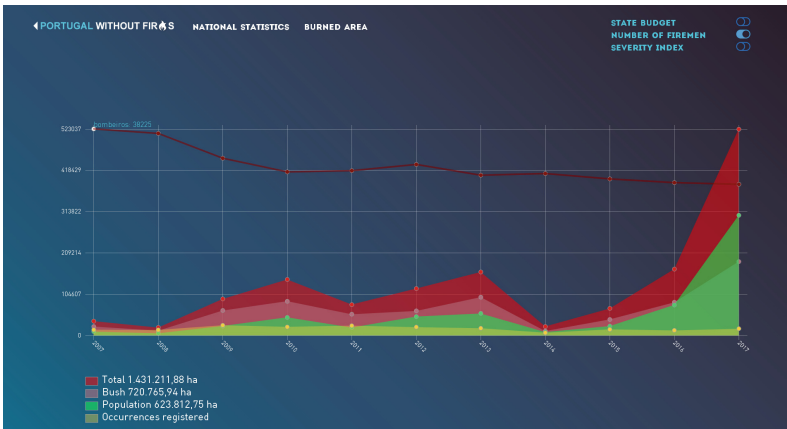


Fig. 4. Comparing data from different sources of information.

6 Conclusions

This paper describes an integrated data visualization interface that offers a set of innovative analysis services over forest fires occurrences data, bringing a new perspective about the fires in Portugal in the period of 2007–2017. Several distinct data sources were selected and processed; extraction processes were implemented and applied, and acquired data was preserved and classified accordingly in non-structured repositories. Using graphics libraries, several visual and data analytics services are possible to explore, and many results can be correlated, easily.

After some public presentations, the application results and knowledge that was transmitted made a significant impact on the audience's sensibility. During the MSc public presentation of the proposed solution, occurred in April 2018 at IPCA, assistants witnessed a set of information that offered them a new perspective on the forest fires problematic in Portugal. The project was then presented in an institutional meeting at ANPC - Portuguese Authority for Civil Protection, in May 2018. According to that institution, the most relevant result of this visualization system is the existence of a global and integrated data visualization tool and the possibility to dynamically analyze any result in multiple perspectives, in such fluent way, towards a more in-depth analysis of the fire problem and causes. They further strengthen the possibility to remotely analyze distinct contexts, providing real indicators for authorities and contributing to co-decisions and co-analysis, an evident advantage for a more in-depth analysis of the fire problem and causes.

A video demonstration of the data visualization system can be observed at: http://web.ipca.pt/mei/portugal-without-fires_papper-assets/video.mp4.

Acknowledgements. We thank the Civil Protection Service of the Municipality of Esposende, especially in the person of Engineer Carlos do Carmo, who facilitated access to the data that served as the basis for this work. To our families, while we were working on this project. We also dedicate this research to all the families that lost their relatives in the tragic forest fires in Portugal, in 2017.

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